Trends in Perinatal Transmission of HIV/AIDS in the United States

Mary Lou Lindegren, MD
Robert H. Byers, Jr, PhD
Pauline Thomas, MD
Susan F. Davis, MD
Blake Caldwell, MD, MPH
Martha Rogers, MD
Marta Gwinn, MD, MPH
John W. Ward, MD
Patricia L. Fleming, PhD

PERINATAL TRANSMISSION OF human immunodeficiency virus (HIV) accounts for 90% of pediatric acquired immunodeficiency syndrome (AIDS) cases in the United States and almost all new HIV infections in children. An estimated 6000 to 7000 infants were born to HIV-infected women each year from 1989 through 1994; by 1995, more than 16,000 perinatally HIV-infected children had been born. In 1994, the Pediatric AIDS Clinical Trials Group (PACTG) protocol 076 demonstrated that zidovudine administered to selected HIV-infected pregnant women and their newborns reduced perinatal transmission rates by two thirds. In August 1994, the US Public Health Service recommended zidovudine to reduce perinatal HIV transmission and, in July 1995, routine HIV counseling and voluntary prenatal testing. Observational studies have confirmed the effectiveness of zidovudine in reducing perinatal HIV transmission in groups that include women with advanced disease, women with prior use of zidovudine, and women treated with short-course prenatal zidovudine. Recently, the number of perinatally acquired AIDS cases has declined. To assess the effect of prevention on the perinatal HIV epidemic, we analyzed nationwide, population-based data on AIDS incidence and data from states with HIV surveillance. Our objectives were to characterize trends in perinatal AIDS incidence and identify contributors to changes in AIDS incidence. We examined trends in AIDS and *Pneumocystis carinii* pneumonia (PCP) incidence among infants because changing rates of perinatal HIV transmission would be reflected earliest in AIDS trends among infants, who represent incident infections.

Conclusions According to these data, substantial declines in AIDS incidence were temporally associated with an increase in zidovudine use to reduce perinatal HIV transmission, demonstrating substantial success in implementing PHS guidelines. Reductions in the numbers of births and effects of therapy in delaying AIDS do not explain the decline.

CONCLUSION

Since 1994, the US Public Health Service (PHS) has recommended routine, voluntary prenatal human immunodeficiency virus (HIV) testing and zidovudine therapy to reduce perinatal HIV transmission.

**Objective** To describe trends in incidence of perinatal AIDS and factors contributing to these trends, particularly the effect of PHS perinatal HIV recommendations.


**Main Outcome Measures** Trends in AIDS by year of diagnosis, incidence rates of AIDS and *Pneumocystis carinii* pneumonia (PCP) among infants younger than 1 year from US natality data for birth cohorts 1988 to 1996; expected number of infants with AIDS from national serosurvey data; and zidovudine use data from selected HIV-reporting states.

**Results** Perinatal AIDS cases peaked in 1992 and then declined 67% from 1992 through 1997, including an 80% decline in infants and a 66% decline in children aged 1 to 5 years. Rates of AIDS among infants (per 100,000 births) declined 69%, from 8.9 in 1992 to 2.8 in 1996 compared with a 17% decline in births to HIV-infected women from 1992 (n = 6990) to 1995 (n = 5797). Among infants, PCP rates per 100,000 declined 67% (from 4.5 in 1992 to 1.5 in 1996), similar to the decline in other AIDS conditions. The percentage of perinatally exposed children born from 1993 through 1997 whose mothers were tested for HIV before giving birth increased from 70% to 94%; the percentage who received zidovudine increased from 7% to 91%.

