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Preventing Perinatal Transmission of HIV Infection in Alaska

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Preventing Perinatal Transmission of HIV Infection in Alaska

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Background Information:

Prior to the widespread use of antiretroviral therapies in the United States, reported HIV perinatal transmission rates ranged from 14% to 33% of births to HIV infected women (1). More recent studies found transmission from infected, untreated mothers to range from 23-27% (2, 3). Preventive treatment with zidovudine (ZDV or AZT) begun before, and continued during and immediately after birth, reduced the risk of perinatal transmission to 6.1% in some populations of infected women (2, 3). At most, 25%-30% of perinatal transmission occurs in utero, 70%-75% during delivery, and 7%-22% through breastfeeding (1). Combining treatment and Caesarian section may further reduce perinatal transmission rates (7).

A very high proportion of women (90% or more) are likely to accept voluntary HIV testing during pregnancy when it is offered (1). Acceptance levels are highest when providers strongly recommend the test and incorporate it into routine practice (1). For example, staff at the Anchorage Neighborhood Health Center (ANHC), a provider to many low income, minority, and high risk women, report that over 90% of ANHC prenatal patients accept HIV testing (4).

The earlier the stage at which antiretroviral treatment begins during pregnancy and childbirth, the greater the reduction in HIV transmission. Current federal treatment guidelines recommend pregnant women who have not previously received antiretroviral treatment initiate prophylactic treatment after the first 10-12 weeks of pregnancy (2).

A retrospective study (3) of infants 180 days of age or younger using the New York State HIV PCR Testing Service found that when treatment for infected mothers and exposed newborns was initiated:

- in the prenatal period and continued through the post-natal period, the rate of HIV transmission was 6.1%;
- intrapartum and continued through the post-natal period, the rate of transmission was 10.0%;
- in the newborn within the first 48 hours of life, the rate of transmission was 9.3%; and
- in the newborn on day three of life or later, the rate of transmission was 18.4%.
- With no treatment during pregnancy or in the newborn, rate of transmission was 26.6%.

This information further highlights the importance of increasing the proportion of women who receive early prenatal care. Only approximately 75% of pregnant women in Alaska were found to have received optimal prenatal care (begun in first trimester of pregnancy and having at least nine visits for a normal-length pregnancy) during the 1990s (5). This rate appears to be declining since 1994, and rates are not consistent across age and racial/ethnic groups (5). The State of Alaska has recently introduced new programs (for example, Denali Kid Care) that may enhance access to prenatal care for low income pregnant women.

Antiretroviral treatment for HIV is demanding and requires the pregnant woman's active participation. Antiretroviral medications often have negative side effects, and such treatment may be even more difficult to tolerate during pregnancy. Treatment for exposed newborns is demanding for both the newborn and the caretaker (usually the mother).

There is currently no means of predicting which women will, and which will not, transmit infection perinatally. Treatment cannot, therefore, be effectively targeted to reduce exposure to antiretroviral drugs for those exposed infants (approximately 73% from the New York study cited above) who would not have been infected perinatally, even if given no treatment in pregnancy. Fortunately, a recent study found no significant adverse effects of ZDV treatment on uninfected children followed for a median age of 4.2 years and as long as 5.6 years (6).

When a woman has not received prenatal care and her HIV status is unknown, voluntary HIV screening can be offered for the mother and/or the newborn. Newborns with positive HIV antibody test results are not necessarily infected with HIV, since newborns carry their mother's antibodies for up to 18 months after birth. A positive screening (antibody) test in the newborn therefore indicates only the mother's HIV status. Confirmation of infection in the newborn (often done with PCR tests) can guide decisions regarding medical management and prophylaxis for opportunistic infections.

If newborn testing is conducted for purposes of preventing HIV infection, prophylactic treatment appears to be necessary within 48 hours of birth (3). Results from HIV testing would have to be available within this period to guide an antiretroviral treatment decision. Achieving such a rapid turnaround for confirmed results is problematic at this time. Commonly used HIV antibody tests (EIA, not rapid tests) are not currently conducted in Alaska laboratories other than the State Virology Laboratory (the Alaska Native Medical Center Laboratory will soon offer EIA in-house). Confirmatory (Western blot or PCR) laboratory testing services are not conducted in laboratories located within the state.

