DIAGNOSIS OF HIV INFECTION IN INFANTS AND CHILDREN

Updated: June 25, 2026
Reviewed: June 25, 2026

Panel's Recommendations

- Virologic assays (quantitative HIV RNA assays, U.S. Food and Drug Administration–approved qualitative HIV1/HIV2 RNA assays, or qualitative HIV DNA nucleic acid tests [NATs]) that directly detect HIV must be used to diagnose HIV in infants and children aged <18 months with perinatal HIV exposure; HIV antibody and HIV antigen/antibody tests should not be used to diagnose HIV in infants and children aged <18 months[a] **(AII).**
- Plasma HIV RNA or cell-associated HIV DNA NATs are generally equally recommended **(AII).**
- Virologic diagnostic testing using an HIV NAT (see Table 13 below) is recommended for all infants with perinatal HIV exposure at the following ages:
  - Birth **(AII)**
    - The test at birth generally should be performed in all infants with perinatal HIV exposure but is not necessary for infants at low risk of HIV acquisition (HIV RNA levels <50 copies/mL from 20 weeks of gestation through delivery). Birth testing should be performed in infants at low risk of HIV acquisition if there are plans to breastfeed or there are concerns about loss to follow-up **(BIII).**
  - 14 to 21 days **(AII)**
  - 1 to 2 months **(AII)**
  - 4 to 6 months **(AII)**
- For infants who receive presumptive HIV therapy, additional virologic diagnostic testing is recommended 2–6 weeks after antiretroviral (ARV) drugs are discontinued **(BII).**
- A positive virologic test should be confirmed as soon as possible by a repeat virologic test **(AII).**
- Definitive exclusion of HIV infection in non-breastfed infants is based on two or more negative virologic tests (and no positive virologic tests), with one negative test obtained at age ≥1 month (and at least 2–6 weeks after discontinuation of infant ARVs) and one at age ≥4 months, or two negative HIV antibody tests from separate specimens that were obtained at age ≥6 months **(AII).**
- Additional HIV testing (e.g., HIV NAT, HIV antibody, HIV antigen/antibody) is not needed routinely for non-breastfed infants who meet the criteria for definitive exclusion of HIV and who have had no known or suspected HIV exposure after birth **(AII).**
- For infants with perinatal HIV exposure who are being breastfed, virologic diagnostic testing is recommended at birth, 14–21 days, 1–2 months, and 4–6 months of age **(AII).** An additional virologic test should be performed if the gap between the tests at ages 1–2 months and 4–6 months is greater than 3 months. See Preventing HIV Transmission During Infant Feeding.
  - Virologic diagnostic testing should be performed at least every 3 months during breastfeeding **(BII);**
  - After cessation of breastfeeding, irrespective of when breastfeeding ends, virologic diagnostic testing should be performed at 4–6 weeks and 3 months after cessation **(BII).**

Infants with potential HIV exposure after birth (e.g., diagnosis of maternal HIV during breastfeeding, premasticated feeding, sexual abuse, contaminated blood products, percutaneous exposure) require additional testing using HIV antigen/antibody and/or HIV NAT assays, based on age at time of exposure and the maternal HIV status at delivery **(AII).**

- Age-appropriate HIV testing is also recommended for infants and children with signs and/or symptoms of HIV, even in the absence of documented or suspected HIV exposure **(AII).**
- For children aged ≥18 months, HIV antibody (or HIV antigen/antibody) tests are recommended for diagnostic testing **(AII).**
  - When early (acute or recent) HIV infection is suspected, additional testing with an HIV NAT may be necessary to diagnose HIV infection **(AII).**

Note: Individual circumstances may warrant modifications to these recommendations. Ascertainment of ongoing HIV exposure risk may be imperfect; diagnostic test performance is highest in the absence of ARV exposure. The National Perinatal HIV Hotline provides consultations on issues related to the management of perinatal HIV infection, including diagnostic testing (1-888-448-8765; 24 hours a day, 7 days a week).