**Conclusions** According to these data, substantial declines in AIDS incidence were temporally associated with an increase in zidovudine use to reduce perinatal HIV transmission, demonstrating substantial success in implementing PHS guidelines. Reductions in the numbers of births and effects of therapy in delaying AIDS do not explain the decline.
PERINATAL TRANSMISSION OF HIV/AIDS

METHODS
AIDS Surveillance
State and local health departments conduct AIDS surveillance in all US states and territories. Health departments forward data on cases, without personal identifiers, to the Centers for Disease Control and Prevention (CDC), Atlanta, Ga. The data abstracted from medical records include demographics, mode of exposure, laboratory data, AIDS-defining conditions, and zidovudine use by mothers and infants. We analyzed trends in perinatal AIDS cases by half-year of diagnosis, adjusting for reporting delays and redistribution of cases with unreported risk, for cases diagnosed through December 1997 and reported to the CDC by June 1998. Reporting delays were estimated with a maximum likelihood procedure, which takes into account the effect of factors such as demographics and HIV exposure groups on delay distributions.

HIV Surveillance
To assess the use of maternal and neonatal zidovudine among children born to HIV-infected mothers, we analyzed HIV surveillance data. Since 1985, many states have conducted HIV surveillance with the same methods as AIDS surveillance. The 29 states that conducted surveillance for HIV infection among children, including perinatally exposed children, accounted for approximately one third of AIDS cases and one third of births to HIV-infected women in 1994. These states monitor perinatally exposed children as they are HIV-antibody positive; update records with HIV tests, AIDS-defining conditions, and vital status; and assess receipt of care. We analyzed data on zidovudine use by HIV-infected mothers and their infants born in 1993 through 1997 from 14 of the 29 HIV-reporting states that had very complete ascertainment of the number of HIV-infected mothers giving birth, as estimated from the Survey of Childbearing Women (SCBW), an anonymous serosurvey of births. By June 1998, these 14 states had ascertained a median of 90% (range, 71%-100%) of estimated children born to HIV-infected mothers in 1995 (n = 11 states) or, if the SCBW was not done in 1995, in 1994 (n = 3 states). The HIV surveillance data from 4 additional states that did not conduct the SCBW were also included (Table 1).

Incidence Trends by Birth Cohort
To evaluate trends in incidence by birth cohort, we modeled observed AIDS incidence from AIDS surveillance data reported to the CDC by means of the Wang procedure, a nonparametric method for estimating the birth incidence of HIV-infected children. Details of the method have been published. The Wang procedure simultaneously adjusts perinatal AIDS surveillance data for reporting delays and progression time to AIDS for HIV-infected children who have not met the AIDS case definition. Because national AIDS surveillance does not include HIV-infected children without AIDS, we modified the Wang procedure by using a parametric estimate of the distribution of progression time to AIDS based on data on HIV-infected children in the Pediatric Spectrum of Disease (PSD) project, a multicenter, active-surveillance project. To estimate the distribution of progression time to AIDS, we evaluated HIV-infected children in the PSD project who were born between 1986 and 1993 (n = 2001). This avoided bias from cases diagnosed early in the epidemic and from cases diagnosed more recently because our null hypothesis was that the decrease in AIDS was not due to a changing progression time to AIDS. The distribution of progression time to AIDS, according to PSD and AIDS surveillance, dropped sharply in infants after age 6 months and was previously modeled as a bimodal distribution by using a mixture of 2 Weibull distributions. According to our model, 21% of HIV-infected children would progress to AIDS by 12 months and 67% by 120 months, which is similar to other studies. We estimated the 95% con-
fidence intervals for Wang-modeled perinatal AIDS incidence by using conditional variance and assuming a Poisson distribution.

To control for changing birth rates, we calculated rates per 100,000 births of perinatally acquired AIDS and PCP in infants by using Wang estimates and natality data from the CDC’s National Center for Health Statistics for birth cohorts 1992 to 1996 (1996 was the latest birth cohort for which reliable estimates could be made). We calculated PCP incidence rates to determine how much changing PCP incidence affected overall AIDS incidence.