Rapid HIV antibody tests will, in the future, facilitate opportunities for initiating treatment for an exposed newborn within 48 hours of birth. The one rapid HIV antibody test now commercially available, the Murex SUDS test, can be performed in approximately 15 minutes in laboratories that are CLIA-approved to conduct tests of moderate complexity. In a low prevalence area such as Alaska, negative test results on SUDS test would reliably identify unexposed newborns, but a significant proportion of positive SUDS test results would be false positives. Confirmatory testing is therefore necessary. Until other, complementary technology rapid tests become commercially available, newborn testing has no productive role in preventing perinatal HIV transmission in Alaska.

The number of perinatally acquired AIDS cases in the U.S. peaked around 1992 and subsequently declined by 43% by 1996. In 1997, perinatally transmitted cases of AIDS were concentrated in African American (60%) and Hispanic (24%) children. Pediatric AIDS cases are concentrated in the eastern states, especially in the New York metropolitan area. In 1997, 39 states had fewer than ten perinatally transmitted AIDS cases. Twelve states, including Alaska, reported no pediatric AIDS cases in 1997 (8).

Injection drug use and unprotected sex with an injection drug user, are associated with up to 72% of perinatally acquired AIDS in the U.S. (1) In Alaska, from 1/96 through 12/97, injection drug use accounted for 47% of adult/adolescent female AIDS cases (15).

Results of the Alaska Survey of Childbearing Women from 1990-1996, in which blood specimens from all Alaska newborns were tested for HIV, found a range of 0-4 births to HIV positive women among 10,000 – 11,000 live births per year. Of 67,423 specimens tested between 1990 and 1996, 12 or 0.02% indicated the mother was HIV infected (9).

The Alaska Pregnancy Risk Assessment Monitoring System (PRAMS) is an ongoing, population-based surveillance study currently conducted in 18 states, including Alaska. PRAMS regularly surveys a stratified, random sample of mothers with live births. Of Alaska women questioned in 1997, 75% indicated their providers had discussed HIV testing with them; the national PRAMS survey has found such discussion to be highly correlated with testing. Alaska results for 1996 were similar (77% of women surveyed in 1996 reported such a discussion) (10).

National Recommendations/Findings Related to Preventing Perinatal Transmission:

A number of national organizations have issued recommendations or findings related to preventing perinatal transmission:

- The Centers for Disease Control and Prevention (CDC) recommends universal counseling and voluntary HIV testing for pregnant women (11).
- The Institute of Medicine (IOM) recommends universal HIV testing, with notification and right of refusal, as a routine component of prenatal care (1). The IOM's 1999 report notes that lack of prenatal care and not being offered a test are the primary reasons why pregnant women are not tested for HIV.
- The American Academy of Pediatrics and the American College of Obstetrics and Gynecology have jointly recommended (12) that:
  - all women receive HIV education and counseling as part of their regular prenatal care;
  - all pregnant women receive HIV testing, with their consent; and
  - for infants whose mothers' HIV status was not determined during pregnancy, the health care provider should educate the parent(s) and recommend HIV testing for the newborn.
- The National Governors Assn. HIV/AIDS Policy (13) supports universal HIV counseling, voluntary HIV testing, improved access to prenatal care, and offering effective treatment to HIV positive women and newborns as strategies to decrease perinatal transmission.

New York State is currently the only state with legislation mandating routine HIV testing for all newborns. Experience with the New York State legislation has been variable in terms of its effectiveness in appropriately notifying parent(s) and in getting infected infants into care (14).

Implications for Public Health Interventions in Alaska:

The ideal intervention point to prevent perinatal transmission is before pregnancy, with appropriate services to prevent HIV infection in women of childbearing age. The number of women infected with HIV and the number of infected women delivering live infants each year in Alaska is small. This low prevalence of infection, although very desirable, makes it difficult to effectively target HIV prevention services to women at increased risk of infection other than services for injection drug users or sexual partners to injectors. In Alaska, the single most effective means of identifying and reaching women at high risk of HIV infection is through partner notification services.

Pregnant, HIV positive women will benefit from extensive education and supportive services in making and carrying out antiretroviral treatment decisions before, during, and after pregnancy. A woman's relationship with her medical provider is extremely important to positive care outcomes. Effective treatment to reduce the risk of perinatal transmission requires the pregnant HIV positive woman's active participation throughout her pregnancy and after her child's birth. An approach involving client-centered education and voluntary HIV testing for pregnant women appears most likely to facilitate a participatory relationship.