Rating of Recommendations: *A = Strong; B = Moderate; C = Optional*

Rating of Evidence: *I = One or more randomized trials in children† with clinical outcomes and/or validated endpoints; I* = One or more randomized trials in adults with clinical outcomes and/or validated laboratory endpoints with accompanying data in children† from one or more well-designed, nonrandomized trials or observational cohort studies with long-term clinical outcomes; II = One or more well-designed, nonrandomized trials or observational cohort studies in children† with long-term outcomes; II* = One or more well-designed, nonrandomized trials or observational studies in adults with long-term clinical outcomes with accompanying data in children† from one or more similar nonrandomized trials or cohort studies with clinical outcome data; III = Expert opinion*

† Studies that include children or children/adolescents, but not studies limited to postpubertal adolescents

[a] HIV antibody testing might be needed in infants aged <18 months to evaluate for HIV exposure when the mother is not available for testing.

Diagnosis of HIV in Infants and Children

HIV can be diagnosed definitively by virologic testing in most non-breastfed infants with perinatal HIV exposure by age 1 to 2 months and in all by age 4 to 6 months. Antibody tests, including antigen/antibody combination immunoassays, do not establish the presence of HIV in infants because HIV antibodies that have been transferred transplacentally may be detected (i.e., false positive); therefore, a virologic test must be used.[1,2]

Positive virologic tests (i.e., nucleic acid tests [NATs]—a class of tests that includes HIV RNA and HIV DNA polymerase chain reaction [PCR] assays and related RNA qualitative or quantitative assays) indicate likely HIV infection. Plasma HIV RNA and HIV DNA NATs are generally equally recommended. However, all tests can be affected by antiretroviral therapy (ART) through transplacental transfer of antiretroviral (ARV) drugs to the fetus during pregnancy or by ARV drugs administered to the infant as prophylaxis or presumptive HIV therapy. HIV DNA assays, though generally less sensitive, may be more sensitive in detecting HIV infection when the infant is receiving ART because identification is based on detection of cell-associated intracellular DNA in whole blood or dried blood spots and does not rely on active viral replication.[3,4] A positive HIV test result should be confirmed as soon as possible by repeat virologic testing, because false-positive results can occur with both RNA and DNA assays.[5]

Antigen/antibody combination immunoassays that detect HIV-1/2 antibodies and HIV-1 p24 antigen **are not recommended** for diagnosis of HIV infection in infants with known perinatal HIV exposure. In the first months of life, the antigen component of antigen/antibody tests is less sensitive than an HIV NAT, and antibody tests should not be used for HIV diagnosis in infants and children aged <18 months.[6-8] Children with perinatal HIV exposure who are aged[3] 18 months occasionally have residual HIV antibodies from the antepartum period; definitive confirmation of HIV infection in children in this age group who remain HIV antibody–positive should be based on a NAT (see Special

Situations below). Diagnosis in children aged ≥18 months relies primarily on HIV antibody and antigen/antibody tests (see Diagnostic Testing in Children With Postnatal HIV Exposure below).[1]

An infant who has a positive HIV antibody test when maternal HIV status is unknown (see Pregnancy and Postpartum HIV Testing and Identification of Perinatal and Postnatal HIV Exposure) should be assumed to have been exposed to HIV. The non-breastfed infant should undergo HIV diagnostic testing, as described in Timing of Diagnostic Testing in Infants with Perinatal HIV Exposure below,[5] and receive presumptive HIV therapy as soon as possible (see Antiretroviral Management of Infants with *In Utero*, Intrapartum, or Breastfeeding Exposure to HIV).

Timing of Diagnostic Testing in Infants With Perinatal HIV Exposure

Confirmation of HIV infection is based on the results of positive virologic tests from two separate blood samples in infants and children aged <18 months. Table 13 below summarizes the timing of recommended virologic diagnostic testing for infants based on HIV transmission risk. Infants at high risk of perinatal HIV transmission may require additional virologic testing, given the increased risk of infection and concern that ARV prophylaxis, particularly combination ARV prophylaxis or presumptive HIV therapy, may reduce the sensitivity of diagnostic testing. The risk of transmission is determined based on whether viral suppression is achieved and sustained during pregnancy and postpartum.