**Observed and Expected AIDS Incidence**

Data from the SCBW were used to estimate expected AIDS incidence. The SCBW, an unlinked, population-based serosurvey, measures HIV prevalence among women giving birth by testing residual dried-blood specimens for HIV antibody. To estimate the number of births to HIV-infected women, the second birth cohort expected AIDS incidence. The Data from the SCBW were used to estimate overall transmission rates by dividing Wang estimates of AIDS in infants by the product of the SCBW data and the proportion (0.21) of HIV-infected children who progressed to AIDS as infants.3

**RESULTS**

**Characteristics of Children With Perinatally Acquired AIDS**

Through June 1998, 7512 children were reported with perinatally acquired AIDS from 48 states, Puerto Rico, the District of Columbia, and the US Virgin Islands. New York (27%), Florida (16%), New Jersey (9%), and California (6%) reported 58% of all cases. The majority of children were black non-Hispanic and Hispanic (Table 2). Overall, by year of AIDS diagnosis, adjusted for reporting delay and redistribution of cases with unreported risk, the number of AIDS cases increased rapidly in the 1980s, peaked in 1992, and declined 67% from 1992 (n = 907) to 1997 (n = 297). Declines occurred in all regions, both urban and rural areas (data not shown), and all racial/ethnic groups. Declines were largest among infants (aged <1 year) (80%) and children aged 1 to 5 years at AIDS diagnosis (66%). The same trend was not seen among children diagnosed at 6 years or older (Figure 1, A-C).

*Pneumocystis carinii* pneumonia was reported for 34% of all children and 57% of infants with perinatally acquired AIDS. From 1992 to 1997, by half-year of diagnosis, the number of infants with AIDS with and without PCP declined similarly (76% and 82%, respectively)(Figure 1, D).

**Incidence Trends by Birth Cohort**

Estimated incidence of perinatally acquired HIV infection, using Wang-modeled perinatal AIDS surveillance data, indicates that births of perinatally HIV-infected children leveled off in 1991 through 1992. An estimated 1650 HIV-infected children were born in 1991; that number declined to an estimated 895 HIV-infected children born in 1995 and 480 HIV-infected children born in 1996. Changes in perinatal transmission rates are reflected sooner in trends in perinatal AIDS incidence in infants (aged <1 year) than in overall perinatal AIDS incidence. Estimated and observed data for infants showed a peak in birth incidence in 1991 and 1992, followed by a dramatic decline, particularly after 1994 (Figure 2). For infants, the observed AIDS and estimated HIV incidences by

---

Table 2. Characteristics of Children With Perinatally Acquired AIDS, United States, Reported Through June 1998 (N = 7512)*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Cumulative Cases (n = 7512)</th>
<th>Reported in 1997 (n = 434)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Race*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black non-Hispanic</td>
<td>4587 (61)</td>
<td>266 (61)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1758 (23)</td>
<td>101 (23)</td>
</tr>
<tr>
<td>White non-Hispanic</td>
<td>1097 (15)</td>
<td>60 (14)</td>
</tr>
<tr>
<td>Asian/Pacific Islander</td>
<td>30 (1)</td>
<td>1 (1)</td>
</tr>
<tr>
<td>American Indian</td>
<td>26 (&lt;1)</td>
<td>2 (1)</td>
</tr>
<tr>
<td>Alaska Native</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age group, y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>3012 (40)</td>
<td>119 (27)</td>
</tr>
<tr>
<td>1-5</td>
<td>3550 (47)</td>
<td>219 (51)</td>
</tr>
<tr>
<td>≥6</td>
<td>950 (13)</td>
<td>96 (22)</td>
</tr>
<tr>
<td>Region†</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>3328 (44)</td>
<td>181 (42)</td>
</tr>
<tr>
<td>North Central</td>
<td>540 (7)</td>
<td>41 (9)</td>
</tr>
<tr>
<td>South</td>
<td>2721 (36)</td>
<td>152 (35)</td>
</tr>
<tr>
<td>West</td>
<td>554 (7)</td>
<td>37 (9)</td>
</tr>
<tr>
<td>Territories</td>
<td>366 (5)</td>
<td>22 (5)</td>
</tr>
<tr>
<td>Maternal HIV risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IDU</td>
<td>2992 (40)</td>
<td>107 (25)</td>
</tr>
<tr>
<td>Sex with IDU</td>
<td>1374 (18)</td>
<td>60 (14)</td>
</tr>
<tr>
<td>Sex with other HIV-infected or at-risk person</td>
<td>1303 (17)</td>
<td>112 (26)</td>
</tr>
<tr>
<td>Transfusion</td>
<td>155 (2)</td>
<td>7 (2)</td>
</tr>
<tr>
<td>HIV-positive, risk not specified</td>
<td>1688 (23)</td>
<td>148 (34)</td>
</tr>
</tbody>
</table>

