Evidence from Zaire that breast-feeding by HIV-1-seropositive mothers is not a major route for perinatal HIV-1 transmission but does decrease morbidity

Robert W. Ryder*, Tarande Manzila*, Ekungola Baende*, Uwa Kabagabo*, Frieda Behets†§, Véronique Batter†§, Edward Paquot‡, Enbonga Binyingo† and William L. Heyward†

Breast-feeding as a route of HIV-1 transmission during infancy but also as a protective measure against early childhood morbidity has been investigated prospectively in children born to HIV-1-seropositive mothers and control children born to age- and parity-matched HIV-1-seronegative women. The mothers of all study children had been enrolled antenatally at a maternity hospital in Kinshasa, Zaire, which served a relatively affluent group of women who sometimes chose not to breast-feed their infants. In 106 children born to HIV-1-seropositive women, the rate of HIV-1 transmission was 21% in 28 infants exclusively breast-fed, 19% in 68 infants both breast- and bottle-fed and 0% in 10 infants who were bottle-fed only \( (P = 0.35) \). In contrast, non-HIV-1-infected children of both HIV-1-seropositive and HIV-1-seronegative mothers who were exclusively breast-fed compared with uninfected children who were not exclusively breast-fed had significantly lower incidence rates of acute diarrhea, fever and lower respiratory tract infection. The lack of a dose-response effect between breast-feeding and perinatal HIV-1 transmission and the presence of a protective effect of breast-feeding against common causes of early childhood morbidity and mortality support the current World Health Organization recommendation that breast-feeding should continue to be promoted in all developing countries, including those with high HIV-1 prevalence rates in women of childbearing age.

AIDS 1991, 5:709–714

Keywords: Breast-feeding, breast-milk, perinatal HIV-1 infection, Zaire, dose–response, human milk.

Introduction

The detection of HIV-1 in breast-milk and the publication of several reports implicating breast-feeding as a transmission route of HIV-1 infection have stimulated health authorities in many developed countries to recommend that HIV-1-seropositive women should not breast-feed their children [1–5]. This recommendation is practical for countries where alternatives to breast-milk are widely available and where the overall benefits of breast-feeding are relatively minor in terms of child survival. In contrast, in developing countries any HIV prevention program which might result in a decrease in breast-feeding would have to consider the well-established protective effects of breast-milk against common causes of early childhood morbidity and mortality versus the as yet unquantified, though probably quite small, risk of HIV-1 transmission through breast-milk [6]. In these same countries prevention of HIV-1 transmission through breast-feeding would also necessitate the creation and continued maintenance of costly pre-pregnancy and antenatal HIV-1 testing and counselling in primary health care programs in regions where resources for these activities are often limited [7]. For

From the *Project SIDA, Department of Public Health, Kinshasa, Zaire, the †Division of HIV/AIDS, Center for Infectious Diseases, Centers for Disease Control, Atlanta, Georgia, USA, the ‡Cliniques Ngaliema, Kinshasa, Zaire and the §Institute of Tropical Medicine, Antwerp, Belgium.

Requests for reprints to: Dennis G. Olsen, Division of HIV/AIDS, Mailstop G29, CDC, Atlanta, GA 30333, USA.


© Current Science Ltd ISSN 0269-9370
these reasons, the World Health Organization (WHO) has continued to recommend that all women in the developing world breast-feed their infants despite the rapid progression of the HIV epidemic in many developing countries, particularly in Africa [8].

The presence of these diametrically opposed recommendations on breast-feeding for HIV-1-seropositive mothers, one for the developing world and another for the developed world, has created confusion among breast-feeding women and concern among public health officials that HIV infection might stigmatize breast-feeding in those areas where it has been shown to be most beneficial [9]. To help resolve this contradiction, we have determined the rates of perinatally acquired HIV-1 infection and subsequent morbidity in a group of children born to either HIV-1-seropositive or HIV-1-seronegative mothers who breast and/or bottle-fed their infants during the first 12 months of life.