HIV infection can be **presumptively excluded** in non-breastfed infants with two or more negative virologic tests (one at age ≥2 weeks and one at age ≥4 weeks), one negative virologic test at age ≥8 weeks at least 2 weeks after discontinuing multidrug ARV prophylaxis/presumptive therapy, or one negative HIV antibody test at age ≥6 months.[1,5]

Definitive exclusion of HIV infection in non-breastfed infants is based on two or more negative virologic tests, with one negative test obtained at age ≥1 month (and at least 2–6 weeks after discontinuation of infant ARVs) and one at age ≥4 months, or two negative HIV antibody tests from separate specimens that were obtained at age ≥6 months. For both presumptive and definitive exclusion of HIV infection, a child must have no other laboratory evidence (i.e., no positive virologic test results or low CD4 T lymphocyte cell count/percentage) or clinical evidence of HIV infection and must not be breastfeeding. No additional HIV testing of any kind (e.g., NAT, antibody, antigen/antibody) is needed routinely for non-breastfed infants who meet the criteria for definitive exclusion of HIV and who have had no known or suspected HIV exposure after birth.

Pneumocystis jirovecii pneumonia (PCP) prophylaxis is recommended for infants with **indeterminate** HIV infection status starting at age 4 to 6 weeks until they are determined to be presumptively or definitively without HIV infection.[9] Thus, PCP prophylaxis can be avoided or discontinued if HIV infection is presumptively excluded (see Initial Postnatal Management of the Neonate Exposed to HIV and *Pneumocystis jirovecii* Pneumonia in the Pediatric Opportunistic Infection Guidelines).

Virologic Testing at Birth

Virologic testing at birth provides insights about the timing of HIV transmission and supports early HIV diagnosis for rapid initiation of ART when indicated (see When to Initiate Antiretroviral Treatment in Children With HIV Infection in the Pediatric Antiretroviral Guidelines). Infants who have a positive virologic test result at or before age 48 hours are considered to have early (*in utero*) infection, whereas non-breastfed infants who have a negative virologic test result during the first

week of life and subsequently have positive test results are considered to have intrapartum infection.[3,10,11]

In addition to early HIV diagnosis, results of birth testing are used in clinical decisions about infant ARV management. Negative HIV virologic testing at birth would rule out *in utero* infection and allow de-escalation of a three-drug presumptive HIV therapy regimen for some infants. See Table 11 and associated content in Antiretroviral Management of Infants With *In Utero,* Intrapartum, or Breastfeeding Exposure to HIV.

Virologic testing at birth should generally be performed for all infants with perinatal HIV exposure but is not necessary for infants who are at low risk of infection (HIV RNA levels <50 copies/mL from 20 weeks of gestation through delivery) unless there are plans to breastfeed. When breastfeeding is planned for an infant at low risk of HIV acquisition, a birth test provides baseline information should the infant subsequently have a positive test. Virologic testing at birth should also be considered whenever there are concerns that the newborn may be lost to follow-up without further testing.

Specimens for HIV testing at birth should be obtained before or immediately after initiating an ARV drug regimen; however, presumptive HIV therapy or ARV prophylaxis should not be delayed. Blood samples from the umbilical cord should not be used for diagnostic evaluation because of the potential for contamination with maternal blood.

Virologic Testing at Age 14 to 21 Days

Virologic assay sensitivity is greatly increased after 2 weeks of age.[5] Early identification of infection permits transition from presumptive HIV therapy to ART (see When to Initiate Antiretroviral Treatment in Children With HIV Infection in the Pediatric Antiretroviral Guidelines).