Mandating universal newborn HIV testing in Alaska might identify a very small number of exposed newborns who would not otherwise be identified as being at risk of HIV infection. With current technology, infants would be identified only after the period when measures to prevent perinatal infection are now believed to be effective. Given the low prevalence of HIV infection among women of childbearing age, a large number of tests would be required per exposed infant identified. A review and cost evaluation of conducting a universal, mandatory newborn screening program for HIV in Alaska follows. Activities leading to voluntary determination of pregnant women's HIV status, while involving a similar number of tests, would provide opportunity for interventions to reduce the probability of perinatal transmission.

A participatory relationship between the provider and mother is essential in effectively addressing issues related to perinatal transmission of HIV. It is unclear whether an exposed newborn, even if exposure were confirmed immediately after birth, could be treated with antiretroviral drugs without the mother's consent.

Additionally, mandatory newborn testing would reveal the mother's HIV status, possibly without her consent. Focusing on such a mandate is likely to divert resources and attention from the more effective and desirable activities of increasing the proportion of women involved in prenatal care and receiving voluntary HIV testing early in pregnancy.

A mandatory testing requirement is not needed in Alaska, given the less intrusive and more efficacious alternatives available, the high probability of a woman accepting voluntary HIV testing if offered and recommended, and the low HIV prevalence in the state.

Recommendations for Alaska:

The Alaska Section of Epidemiology, AIDS/STD Program and the Alaska Section of Maternal, Child and Family Health Services recommend the following:

Mandatory testing programs for pregnant women or newborns are unlikely to be effective in preventing perinatal transmission. Such mandatory testing programs are recommended neither nationally nor in Alaska.

Primary emphasis for preventing perinatal HIV transmission in Alaska should be placed on provision of HIV testing as a routine part of prenatal care, with notification and right of refusal. Emphasis should also be placed on maximizing the proportion of women participating in prenatal care during pregnancy.

Public health programs should place highest priority on partner notification services for HIV infected individuals. This is the single most effective means of identifying women at high risk of exposure in our low prevalence state.

Programmatic emphasis should be placed on providing ongoing prevention services for HIV positive individuals, including case-managed coordination of medical services and treatment, as well as substance abuse treatment and mental health services, as needed.

HIV prevention, counseling, and testing services should be integrated into broader services and contexts reaching women at increased risk of HIV exposure. Special efforts should be conducted to reach women who use injection drugs and those in correctional settings.

References:

1. Reducing the Odds: Preventing Perinatal Transmission of HIV in the United States. Institute of Medicine and National Research Council. National Academy Press, 1999.
2. Public Health Service Task Force Recommendations for the Use of Antiretroviral Drugs in Pregnant Women Infected with HIV-1 for Maternal Health and for Reducing Perinatal HIV-1 Transmission in the United States. MMWR 1998; 47(No. RR-2).
3. Wade, NA, Birkhead, GS, Warren, BL, et al. Abbreviated Regimens of Zidovudine Prophylaxis and Perinatal Transmission of the Human Immunodeficiency Virus. N Engl J Med 339(20):1409-14.
4. Verbal communication from Sharon Zandman-Zeman, RN, Medical Case Manager, Anchorage Neighborhood Health Center, to Maternal, Child and Family Health personnel, 1998.
5. Health Status in Alaska. Alaska Department of Health & Social Services, December 1998.
6. Culnane, M, Fowler, M, Lee, SS, et al. Lack of Long-term Effects of In Utero Exposure to Zidovudine Among Uninfected Children Born to HIV-Infected Women. JAMA 281(2):151-7.
7. International Perinatal Group. The Mode of Delivery and the Risk of Vertical Transmission of Human Immunodeficiency Virus Type 1 – A Meta Analysis of 15 Prospective Cohort Studies. N Engl J Med (Prepublication release; publication scheduled for 4/1/99).
8. HIV/AIDS Surveillance Report, Year-end edition. Centers for Disease Control and Prevention, 9(2).
9. Alaska Section of Epidemiology, Alaska Survey in Childbearing Women.
10. Personal discussion with Kathy Perham-Hester, Alaska Section of Maternal Child and Family Health.
11. U.S. Public Health Service Recommendations for Human Immunodeficiency Virus Counseling and Voluntary Testing for Pregnant Women. MMWR 1995;44 (No. RR-7).
12. Joint Statement of the American Academy of Pediatrics and the American College of Obstetricians and Gynecologists. Testing for HIV (REX036). Policy approved by AAP Board of Directors August 1995 and reaffirmed February 1997.
13. HR-38. HIV/AIDS. National Governors Association policy adopted 1987, reaffirmed 1992, revised 1995, revised February 1999.
14. Letter to B.J. Harris, NASTAD, 8/7/97. From Theresa M. McGovern, Esq., HIV Law Project, regarding class action suit against the State of New York.
15. AIDS and HIV Infection in Alaska. State of Alaska, Section of Epidemiology, Recommendations and Reports, 1998; 2(No. 2).