*AIDS indicates acquired immunodeficiency syndrome; HIV, human immunodeficiency virus; and IDU, injection drug user. All data are presented as number (percentage). Percentages may not sum to 100 due to rounding.
†Race is unknown for 14 children, including 2 reported in 1997.
‡Region is unknown for 3 children.
month of birth fit closely because of the rapid (<1 year) progression to AIDS. The difference between observed AIDS incidence and the estimated HIV incidence reflects infants who will be reported with AIDS in the future, as shown by the predicted trends in AIDS diagnoses.

**Observed and Expected AIDS Incidence**

To examine whether declining births to HIV-infected mothers accounted for the decline in AIDS, we compared the estimated observed and expected AIDS incidence by birth cohort. The observed incidence for infants was similar to the expected incidence, based on the SCBW, until the second half of birth year 1994, when the observed incidence was substantially less (27%) than expected. The observed incidence continued to decline more than expected through the first and second halves of 1995 (17% and 31%, respectively) and declined further in 1996 (FIGURE 3). Recent declines in observed AIDS incidence were substantially greater than could be accounted for by the declines in births.

**AIDS and PCP Incidence Trends by Birth Cohort**

To determine whether increasing use of PCP prophylaxis accounted for the decline in AIDS, we examined estimated rates of AIDS and PCP among infants by birth cohort. For birth cohorts 1992 through 1996, rates per 100,000 births declined 69% for AIDS (8.9 to 2.8 per 100,000 births) and declined 67% for PCP (4.5 to 1.5 per 100,000) (TABLE 3). The decline in AIDS occurred most dramatically from the first to the second half of the 1994 birth cohort (28%) (8.0 to 5.8 per 100,000 births, respectively) and has continued to decline. The ratio of PCP rate to AIDS rate declined from the 1990 (0.61) to the 1991 (0.49) birth cohort and then remained relatively constant (mean = 0.50) from 1991 to 1996. Similar declines in AIDS rates for infants per 100,000 births and per 100 HIV-infected mothers occurred from 1993 to 1995 (39% and 32%, respectively). Estimated transmission rates declined 33% from 1993 to 1995 (TABLE 4). From national AIDS incidence, we estimated that 23% of HIV-positive women who gave birth in 1994 and 52% in 1995 were likely to have received prenatal zidovudine.