Virologic Testing at Age 1 to 3 Months

Testing performed at age 1 to 3 months is intended to maximize the likelihood of detecting HIV infection in infants with perinatal HIV exposure. In the HIV Prevention Trials Network 040 study, 93 of 140 infants with HIV infection (66.4%) were identified at birth. Infants who received negative test results in the first 7 days of life received an HIV diagnosis when the next diagnostic test was performed at 3 months of age.[12] For infants at high risk of perinatal HIV transmission, the Panel on Antiretroviral Therapy and Medical Management of Children Living With HIV and the Panel on Treatment of HIV During Pregnancy and Interventions to Reduce Perinatal Transmission (the Panels) suggest performing an additional virologic test 2 to 6 weeks after ARV drugs are discontinued (i.e., at age 8–12 weeks when the infant receives 6 weeks of prophylaxis), given the increased risk of infection and concern that ARV prophylaxis, particularly combination ARV prophylaxis or presumptive HIV therapy, may reduce the sensitivity of diagnostic testing.[12,13] In these situations, many experts recommend one test at age 4 to 6 weeks to allow prompt diagnosis of HIV in infants, with an additional test at 8 to 12 weeks of life (i.e., 2–6 weeks after cessation of prophylaxis or presumptive HIV therapy) to capture additional cases (see Table 13 below). For infants at low risk of HIV transmission, a single test obtained at 1 to 2 months of age may be timed to occur 2 to 4 weeks after cessation of ARV prophylaxis.

Virologic Testing at Age 4 to 6 Months

Infants with HIV exposure who have had negative virologic assays at age 14 to 21 days and at age 1 to 2 months, who have had no positive virologic tests, who have no clinical evidence of HIV infection, and who are not breastfed should be retested at age 4 to 6 months for definitive exclusion of HIV infection.

Antibody Testing at Age 6 Months and Older

Two or more negative results of HIV antibody tests that are performed in non-breastfed infants at age ≥6 months also can be used to exclude HIV infection definitively in children with no clinical or virologic laboratory-documented evidence of HIV infection.[14,15]

Antibody Testing at Age ≥18 Months to Document Seroreversion

In general, no additional HIV testing of any kind (e.g., NAT, antibody, antigen/antibody) is needed routinely for non-breastfed infants who meet the criteria for definitive exclusion of HIV and who have had no known or suspected HIV exposure after birth.

Virologic Testing for Infants Continuing to Breastfeed

Some women with HIV may choose to breastfeed (see Preventing HIV Transmission During Infant Feeding). A descriptive study of 72 people with HIV who breastfed their infants in North America reported high variability in policies, infant ARV prophylaxis, and infant and parental testing practices among institutions and noted the need to identify best care practices.[16] Table 13 summarizes the recommended diagnostic testing schedule for infants who are being breastfed. Infants with perinatal HIV exposure who are breastfed should have virologic diagnostic testing at the standard time points: birth, 14 to 21 days, 1 to 2 months, and 4 to 6 months (see Table 13 below). Additionally, in cases where the gap between the 1-to-2-month and 4-to-6-month time points is greater than 3 months, an additional virologic test should be performed. Birth testing is recommended to provide baseline information should the infant subsequently have a positive test. Infants continuing to be breastfed beyond 6 months of age should have virologic diagnostic testing at least every 3 months during breastfeeding. At cessation of breastfeeding, virologic diagnostic testing should be performed at 4 to 6 weeks and 3 months after breastfeeding has ended, regardless of the age of the infant or child. If the infant is receiving extended ARV prophylaxis during breastfeeding, subsequent exclusion of HIV infection requires two negative HIV NAT tests at least 2 to 6 weeks after ARV drugs have been discontinued and 3 months after breastfeeding cessation. If an infant's virologic test result is positive, a repeat test should be performed as soon as possible and ART promptly initiated.

No data exist to inform the appropriate frequency of maternal viral load testing during breastfeeding. One approach is to monitor plasma viral load every 1 to 2 months during breastfeeding. Additional infant virologic testing using an HIV NAT is indicated if the maternal viral load becomes detectable during breastfeeding (for infant ARV prophylaxis considerations, see Table 12 and Table 12.1 in Antiretroviral Management for Infants With *In Utero*, Intrapartum, or Breastfeeding Exposure to HIV). If maternal viral load is detectable and breastfeeding continues, some Panel members would recommend monthly virologic testing of the infant as an approach to early detection of HIV infection during ongoing exposure. Consultation with an expert and/or the National Perinatal HIV Hotline (1-888-448-8765) is recommended in these situations and for questions about HIV diagnostic testing for infants with perinatal HIV exposure who are being breastfed. For additional information, see Preventing HIV Transmission During Infant Feeding.