Methods

Study site and patients

The study was carried out at a Kinshasa maternity clinic serving mothers of relatively high socioeconomic status who frequently chose not to breast-feed their children or to breast-feed for only a few months postpartum. It was conducted as part of an ongoing study to define the incidence and natural history of perinatally acquired HIV-1 infection in Zaire [10]. Between 30 April 1988 and 28 February 1989, 2192 women consecutively attending the hospital’s antenatal clinic were screened for HIV-1 antibodies. For each HIV-1-seropositive woman, one or two HIV-1-seronegative control women seen on the same day and matched for age (within 2 years) and parity were selected. These women and their newborn infants were seen at monthly intervals for the first 18 months after delivery. To assess the socioeconomic status of women at the start of the study the following indices were used: presence of municipal water or electricity in the home, type of toilet, and highest level of education attained.

All children initially enrolled in the study, and who were still alive at the age of 6 months, were subsequently entered into a sub-study which sought to define the risk of HIV-1 infection associated with breast-feeding. At each clinic visit, mothers of study infants were asked to estimate the relative amounts of milk that their child had consumed during the previous month through breast- and/or bottle-feeding (exclusively breast-fed, mixture of breast- and bottle-feeding, or exclusively bottle-fed). Through this method of quantification we sought to determine whether a dose–response effect could be demonstrated between the amount of breast-milk consumed and the risk of acquiring perinatal HIV-1 infection. The demonstration of a dose–response effect is an epidemiologic method of demonstrating causality in which a change in level of exposure (amount of breast-milk consumed) is associated with a change in risk of a specified outcome (perinatally acquired HIV-1 infection) [11]. At each clinic visit mothers were also asked if their child had experienced any episodes of acute diarrhea, fever, acute lower respiratory tract infection, or purulent otitis media in the previous 30 days. Height and weight measurements were obtained at each visit. An episode of acute diarrhea was defined as the passage of at least two stool samples which took the form of a cup in a 24h period and which ended within 7 days of onset. Episodes of acute fever consisted of a fever lasting for more than 7 days. Acute lower respiratory tract infection consisted of an episode of tachypnea, nasal flaring, cough, auscultatory findings elicited by a physician member of the research team which were compatible with pulmonary consolidation and/or a chest radiograph with a pulmonary infiltrate. Purulent otitis media was defined as the observation of purulent drainage from one or both ears. Failure-to-thrive was defined as having a weight-for-age ratio below the 10th percentile for 2 consecutive months using the standards of the National Center for Health Statistics, Bethesda, Maryland, USA.

To maximize the likelihood that all episodes of morbidity and mortality would be identified by the research team, all mothers of study children were encouraged to bring their children to the research clinic each time they were ill. All taxi transportation, health professional and medication costs were borne by the research team.

Before being enrolled, all study women gave informed consent for themselves and their infants to participate in the study according to guidelines approved by the Zairian Ministry of Health.

Laboratory procedures

Antepartum maternal serum samples were tested for antibodies to HIV-1 by an enzyme-linked immunosorbent assay (ELISA; Wellcozyme, Wollstone, London, UK). Blood obtained from all children in the cohort at the age of 12 and 18 months was also tested for the presence of HIV-1 antibodies by ELISA. All repeatedly reactive specimens on RIA were confirmed as positive by HIV-1 Western blot (Du Pont de Nemours, Geneva, Switzerland) if at least two of the bands corresponding to gp24, gp41 or gp120/gp160 were visualized [12].