---

**Figure 1.** Number of Perinatally Acquired AIDS Cases by Half-Year of Diagnosis, United States

AIDS indicates acquired immunodeficiency syndrome; PCP, Pneumocystis carinii pneumonia. Diagnoses through December 1997 among cases reported through June 1998, adjusted for reporting delays and redistribution of cases with unreported risk, by region (A); race/ethnicity (B); age (C); and for infants younger than 1 year with PCP and those with other AIDS-defining conditions (D). Northeast includes Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; South: Alabama, Arkansas, Delaware, District of Columbia, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming; and Midwest: Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin.
Surveillance of Zidovudine Use
We analyzed HIV surveillance data on zidovudine use by HIV-infected mothers and their newborns (Table 1). In the 18 HIV-reporting states, of 1951 perinatally exposed children born from 1993 through 1997, the proportion whose mothers were tested for HIV before the child’s birth increased from 70% to 94% (Table 1), and the proportion of children and their mothers who received any zidovudine prophylaxis (ie, prenatal, intrapartum, or neonatal) increased from 7% to 91% and prenatal zidovudine use increased from 4% to 73%. Among mothers tested for HIV before the child’s birth, the proportion who received prenatal zidovudine increased from 28% in 1994 to 76% in 1997; 61% received all 3 zidovudine components and 21% received other antiretrovirals in addition to zidovudine during pregnancy in 1997. A stable proportion (15% to 18%) of HIV-infected women delivered their infants via cesarean section from 1994 to 1997.

Of 329 children born in 1995 and 1996 and reported with perinatally acquired AIDS, the mothers of 112 (34%) were tested for HIV after the child’s birth, 147 (45%) were tested before giving birth, and the timing of testing was unknown for 67 (20%). Of the 147 mothers who were tested before giving birth, 52 (35%) received prenatal zidovudine, 43 (29%) did not receive prenatal zidovudine, 27 (18%) received no zidovudine, and 25 (17%) received all 3 components.

COMMENT
Incidence of perinatally acquired AIDS in the United States has declined dramatically, especially since the 1994 Public Health Service prevention guidelines were published. The declines were greater than those expected from declining births to HIV-infected women and reductions in PCP rates. Data from HIV-reporting states on exposed and infected children demonstrate the rapid implementation of recommendations for voluntary prenatal HIV testing and the increasing use of zidovudine by HIV-infected mothers and infants. This zidovudine use was temporally associated with a widespread, steep, and sustained decline in AIDS incidence. The small number of children with AIDS born in recent years represents populations for which prevention efforts were less successful because the mothers did not receive timely HIV testing or zidovudine.

The declining incidence of perinatal AIDS, coincident with the increasing use of zidovudine, is consistent with data from clinical trials and observational studies confirming the effectiveness of zidovudine in reducing perinatal HIV transmission.5,8-14 Recent trials

©1999 American Medical Association. All rights reserved.

Figure 1. Expected Perinatally Acquired AIDS Incidence in Infants Based on Survey of Childbearing Women Data Compared With Observed AIDS Incidence by Half-Year of Birth

AIDS diagnoses reported through June 1998 for children diagnosed as having AIDS in the first year of life. AIDS indicates acquired immunodeficiency syndrome; HIV, human immunodeficiency virus.

Figure 2. Estimates of Perinatally Acquired AIDS and HIV Births

AIDS indicates acquired immunodeficiency syndrome; CI, confidence interval. Observed AIDS incidence was adjusted for reporting delays and progression time to AIDS.

Figure 3. Expected Perinatally Acquired AIDS Incidence in Infants Based on Survey of Childbearing Women Data Compared With Observed AIDS Incidence by Half-Year of Birth

AIDS indicates acquired immunodeficiency syndrome; CI, confidence interval. Observed AIDS incidence was adjusted for reporting delays and progression time to AIDS.
report transmission rates as low as 5.0% for mothers who received zidovudine, including those with low CD4 cell counts and previous therapy. Updated perinatal prevention guidelines recommend zidovudine for all HIV-infected pregnant women, in addition to their antiviral therapy. After 4 years of follow-up in the ACTG protocol 076, there were no adverse effects in HIV-uninfected children from zidovudine exposure in utero, although the long-term effects of in utero exposure to antiretrovirals are unknown.

In the early 1990s, increasing numbers of HIV-infected women were treated with zidovudine for maternal indications because most obstetricians applied standards of care for nonpregnant women to pregnant women unless there were compelling fetal concerns. Up to 20% of HIV-infected women received zidovudine during pregnancy for their own health before ACTG protocol 076. The CDC's Adolescent and Adult Spectrum of Disease study reported that during 1990 through 1996, most (82%) HIV-infected pregnant women receiving medical care with a CD4 cell count of less than 0.20 × 10^9/L received zidovudine during pregnancy. This zidovudine use likely contributed to earlier declines in AIDS cases.