A Cost Evaluation of Universal Newborn Human Immunodeficiency Virus Screening in Alaska

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Introduction

Current technology allows newborn infants to be screened for human immunodeficiency virus (HIV) infection from the newborn dried blood spot. Theoretically, early diagnosis could lead to either prevention of infection or improved clinical outcome among persons who become infected. Current data suggests that anti-retroviral therapy administered at later than 48 hours of age to an infant whose mother did not receive antiretroviral therapy will not prevent the establishment of HIV infection in the infant (Wade et al, 1998). An evaluation of the Alaska Newborn Screening Program suggests that it is unreasonable to expect initial and confirmatory test results to be completed at less than 48 hours (Family Health Dataline, 1996). Consequently, the decision to introduce newborn HIV screening would be based on the extent to which early diagnosis leads to an improved clinical outcome. The current analysis attempts to define the likely costs and outcomes of a newborn HIV screening program in Alaska.

Methods

Outcomes

Several studies have demonstrated that viral RNA load is associated with disease progression in perinatally infected children (Mofenson et al, 1997; Palumbo et al, 1998). Additionally, one recent study also found that combination therapy initiated soon after birth could effectively and safely reduce the viral RNA load (Luzuriaga et al, 1997). Nevertheless, early diagnosis and treatment of HIV infection (i.e., within the first month of life) has not been demonstrated to decrease mortality or to alter the clinical course of infected infants when compared to initiation of therapy at the time of symptom onset. Consequently, results are presented as cost per child tested, cost per child with HIV infection identified, and cost for each year of diagnosing a child earlier as a result of newborn screening.

Testing strategy

Determination of HIV infection in a neonate would require demonstration of repeated reactivity on a blood spot specimen in combination with a positive DNA polymerase chain reaction (PCR) test (Dunn et al, 1995). To simplify the calculations, and because the initial cost of testing all newborns overwhelms the cost of repeat testing for a few infants, only the initial screening costs were included.

Probabilities

The total number of HIV positive infants detected solely as a result of newborn screening was calculated. The number of newborns screened was determined by multiplying the number of births per year by the proportion of infants who receive a newborn screening test (Table 1). The number of infants born to HIV positive women was determined from seven years of data collected from all women giving birth in Alaska. The total number of infants whose HIV status in the neonatal period would be unknown in the absence of newborn screening was then calculated by multiplying the following numbers and proportions together:

- Number of newborns screened (Alaska Bureau of Vital Statistics)
- Proportion of HIV positive women delivering a live born infant (Alaska Survey of Childbearing Women)
- Proportion of infants born to women whose HIV status is unknown (National Surveys; Alaska specific data not available)

It was assumed that infants born to women taking antiretroviral therapy for a known HIV infection would receive testing at birth

regardless of whether or not universal newborn screening was implemented. Thus, the total number of HIV positive infants detected solely as a result of newborn screening would equal the total number of infants whose HIV status in the neonatal period would be unknown in the absence of newborn screening multiplied by the perinatal HIV infection rate in infants born to women not taking antiretroviral therapy.

It was assumed that in the absence of screening, HIV positive children would be diagnosed when they entered clinical stage B (Barnhart et al, 1996). The total number of years of earlier diagnosis resulting from screening was then calculated as the difference in average diagnostic age with and without newborn screening multiplied by the total number of infants whose HIV status in the neonatal period would be unknown in the absence of newborn screening. Other probabilities used included the sensitivity and specificity of the initial newborn screen.

Costs

Costs included the cost of the initial screen, the programmatic costs of adding HIV status to the newborn screening panel, and the costs of three drug antiretroviral therapy plus *Pneumocystis carinii* prophylaxis for children diagnosed early as a result of newborn screening. The initial screening tests and programmatic components constituted the overwhelming majority of costs included in the analysis.