Clinical criteria for AIDS

The WHO case definition of adult AIDS in Africa, previously validated in Kinshasa, was used to diagnose AIDS in the mothers in our study [13]. To assess the clinical evolution of HIV-1 infection in children of seropositive...
mothers, we calculated a monthly infant AIDS score for each child [10]. This score was based on the criteria set out in the WHO clinical case definition of pediatric AIDS in Africa [14]. Major criteria were: prolonged fever (documented temperature higher than 37.5°C for 15 days in 1 month), persistent diarrhea (passage of more than two stools per day that took the shape of a container for 15 days during a month), and failure to thrive (weight-for-age ratio below the 10th percentile on the scale of the National Center for Health Statistics for 2 consecutive months). Minor criteria in the definition were generalized lymphadenopathy, oropharyngeal candidiasis after the age of 6 months, pneumonia, and a generalized papular dermatitis. We assigned a point score of 3 for each major criterion and 2 for each minor criterion except dermatitis, which was given a value of 1 because of the relative frequency of various non-specific skin conditions in our study population. Any child with an HIV-1-seropositive mother and a cumulative score of 10 or more points was considered to have clinically defined AIDS.

Criteria for perinatally acquired HIV-1 infection
Any child who developed a positive AIDS score and/or had detectable HIV-1-specific immunoglobulin G (IgG) antibodies in a serum sample collected at the age of 12 and/or 18 months was defined as having perinatally acquired HIV-1 infection.

Results

Between April 1986 and February 1987, 133 HIV-1-seropositive and 269 HIV-1-seronegative mothers matched for age and parity were recruited into the perinatal HIV-1 transmission study [10]. From this group, 106 (80%) HIV-1-seropositive mothers and their infants and 231 (86%) HIV-1-seronegative control mothers and their infants participated in our study to determine the risk of HIV-1 infection associated with breast-feeding. Twenty-seven (20%) HIV-1-seropositive children were included in the perinatal transmission cohort but not in the breast-feeding study. The reasons for their non-inclusion were: death of the child before the age of 6 months (16) and loss to follow-up (11). Thirty-eight (14%) control infants in the perinatal transmission study were not included in the breast-feeding study. Their reasons for non-inclusion were: death of the child before the age of 6 months (eight) and loss to follow-up (30). None of the 337 children enrolled in the breast-milk study died before the age of 12 months.

The age of weaning of study infants did not vary by maternal HIV-1 serostatus (Fig. 1). The mean age of weaning was the same in HIV-1-seropositive and HIV-1-seronegative mothers (9.9 months). Of the various indices of socioeconomic status which we used to compare breast-feeding and non-breast-feeding women during the year of follow-up, only a high level of education in HIV-1-seronegative women and early cessation of breast-feeding was significantly associated (Table 1). Twenty-six per cent of the HIV-1-seropositive and 29% of the HIV-1-seronegative mothers exclusively breast-fed their infants during the first 3 months of life. Ten of 106 (9%) HIV-1-seropositive mothers never breast-fed their infants compared with three (1%) of 231 HIV-1-seronegative women ($P < 0.001$). One of the six (17%) HIV-1-seropositive women with AIDS at the time of delivery exclusively breast-fed her infant during the 3-month postpartum period compared with 27 of the 100 (27%) HIV-1-seropositive women who did not have AIDS ($P < 0.01$). The mean age of weaning did not vary with HIV-induced disease status; mothers with AIDS ($n = 6$) at the time of delivery weaned their children at an average age of 10.8 months, compared with a mean age of 10.2 months for mothers with AIDS-related complex ($n = 4$) and a mean age of 9.9 months for asymptomatically-infected women ($n = 96$). All infants who were bottle-fed received powdered commercial milk containing formula or cow's milk.

![Fig. 1. Percentage of children exclusively receiving breast-milk by age in months according to maternal HIV-1 serostatus. Experience of the 231 children with HIV-1-seronegative mothers (○); experience of 106 children with HIV-1-seropositive mothers (●). Nineteen of the 106 (18%) children born to HIV-1-seropositive mothers developed evidence of perinatally acquired HIV-1 infection. In 11 of these infants the diagnosis was based on the detection of HIV-1 IgG antibodies at the age of 12 and 18 months of life. Four infants with HIV-1-seropositive mothers died at ages 15 months (two), 16 months (one) and 23 months (one). These four infants most probably died with AIDS as they all had a positive AIDS score at the time of death and had detectable HIV-1 IgG antibodies in their serum samples collected at the age of 12 months.
Table 1. Relationship between maternal education, infant-feeding practice and maternal serostatus.