Table 13. Recommended Virologic Testing Schedules for Infants With Perinatal and Breastfeeding Exposure to HIV

Infants With Perinatal HIV Exposure (Including Exposure Through Breastfeeding)	
Time Period	**Age at HIV NAT[b,c] Testing**
Birth to 6 months (whether breastfeeding or not)	**Birth** (see note below if Low Risk[a]) **14–21 days** **1–2 months** **2–3 months** (see note below) **4–6 months** **Note:** A test generally should be performed at birth, but beginning testing at 14-21 days could be appropriate for infants at Low Risk[a] of HIV acquisition where loss to follow-up is not a concern. **Note:** For breastfeeding infants and infants with Indeterminate or High Risk[a] of HIV acquisition, 2–3 months testing is indicated if the gap between the tests at age 1–2 months and 4–6 months is greater than 3 months. For all infants, additional virologic testing is recommended 2–6 weeks after infant ARV drugs are discontinued (i.e., at age 2–3 months if the infant receives 6 weeks of ARV drugs). All infants at High Risk[a] of perinatal HIV transmission should have specimens obtained for HIV testing at birth before or immediately after initiating an ARV drug regimen; however, presumptive HIV therapy should not be delayed. If an infant's NAT test result is positive, a repeat test should be performed as soon as possible and ART promptly initiated.
If breastfeeding beyond 6 months	At least every 3 months during breastfeeding
At cessation of breastfeeding (regardless of when breastfeeding ends)	At 4 to 6 weeks after cessation of breastfeeding At 3 months after cessation of breastfeeding **Note:** If the infant is receiving ARV prophylaxis during the breastfeeding period and one of the tests is <2 weeks after cessation of prophylaxis but completed within 4–6 weeks after cessation of breastfeeding, an additional test is needed 2–6 weeks after completion of ARV prophylaxis.
If maternal viremia develops while breastfeeding (a detectable maternal viral load)	Prompt NAT testing of the infant Additional testing time points are based on the clinical scenario and use of infant ARV prophylaxis or presumptive HIV therapy; see Table 12 in Antiretroviral Management of Infants With *In Utero*, Intrapartum, or Breastfeeding Exposure to HIV. If there is a detectable maternal viral load and breastfeeding continues, some Panel members would recommend monthly virologic testing of the infant as an approach to early detection of HIV infection during ongoing exposure. Consultation with an expert is recommended to determine the need for infant ARV prophylaxis or presumptive HIV therapy and additional testing time points.

See Table 11 and Table 11.1 in Antiretroviral Management of Infants With *In Utero*, Intrapartum, or Breastfeeding Exposure to HIV for information about presumptive HIV therapy and ZDV prophylaxis, including duration of ARV drugs.

Consultation with an expert and/or the National Perinatal HIV Hotline (1-888-448-8765) is recommended for questions about HIV diagnostic testing for infants with perinatal HIV exposure who are being breastfed.

See Table 12 in Antiretroviral Management of Infants With *In Utero*, Intrapartum, or Breastfeeding Exposure to HIV for information about extended ARV prophylaxis and presumptive HIV therapy during breastfeeding.

See Preventing HIV Transmission During Infant Feeding for additional guidance about breastfeeding.

[a] This table summarizes standard time points for HIV virologic diagnostic testing of infants according to risk of perinatal acquisition. **High Risk** is defined as maternal viremia (HIV RNA viremia [HIV RNA ≥50 copies/mL]) in the 4 weeks prior to delivery, acute or recent HIV during pregnancy, or HIV diagnosed in labor or postpartum. Viremia can be documented by a laboratory or presumed by other clinical factors (e.g., new diagnosis, ART adherence challenges, stopping ART prior to delivery). **Low Risk** is defined as sustained maternal viral suppression (<50 copies/mL) from 20 weeks of gestation through delivery. Ideally, sustained viral suppression is documented by HIV RNA testing, including at least two consecutive tests obtained at least 4 weeks apart with HIV RNA <50 copies/mL, but can be based on the clinical judgment of providers. **Indeterminate Risk** is defined as infants not meeting criteria for High Risk or Low Risk of HIV acquisition.

[b] HIV RNA or HIV DNA NATs that directly detect HIV.