Changes in the prevalence of other risk factors associated with perinatal transmission may have contributed to declining numbers of AIDS cases, for example, fewer women with advanced disease and obstetric factors such as elective cesarean delivery. In HIV-reporting states, the proportion of HIV-infected women undergoing cesarean delivery did not change from 1993 to 1997, although data were not available on elective cesarean delivery. The avoidance of breastfeeding, recommended since 1985 among HIV-infected women, also may have contributed, as more women learn their HIV status during pregnancy and do not breastfeed. Although the magnitude of the contribution of these factors on reduction of perinatal HIV transmission is unknown, they are unlikely to contribute as substantially as increasing zidovudine use. We estimated that observed AIDS trends could be explained if 50% of HIV-positive women who gave birth in 1995 used zidovudine if zidovudine were the only influence on transmission. Data on zidovudine use from HIV-reporting states were similar.

An estimated 120 000 to 160 000 pregnant women lived with HIV infection in the United States. The incidence of perinatal HIV infection increased in the 1980s, similar to increasing trends among women of childbearing age. Seroprevalence of HIV among childbearing women leveled off from 1989 through 1993 with declining rates in the Northeast and increasing, then stabilizing, rates in the South. This leveling may be due to several factors: changing reproductive decisions, stable HIV incidence among women of childbearing age, older women aging out of the childbearing years, and a reduction in fertility in HIV-infected women caused by advanced HIV disease. From 1992 through 1995, births to HIV-infected women declined 17% while perinatally acquired AIDS rates declined 42%. Although declining births to HIV-infected women contribute, they do not explain the substantial decline in AIDS cases.

Increasing use of PCP prophylaxis may delay progression to AIDS. Fifty-four percent of AIDS-defining conditions in infants was accounted for by PCP, which occurs predominantly at age 3 to 6 months. In 1991, PCP prophylaxis guidelines for children were published. Incidence of PCP among infants changed little from 1991 through 1993 because HIV infection was not diagnosed in time for prophylaxis. The 1995 revised guidelines recommended PCP prophylaxis for all perinatally exposed infants at 4 to 6 weeks of age. Our data demonstrate that the ratio of PCP rate to rate of other AIDS-defining conditions among infants declined from birth cohorts 1990 to 1991, suggesting

Table 3. Incidence Rates of Perinatally Acquired AIDS and PCP in Infants Younger Than 1 Year by Year of Birth*