<table>
<thead>
<tr>
<th>Maternal serostatus</th>
<th>HIV+</th>
<th>HIV-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excl BF* (n = 24)</td>
<td>Not excl BF (n = 70)</td>
<td>Excl BF (n = 48)</td>
</tr>
<tr>
<td>Primary school</td>
<td>9%</td>
<td>7%</td>
</tr>
<tr>
<td>Secondary school</td>
<td>82%</td>
<td>83%</td>
</tr>
<tr>
<td>University</td>
<td>9%</td>
<td>10%</td>
</tr>
</tbody>
</table>

*Excl BF, exclusively breast-fed in first 3 months life. \*P < 0.01 for trend in HIV-1-seropositive mothers. Information on educational status was not available for 12 HIV-1-seropositive and 82 HIV-1-seronegative mothers included in the initial cohort.

Two additional infants with perinatally acquired infection were HIV-1-seropositive at the age of 12 months and had a positive AIDS score at the time they were lost to follow-up at the ages of 19 and 20 months. The final two children with HIV infection had HIV-1 IgG antibodies at the age of 12 months and were asymptomatic when lost to follow-up before the confirmatory 18-month blood sample could be obtained. All control infants remained alive and HIV-1-seronegative throughout the observation period.

Among babies born to HIV-1-seropositive mothers, we were unable to demonstrate a significant dose-response effect between the amount of breast-feeding and HIV-1 infection (Table 2). All children who were exclusively breast-fed for the first 6, 9 and 12 months of life also failed to show a significant dose-response effect.

Table 2. Risk of developing HIV-1 infection in infants with seropositive mothers according to feeding practice during the first 3 months of life.

<table>
<thead>
<tr>
<th>Type of feeding practice</th>
<th>Breast and Bottle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did develop perinatal HIV-1 infection (%)</td>
<td>(n = 28)</td>
</tr>
<tr>
<td>Breast</td>
<td>6 (21)</td>
</tr>
<tr>
<td>Bottle</td>
<td>22</td>
</tr>
</tbody>
</table>

\*P = 0.35 \times \chi^2 for trend.

3). Among the 19 children with laboratory evidence of perinatally acquired HIV-1 infection, the development of clinical AIDS did not correlate with the type of infant-feeding practice during his/her first 3 months of life. One out of seven (14.2%) infants receiving only mother’s milk during the first 3 months of life developed AIDS by the age of 12 months, compared with four out of eight (50%) infants who received both artificial and mother’s milk and one out of four (25%) of infants who received artificial milk only.

Table 3. Morbidity in study children during the first year of life according to maternal and child HIV-1 infection and breast-feeding pattern.

<table>
<thead>
<tr>
<th>Disease or condition*</th>
<th>HIV+ children BF (n = 19)</th>
<th>HIV+ children Not BF (n = 60)</th>
<th>HIV- children BF (n = 54)</th>
<th>HIV- children Not BF (n = 177)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute diarrhea</td>
<td>284.2†</td>
<td>92.6†</td>
<td>23.7†</td>
<td>118.5†</td>
</tr>
<tr>
<td>Acute fever</td>
<td>257.9</td>
<td>100.0</td>
<td>310.0</td>
<td>166.7†</td>
</tr>
<tr>
<td>Acute lower respiratory tract infection</td>
<td>57.9</td>
<td>0.0†</td>
<td>150.0†</td>
<td>19.0†</td>
</tr>
<tr>
<td>Acute purulent otitis media</td>
<td>36.8†</td>
<td>11.7†</td>
<td>25.0†</td>
<td>3.7†</td>
</tr>
<tr>
<td>Failure to thrive</td>
<td>84.2†</td>
<td>3.7†</td>
<td>15.0†</td>
<td>9.2†</td>
</tr>
</tbody>
</table>