Sensitivity analysis

Probabilities and costs were varied over a wide range during sensitivity analysis (Tables 1 and 2).

Table 1. Probabilities used for a cost-effectiveness analysis of newborn human immunodeficiency virus screening.

Variable	Value (range for sensitivity analysis)	Source
Births per year	10,000	Alaska Bureau of Vital Statistics
Proportion of births receiving an initial newborn screen	0.96 (0.9-1.0)	Family Health Dataline, 1996
Proportion of women delivering a live born infant infected with HIV in Alaska	0.000178 (0.000133-0.000222)	Alaska Survey of Childbearing Women; 1990-1996
Proportion of infants born to women whose HIV status is unknown	0.08 (0.04-0.2)	MMWR, 1997; Wiznia et al, 1996; Fiscus et al, 1996
Perinatal transmission rate in the absence of maternal antiretroviral therapy or neonatal therapy within 48 hours of birth	0.27 (0.20-0.33)	Wade et al, 1998
Perinatal transmission rate with maternal antiretroviral therapy and neonatal therapy within 48 hours of birth	0.061 (NA)	Wade et al, 1998
Age at diagnosis with screening (days)	30 (15-60)	Family Health Dataline, 1996
Age at diagnosis without screening (days)	426 (320-533)	Barnhart et al, 1996
Sensitivity in neonates of Genetic Systems rLAV EIA for dried blood spot testing	0.999 (0.99-0.9999)	Sanofi Laboratories, package insert
Specificity in neonates of Genetic Systems rLAV EIA for dried blood spot testing	0.995 (0.99-0.999)	Sanofi Laboratories, package insert

Table 2. Costs associated with a hypothetical newborn human immunodeficiency virus screening program.

Variable	Unit Cost (range for sensitivity analysis)	Total yearly cost
Blood spot screen	$4 per test (3-5)	$38,400
Medication costs for zidovudine, nelfinovir, lamivudine, and trimethoprim/sulfamethoxazole	$1,312 per year per person (984-1,640)	$52
Staff costs (5% of an FTE costing $60,000 per year for every 50 positive tests on initial screen)	$3,000 per 50 positive tests	$2,888
Supply costs	$500 per year	$500

Results

Base case

The cost per child tested equaled $4.36. At current rates of infection of pregnant women in Alaska, approximately one infant with HIV infection will be born every 10 years to a woman whose HIV status is known and one infant with HIV infection will be born every 28 years to a woman whose HIV status is unknown. It is this second group that could potentially benefit from universal newborn screening. The cost for each child identified in this group would equal $1.15 million. The cost for every additional year of diagnosis gained would equal $1.06 million.

Sensitivity analysis

If all worst case scenarios held, the costs per child tested, per child with HIV identified, and per additional year of diagnosis gained would equal $6.28, $5.9 million, and $8.4 million, respectively. If all best case scenarios held, the costs per child tested, per child with HIV identified, and per additional year of diagnosis gained would equal $3.07, $208,000, and $147,000, respectively.

Discussion

Two questions arise from the current analysis. First, is it worth screening approximately 270,000 normal newborns to identify one additional child with HIV infection? In principle, the answer could be yes. Currently, Alaska screens for maple syrup urine disease (MSUD), which occurs in one in 250,000-400,000 births (Family Health Dataline, 1996). The newborn screen for MSUD, however, is essentially 100% specific and is performed at no additional cost by the Oregon Public Health Laboratory. Thus, there is no additional cost to the State to include MSUD.

The more pertinent question, then, is whether it is worth approximately one million dollars to diagnose an individual child at one month of age rather than at a little over one year of age. Again, the answer potentially could be yes. For example, in the case of phenylketonuria, it might be worth that price because early diagnosis leads to the prevention of mental retardation. Mental retardation, in addition to its human cost for the child, results in considerable costs to society related to institutionalization, special education services, family disruption, and loss of employment.

Based on the current state of medical knowledge for perinatal HIV infection, though, it is unclear what if any benefit would result from early HIV diagnosis. One study has shown that initiation of antiretroviral therapy at later than 48 hours of age does not prevent infection (Wade et al, 1998). The justification for newborn screening, then, must be improvement of the clinical course with early diagnosis and treatment. This might be in terms of quality of life, hospitalizations, or life expectancy. To date, however, there is no convincing evidence that early treatment affects the clinical course.