<table>
<thead>
<tr>
<th>Year of Birth</th>
<th>NCHS Natality</th>
<th>With AIDS at Younger Than 1 Year†</th>
<th>AIDS Rate per 100 000 Births</th>
<th>Children Born to HIV-Positive Women, No.</th>
<th>AIDS Rate per HIV+CBW‡</th>
<th>With PCP at Younger Than 1 Year, No.†</th>
<th>PCP Rate per 100 000 Births</th>
<th>Ratio of PCP:AIDS Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>3 909 9510</td>
<td>263</td>
<td>6.8</td>
<td>5430</td>
<td>4.8</td>
<td>157</td>
<td>4.0</td>
<td>0.59</td>
</tr>
<tr>
<td>1989</td>
<td>4 040 9580</td>
<td>303</td>
<td>7.6</td>
<td>6370</td>
<td>4.8</td>
<td>194</td>
<td>4.8</td>
<td>0.63</td>
</tr>
<tr>
<td>1990</td>
<td>4 158 212</td>
<td>342</td>
<td>8.2</td>
<td>6770</td>
<td>5.1</td>
<td>209</td>
<td>5.0</td>
<td>0.61</td>
</tr>
<tr>
<td>1991</td>
<td>4 110 907</td>
<td>369</td>
<td>9.0</td>
<td>7040</td>
<td>5.2</td>
<td>182</td>
<td>4.4</td>
<td>0.49</td>
</tr>
<tr>
<td>1992</td>
<td>4 065 014</td>
<td>361</td>
<td>8.9</td>
<td>6990</td>
<td>5.2</td>
<td>183</td>
<td>4.5</td>
<td>0.51</td>
</tr>
<tr>
<td>1993</td>
<td>4 000 240</td>
<td>326</td>
<td>8.2</td>
<td>6422</td>
<td>5.0</td>
<td>154</td>
<td>3.8</td>
<td>0.46</td>
</tr>
<tr>
<td>1994</td>
<td>3 952 767</td>
<td>272</td>
<td>6.9</td>
<td>6145</td>
<td>4.4</td>
<td>130</td>
<td>3.3</td>
<td>0.48</td>
</tr>
<tr>
<td>1995</td>
<td>3 899 589</td>
<td>196</td>
<td>5.0</td>
<td>5797</td>
<td>3.4</td>
<td>96</td>
<td>2.5</td>
<td>0.50</td>
</tr>
<tr>
<td>1996</td>
<td>3 891 494</td>
<td>109</td>
<td>2.8</td>
<td>NA</td>
<td>NA</td>
<td>59</td>
<td>1.5</td>
<td>0.54</td>
</tr>
</tbody>
</table>

*AIDS indicates acquired immunodeficiency syndrome; PCP, Pneumocystis carinii pneumonia; NCHS, National Center for Health Statistics; HIV, human immunodeficiency virus; HIV+CBW, HIV-positive childbearing women as estimated by the Survey of Childbearing Women; NA, not available.
†AIDS and PCP cases adjusted for reporting delays, cases reported without risk, and progression time to AIDS (Wang procedure) on births through December 1996, diagnosed through December 1997, and reported through June 1998.
an early impact of PCP prophylaxis on PCP incidence. Subsequently, the rate of PCP and the rate of other AIDS conditions declined substantially from 1993 through 1996, but the relative decline of PCP was not greater than that of other AIDS-defining conditions. Thus, declines in AIDS incidence in recent years were primarily due to the substantial impact of declining perinatal HIV transmission resulting from increased zidovudine use, although declines in PCP incidence due to PCP prophylaxis probably contributed.

Increased use of combination antiretroviral therapy for children may have contributed to the decline in AIDS cases by delaying the progression to AIDS. In 1993, antiretroviral therapy, principally zidovudine monotherapy, was recommended for symptomatic or immunosuppressed HIV-infected children. In 1996, data emerged on the benefits of combination therapy, including protease inhibitors, on the delay of disease progression and improved survival for adults; in 1997, aggressive use of combination therapy was recommended. Specific data among pediatric populations on the use of protease inhibitors, including data on safety and appropriate dosage, especially for young children, lagged behind those for adults. Although treatment may have contributed, the steep declines in perinatally acquired AIDS from 1994 through 1997, particularly among infants, which were not accompanied by substantial declines among older age groups, probably do not reflect the effect of combination therapy with protease inhibitors as the standard of care for children to the extent reflected in recent AIDS trends in adults.

Progression time to AIDS was determined from the PSD project, which reflected patients in care and may have included more symptomatic children. Byers et al, who compared symptomatic children in the PSD project with children who were identified as perinatally exposed at birth, found that incubation times were not significantly different. Our estimates of progression time to AIDS were similar to those of other studies. We assumed that progression to AIDS did not depend on date of birth. The validity of our Wang estimates is shown by the similarity to SCBW estimates from 1989 to the first half of 1994.