BF, breast-fed exclusively during the first 6 months of life; Not BF, not exclusively breast-fed during the first 6 months of life. *Incidence = episodes per 100 years of observation. †Includes breast-fed and not exclusively breast-fed children. Differences in the incidence rates in children with HIV-1 infection and the rates in uninfected children with HIV-positive mothers is significant \(P < 0.01\). ‡For children with HIV-positive mothers the incidence in children between uninfected exclusively breast-fed infants and uninfected and not exclusively breast-fed infants is significant \(P < 0.01\). §For children with HIV-negative mothers the difference in incidence between uninfected exclusively breast-fed infants and uninfected not exclusively breast-fed infants is significant \(P < 0.01\).

**Discussion**

In this prospective study undertaken in a maternity hospital serving pregnant mothers from the higher socioeconomic strata of Kinshasa, 19 of the 106 (18%) children born to HIV-1-seropositive mothers included in our study developed evidence of HIV-1 infection. Our inability to demonstrate a significant dose-response effect between the proportion of milk received through breast or bottle-feeding and the subsequent risk of developing HIV-1 infection suggests that, in this study population of largely asymptomatically HIV-1-infected mothers, HIV-1 infection via breast-feeding was not a major mode of HIV-1 transmission.

Our study does not enable us to say that some of our study infants who acquired perinatal HIV-1 infec-
tion did not acquire their infection through breast-milk. HIV-1 infection through breast-feeding may have occurred at a rate too low for us to detect because of the limited statistical power of our study. It will be difficult to carry out quantitative studies to establish the attributable risk associated with breast-feeding and HIV-1 transmission, even in regions such as Kinshasa where the HIV-1 seroprevalence among women of child-bearing age is high. Breast-feeding is almost universally practised in these areas and identification of a suitable control group of bottle-fed infants would be difficult for ethical reasons. The requirement of a large sample size would also hinder the conduct of such a study. For example, in the present study we observed an 18% perinatal HIV-1 transmission rate. If we assume that 25% of all perinatal HIV-1 transmission in our study population occurred through breast-feeding (probably a high estimate), then the HIV-1 transmission rate in a group of exclusively bottle-fed babies in our study population would have been approximately 14%. An intervention study in this population with a power of 90% and a P value of 0.05 would require 1252 infants born to HIV-1-seropositive mothers who exclusively breast-feed their infants during the first 3 months of life and an additional 1252 infants born to HIV-1-seropositive mothers who would be asked to not exclusively breast-feed their infants during the first 3 months of life. Given the present HIV-1 seroprevalence of 6% which we have established in several Kinshasa maternity clinics, we would have to test and counsel approximately 42,000 consenting pregnant women simply to identify the study population necessary for the conduct of this study [15]. For these reasons, the exact attributable risk of HIV-1 transmission through breast-feeding is likely to remain poorly defined, though, as shown by our study, probably quite low.

Previous case reports documenting that breast-feeding can be a mode of HIV-1 transmission have primarily consisted of atypical circumstances involving mothers who developed HIV-1 infection shortly after the birth of their child [2,3,4,16]. These children were therefore exposed to HIV-1 during their mothers’ seroconversion phase when HIV-1 viremia and the risk of infectivity is particularly high. The mothers enrolled in the present study more typically reflect the most commonly encountered situation; that is, most women were probably infected before the birth of their infant and may have posed less of an infective risk than women infected during the period that they breast-fed their child.

In presenting our data, we have focused on infant-feeding practices during the first 3 months of life. We have hypothesized that if breast-milk from a seropositive mother is infectious, it is likely that most transmission would occur during this period. However, HIV-1 infection rates for children of seropositive mothers who exclusively breast-fed their infants for the first 6, 9 and 12 months of life also failed to demonstrate a significant dose–response effect.