[c] If maternal HIV-2 infection is suspected or confirmed, infant testing for HIV-2 can follow the same schedule (see Virologic Assays to Diagnose HIV-2 Infections below).

Key: ART = antiretroviral therapy; ARV = antiretroviral; NAT = nucleic acid test; Panel = the Panel on Antiretroviral Therapy and Medical Management of Children Living With HIV and the Panel on Treatment of HIV During Pregnancy and Interventions to Reduce Perinatal Transmission; ZDV = zidovudine

Diagnostic Testing in Children With Postnatal HIV Exposure

Infants and children with potential HIV exposure after birth (e.g., HIV diagnosed during breastfeeding, premasticated feeding, sexual abuse, contaminated blood products, percutaneous exposure) require age-appropriate testing. Infants with perinatal HIV exposure who have these additional exposures after birth require HIV NAT testing for diagnosis. Infants aged <18 months who were not exposed to HIV at delivery and infants aged ≥18 months who have these potential exposures require HIV antigen/antibody testing, unless the time between potential exposure and testing indicates that the patient is in the window for seroconversion, when an HIV NAT is more sensitive. Repeat testing may still be required (see Pregnancy and Postpartum HIV Testing and Identification of Perinatal and Postnatal HIV Exposure for additional information).

New Maternal HIV Diagnosis While Breastfeeding

Infants may be exposed to HIV through breastfeeding if acute maternal HIV infection occurs or when pre-existing HIV infection was not diagnosed during pregnancy or postpartum.[17] The diagnosis of maternal HIV infection during breastfeeding should prompt health care professionals to counsel to discontinue breastfeeding immediately to reduce the risk of postnatal transmission to the infant. In these situations, iterative infant virologic diagnostic testing using an HIV NAT is recommended immediately and 14 to 21 days, 4 to 6 weeks, and 3 months after the infant's last exposure to breast milk (i.e., cessation of breastfeeding). A virologic test also should be performed at least 2 weeks after cessation of presumptive HIV therapy if provided (see Antiretroviral Management of Infants With In Utero, Intrapartum, or Breastfeeding Exposure to HIV). Duplicate tests are not needed if some of these time points overlap with standard postnatal testing. For additional information, consult the National Perinatal HIV Hotline (1-888-448-8765).

Premastication

Receipt of solid food that has been premasticated or prewarmed in the mouth by a caregiver with HIV is associated with risk of HIV transmission.[18-24] If this occurs in children with perinatal HIV exposure aged <18 months with prior negative virologic tests, it will be necessary for such children to undergo virologic diagnostic testing because they may have residual HIV antibodies from the antepartum period (see Special Situations below).

Additional Routes of HIV Transmission

Additional routes of HIV transmission in children include sexual abuse, receipt of contaminated blood products, and needlestick with contaminated needles. It may be difficult to obtain a history of HIV exposure. Therefore, age-appropriate HIV testing is recommended for infants and children with signs and/or symptoms of HIV infection, even in the absence of documented or suspected perinatal or non-perinatal HIV exposure. Acquisition of HIV in older children is possible through accidental needlestick injuries, sexual transmission, or injection drug use. The only known cases of HIV transmission through cosmetic procedures have been from unsafe infection control procedures involving injections.[25] Although tattooing or body piercing present a potential risk of HIV transmission, no reported cases of HIV transmission from these specific activities have been documented.[26]

Diagnostic Testing

Diagnosis of HIV-1 infection in infants and children with non-perinatal HIV exposure only or in children with perinatal HIV exposure who are aged ≥18 months relies primarily on HIV antibody and antigen/antibody tests.[1,27] U.S. Food and Drug Administration (FDA)–approved diagnostic tests include the following:

- Antigen/antibody combination immunoassays, which detect HIV-1/2 antibodies and HIV-1 p24 antigen. These tests are recommended for initial testing to screen for established infection with HIV-1 or HIV-2 and for acute HIV-1 infection. Some data suggest that the use of immunoassays and rapid diagnostic test combination algorithms that have limited HIV antigen breadth may not be adequate for the diagnosis of HIV infection in children following early treatment with ART.[28] Antigen/antibody combination immunoassays can be used in infants aged <18 months, with the purpose of documenting exposure to maternal HIV infection. Detection of maternal antibodies that have passed transplacentally is an appropriate surrogate when direct testing of the mother is not possible (e.g., infant was abandoned). This use is considered “off label” and outside the FDA-approved indication.
- HIV-1/HIV-2 antibody differentiation immunoassay, which differentiates HIV-1 antibodies from HIV-2 antibodies. This immunoassay is recommended for supplemental testing.
- HIV-1 NAT. A NAT is always indicated as an additional test to diagnose acute HIV infection.