Moreover, investing resources in universal newborn screening must be weighed against a strategy to increase the proportion of pregnant women receiving HIV testing and to increase the proportion of HIV positive women who receive antiretroviral therapy. This second strategy has the distinct advantage that it can decrease perinatal transmission from 27% to 6% (Wade et al, 1998). Additionally, if every HIV positive woman were detected during pregnancy, newborn screening could be targeted solely to their infants, thereby also achieving all of the advantages of universal newborn screening while eliminating most of the costs associated with this strategy.

It is likely that for the foreseeable future, the State would need to assume the programmatic and test costs of a universal newborn HIV screening program. Current regulations set reimbursement for newborn screening at $24.99 and require a sliding fee system for any charges over $25.00. Consequently, increasing the reimbursement rate for newborn screening to cover the cost of HIV testing would require revising the newborn screening regulations as well as the regulations governing the method by which the State is reimbursed for the provision of medical services.

In summary, a universal newborn HIV screening program does not seem justified at this point. Instead, efforts should be directed at increasing the proportion of pregnant women receiving early and consistent prenatal care, increasing the proportion of those in prenatal care who receive HIV testing, and increasing the proportion of HIV positive pregnant women who adhere to an appropriate antiretroviral therapy regimen. These conclusions are in agreement with an independent report produced by the Division of Public Health on preventing perinatal HIV transmission (see “Preventing Perinatal Transmission of HIV Infection in Alaska”).

References

Barnhart HX, Caldwell MB, Thomas P, Mascola L, Ortiz I, Hsu HW, Schulte J, Parrott R, Maldonado Y, Byers R (1996). Natural history of human immunodeficiency virus disease in perinatally infected children: an analysis from the Pediatric Spectrum of Disease Project. Pediatrics vol. 97:710-6.

Dunn DT, Brandt CD, Krivine A, Cassol SA, Roques P, Borkowsky W, De Rossi A, Denamur E, Ehrnst A, Loveday C (1995). The sensitivity of HIV-1 DNA polymerase chain reaction in the neonatal period and the relative contributions of intra-uterine and intra-partum transmission. AIDS vol. 9:F7-11.

Family Health Dataline (1996). Alaska Newborn Screening Program. Alaska Section of Maternal, Child, and Family Health. September, vol. 2, # 7.

Fiscus SA, Adimora AA, Schoenbach VJ, Lim W, McKinney R, Rupar D, Kenny J, Woods C, Wilfert C (1996). Perinatal HIV infection and the effect of zidovudine therapy on transmission in rural and urban counties. JAMA vol. 275:1483-8.

Luzuriaga K, Bryson Y, Krogstad P, Robinson J, Stechenberg B, Lamson M, Cort S, Sullivan JL (1997). Combination treatment with zidovudine, didanosine, and nevirapine in infants with human immunodeficiency virus type 1 infection. N Engl J Med vol. 336:1343-9.

MMWR (1997). Perinatally Acquired HIV/AIDS -- United States, 1997 November 21, vol. 46:1086-1092.

Mofenson LM, Korelitz J, Meyer WA 3rd, Bethel J, Rich, K, Pahwa S, Moye J Jr, Nugent R, Read J (1997). The relationship between serum human immunodeficiency virus type 1 (HIV- 1) RNA level, CD4 lymphocyte percent, and long-term mortality risk in HIV-1-infected children. National Institute of Child Health and Human Development Intravenous Immunoglobulin Clinical Trial Study Group. J Infect Dis vol. 175:1029-38.

Palumbo PE, Raskino C, Fiscus S, Pahwa S, Fowler MG, Spector SA, Englund JA, Baker CJ (1998). Predictive value of quantitative plasma HIV RNA and CD4+ lymphocyte count in HIV-infected infants and children. JAMA vol. 279:756-61.

Wade NA, Birkhead GS, Warren BL, Charbonneau TT, French PT, Wang L, Baum JB, Tesoriero JM, Savicki R (1998). Abbreviated regimens of zidovudine prophylaxis and perinatal transmission of the human immunodeficiency virus. N Engl J Med vol. 339:1409-14.

Wiznia AA, Crane M, Lambert G, Sansary J, Harris A, Solomon L (1996). Zidovudine use to reduce perinatal HIV type 1 transmission in an urban medical center. JAMA vol. 275:1504-6.