Because 92.6% of HIV-1-seropositive and 93.9% of HIV-1-seronegative women had completed high school and were therefore likely to be literate emphasizes the generally high socioeconomic status of women enrolled in this study. The correlation between early weaning and high level of education status in HIV-1-seronegative women reflects the previously documented trend in Africa for better educated women either to never breast-feed or to wean their children at an early age [17].

Previous studies of early childhood acquired HIV-1 infection have been hindered by high infant mortality rates in the first 6 months of life, when the presence of maternal antibodies in an infant’s blood prevents a conclusive diagnosis of HIV-1 infection [10,18,19]. We sought to avoid this selection bias by enrolling only children who were still alive at the age of 6 months. However, by selecting children in this manner it is possible that we may have inadvertently introduced another selection bias into our study. Although apparently biologically implausible, most cases of HIV-1 transmission through breast-feeding might have occurred in the 27 children with HIV-1-seropositive mothers who died [16] or were lost to follow-up [11] in the first 6 months of life before enrollment in the present study.

While no child enrolled in our cohort died during follow-up, children with perinatally acquired HIV-1 infection and uninfected children who were not breast-fed experienced similar high rates of morbidity. Investigators in Italy have recently presented data which suggested that children with perinatally acquired HIV-1 infection who were breast-fed progress to AIDS more slowly and live longer than similarly infected children who were not breast-fed [20]. In the present study our inability to demonstrate that HIV-infected infants who were exclusively breast-fed experienced significantly lower rates of morbidity and mortality than similarly infected infants who were not exclusively breast-fed may be due to the small number of these children included in our study and the resultant low statistical power. Among non-HIV-infected children, with or without HIV-1-seropositive mothers, morbidity from all five indicator diseases/conditions was consistently lower among exclusively breast-fed compared with non-exclusively breast-fed infants. The protective effect of breast-feeding against agents responsible for most early childhood morbidity caused by an infectious agent has been demonstrated previously [6,21–23]. Non-breast-fed children with perinatally acquired HIV-1 infection may be at increased risk of early childhood morbidity as these children may have lower threshold doses for effective expo-
sure to these agents. In studying morbidity patterns we
grouped infants according to their breast-feeding sta-
tus during the first 6 months of life. After the age of
6 months weaning rates became so high that they left
an insufficient number of exclusively breast-fed infants
available for analysis.

The perinatal HIV-1 transmission rate in this study
is lower than the rate we documented in previous
studies in the same population [10]. This difference
is probably explained by our selection criteria (only
infants alive at the age of 6 months were included
in the breast-feeding study) and by the low preva-
ence of AIDS in mothers in the study population.
We have previously shown that pregnant HIV-1-seroposi-
tive women most advanced in the natural history of
their disease are most infectious to their newborn in-
fants [10].

In conclusion, a risk of perinatal transmission of HIV-1
infection through breast-feeding could not be demon-
strated in our study. This non-detectable and presumed
ly low risk combined with the significantly lower morbi-
dity from common childhood diseases such as
diarrhea or lower respiratory tract infection, which we
found in non-HIV-1-infected breast-fed infants with ei-
ther HIV-1-seropositive or seronegative mothers, re-
confirms the current WHO recommendation that all
mothers in the developing world, regardless of their
HIV-1 serostatus, should breast-feed their young in-
fants [8].

Acknowledgements

We would like to acknowledge the assistance of Cits. B. Zola, M.
Mudihary, M. Kashamuka and Drs. S. Hassig, M. Okeya, H. Francis,
R. Colebunders, P. Piot, T. Quinn and J. Currin. The secretarial
assistance of Gt. Ephrem Maozyo and Ms. Alvara McBean is also
gratefully acknowledged.