Other factors must be considered in interpreting these trends. We adjusted AIDS data for reporting delay, assuming that reporting delay has not changed over time. This assumption is supported by analyses by Green and Byers et al. Data from HIV-reporting states, although population-based, describe HIV-infected mothers and infants in care and may be more likely to include mothers who received zidovudine. Our analysis was restricted to states that ascertained a high proportion of children born to HIV-infected mothers and therefore is a representative estimate of the implementation of perinatal prevention in those states.

AIDS data have been critical in characterizing the perinatal HIV epidemic in the United States. The incidence of AIDS in the future will reflect access to care, effectiveness of treatment in delaying progression to AIDS, as well as reduced HIV incidence. Data from HIV-reporting states highlight the need to expand surveillance nationwide to monitor perinatal HIV exposure and subsequent infection and AIDS status, assess resources needed for prevention and care, evaluate effect of public health recommendations, assess reasons for continued transmission, assess the timeliness of HIV testing and care, and assess adverse effects of in utero exposure to antiretroviral therapy. The CDC has recommended, and the Council of State and Territorial Epidemiologists and the American Academy of Pediatrics both support, surveillance of perinatal exposure and HIV infection as an extension of AIDS surveillance.

These population-based data demonstrate successful implementation of guidelines for routine voluntary prenatal HIV testing and use of zidovudine and their clear effect on the reduction in perinatal HIV transmission in the United States. As emphasized in a recent Institute of Medicine report, to further reduce perinatal transmission we need comprehensive strategies to ensure access to prenatal care, HIV counseling and testing; therapy to reduce perinatal transmission; avoidance of breastfeeding; and appropriate treatment and services for mothers. Additional challenges include monitoring the emergence of antiretroviral resistance and potential toxicities of antiretrovirals, and improving the adherence of HIV-positive pregnant women to antiretroviral therapy. Prevention of HIV infection in women is the

Table 4. Incidence of Perinatally Acquired AIDS in Infants Younger Than 1 Year by Year of Birth*

<table>
<thead>
<tr>
<th>Year of Birth</th>
<th>Children Born to HIV-Positive Mothers, No.†</th>
<th>Estimated No. of AIDS Cases in Infants Younger Than 1 Year</th>
<th>Observed Adjusted No. of AIDS Cases§</th>
<th>Estimated Transmission Rate</th>
<th>Estimated % Receiving Zidovudine ¶</th>
</tr>
</thead>
<tbody>
<tr>
<td>1992</td>
<td>6990</td>
<td>367 117</td>
<td>361</td>
<td>0.246</td>
<td>23</td>
</tr>
<tr>
<td>1993</td>
<td>6422</td>
<td>337 110</td>
<td>326</td>
<td>0.242</td>
<td>23</td>
</tr>
<tr>
<td>1994</td>
<td>6145</td>
<td>323 103</td>
<td>272</td>
<td>0.211</td>
<td>23</td>
</tr>
<tr>
<td>1995</td>
<td>5797</td>
<td>204 97</td>
<td>196</td>
<td>0.161</td>
<td>52</td>
</tr>
<tr>
<td>1996</td>
<td>NA</td>
<td>NA NA</td>
<td>109</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Estimates based on Survey of Childbearing Women (SCBW) for the United States, excluding US territories.
†Estimates based on SCBW and either 25% or 8% HIV transmission rate and 21% progression rate to AIDS in first year of life.
§Estimated AIDS cases adjusted for reporting delays, cases reported without risk, and progression time to AIDS (Wang procedure) on births through December 1996, diagnosed through December 1997, and reported through June 1998. (Estimate represents the product of the transmission rate and completeness of AIDS reporting).
¶Estimate based on the assumption that zidovudine reduced transmission to 8%, that the transmission rate in the absence of zidovudine was 25%, and that zidovudine was the only influence on transmission.

©1999 American Medical Association. All rights reserved.
ultimate goal to further reduce perinatal HIV infection.

Acknowledgment: We thank R. J. Simonds, MD, for manuscript review, and Mitzi Mays and Thamban Valapil for help with data management and analysis.

REFERENCES