References

1. THIRY I, SPECHER-GOLDBERGER S, JONKER T, ET AL.: Isolation
   of the AIDS virus from cell-free breast-milk of three healthy
2. ZEDEK JI, COOPER DA, JOHNSON RD, GOLD J: Postnatal trans-
   mission of AIDS-associated retrovirus from mother to in-
3. COLEBUNDERS RL, KAPITA B, NDKWE W, BAFWE Y, IBEBUE I,
   ORTOBY M, RYDER RW: Breast-feeding and transmission of
4. LEPAGE P, VAN DE PIERRE P, CARAIL M, ET AL.: Postnatal trans-
5. CENTERS FOR DISEASE CONTROL: Recommendations for assist-
   ing in the prevention of perinatal transmission of human
   T-lymphotropic virus type III, lymphadenopathy-associated
   virus and acquired immunodeficiency syndrome. _MMWR_
6. VICTORA CG, SMITH PG, VAUGHAN JP, ET AL.: Evidence of pro-
   tection by breast-feeding against infant deaths from infec-
7. HASSIG S, KINKELA N, NIA W, ET AL.: Prevention of perinatal
   HIV transmission: are there alternatives to pre-pregn-
   nancy serological screening in Kinshasa, Zaire? _AIDS_ 1990,
   4:913–916.
8. WORLD HEALTH ORGANIZATION: Breast-feeding/breast-milk and
   human immunodeficiency virus (HIV). _Weekly Epidemiol Rec_
9. NICOL A, KILEYTO JZ, MGONE C: HIV and infant-feeding
   practices: epidemiological implications for sub-Saharan
10. RYDER RW, NIA W, HASSIG SE, ET AL.: Perinatal transmis-
    sion of the human immunodeficiency virus type 1 to in-
    fants of seropositive women in Zaire. _N Engl J Med_ 1989,
    320:1657–1662.
12. CENTERS FOR DISEASE CONTROL: Interpretation and use of
    Western blot assay for serodiagnosis of human immuno-
    deficiency virus type 1 infection. _MMWR_ 1989, 38:1–7.
13. COLEBUNDERS RL, MANN JM, FRANCIS H, ET AL.: Evaluation of a
    clinical case definition of acquired immunodeficiency syn-
14. COLEBUNDERS RL, GREENBERG A, NGUYEN-DINH P, ET AL.: Evalua-
    tion of a clinical case definition of AIDS in African children.
15. KAMENGA M, RYDER RW, N’GALY B, ET AL.: An HIV survey-
    oscope in the general population of Kinshasa appears feasible.
    _V International Conference on AIDS_ Montreal, June 1989 [ab-
    stract MGO07].
16. HERA S, MANGROGA U, MWALE C, MWANSA N, CHINTU C, PERBEK
    P: Breast-feeding and HIV-1 transmission. _V International
    Conference on AIDS_ Montreal, June 1989 [abstract TH105].
17. FORMAN M: Review of research on the factors associated
    with choice and duration of infant-feeding in less devel-
18. BLANCHE S, ROUDZUIN J, MOSCATO MG, ET AL.: A prospec-
    tive study of infants born to women seropositive for hu-
    man immunodeficiency virus type 1. _N Engl J Med_ 1989,
    320:1643–1648.
19. SCOTT GB, HOUTO C, MAKUCH RW, ET AL.: Survival in children
    with perinatally acquired immunodeficiency virus type 1
20. TOZZI AE, PEZZOTTI P, GRECO D: Does breast-feeding delay
    progression to AIDS in HIV-infected children? (letter). _AIDS_
21. LAUER U, HABICHT JP, KARJATI S: Breast-feeding protects in-
    fants in Indonesia against illness and weight loss due to
22. CLEMENS JD, STANTON B, STALL B, ET AL.: Breast-feeding as a
    determinant of severity of shigellosis; evidence for protec-
    tion throughout the first three years of life in Bangladesh:
23. FRANK AI, Toker J, GLEZEN WP, ET AL.: Breast-feeding and