For information on diagnosis of HIV-2 infection, see Virologic Assays to Diagnose HIV-2 Infections below.

Special Situations

Late Seroreversion (Aged ≥18 Months)

Non-breastfed children with perinatal HIV exposure, no other HIV transmission risk factor, and no clinical or virologic laboratory evidence of HIV infection may have residual HIV antibodies from the

antepartum period and later, persisting to age 24 months of age. These children are called late seroreverters.[29-32] In one study, 14% of children with HIV exposure who did not have HIV infection seroreverted after age 18 months.[32] Due to the possibility of residual maternal HIV antibodies, HIV NAT testing is necessary to definitively exclude or confirm HIV infection in children with perinatal HIV exposure who have a positive HIV antibody (or antigen/antibody) test at age ≥18 months. Virologic testing will distinguish late-seroreverting children who do not have HIV but have residual antibodies from children who have antibodies due to underlying HIV infection.

Postnatal HIV Infection in Children With Perinatal HIV Exposure and Prior Negative Virologic Test Results With Additional HIV Transmission Risks

In contrast to late seroreverters, in rare situations, postnatal HIV infections have been reported in children with HIV exposure who had prior negative HIV virologic test results. This occurs in children who acquire HIV through an additional risk factor after completion of testing.

Suspicion of HIV-2 or HIV-1 Infections With False-Negative Virologic Test Results

Children with HIV-2 may have false-negative HIV NAT tests but persistent positive immunoassay results.[33-35] The diagnostic approach in these situations is discussed below in Virologic Assays to Diagnose HIV-2 Infections.

HIV NATs to Diagnose Infection in Infants Younger Than 18 Months With Perinatal HIV-1 Exposure

HIV RNA Assays

HIV RNA assays detect extracellular viral RNA in plasma. Reported specificity is 100% at birth and age 1 month, 3 months, and 6 months and is comparable to the specificity of HIV DNA PCR.[13] Testing at birth is expected to detect HIV RNA in infants who acquire HIV *in utero* and not in those who acquire HIV from exposure during delivery or immediately before delivery (i.e., during the intrapartum period). Studies report that HIV RNA assays identify 25% to 58% of infants with HIV infection from birth through the first week of life, 89% at age 1 month, and 90% to 100% by age 2 months to 3 months. These results are similar to the results of HIV DNA PCR for early diagnosis of HIV.[5]

The sensitivity of HIV RNA assays is affected by maternal antenatal ART or ARV drugs administered to the infant as prophylaxis or presumptive therapy.[36]

An HIV quantitative RNA assay can be used as a confirmatory test for infants who have an initial positive HIV DNA PCR test result. In addition to providing virologic confirmation of infection status, an HIV RNA measurement assesses baseline viral load. An HIV genotype can be performed on the same sample to guide initial ART in an infant with HIV.

An HIV qualitative RNA assay is an alternative diagnostic test that can be used for infant testing.[3,37-41] The Cobas qualitative HIV1/HIV2 RNA assay is a nucleic acid amplification test approved by the FDA in 2020 for the simultaneous detection and differentiation of HIV-1 and HIV-2 RNA in serum and

plasma. This assay may be used in the diagnosis of HIV infection in pediatric patients aged <2 years and in pregnant women.[41]

HIV DNA PCR and Related Assays

HIV DNA PCR is a sensitive technique that is used to detect intracellular HIV viral DNA in peripheral blood mononuclear cells. The specificity of the HIV DNA PCR is 99.8% at birth and 100% at age 1 month, 3 months, and 6 months. Studies report that HIV DNA PCR assays identify 20% to 55% of infants with HIV infection from birth through the first week of life, with the same caveat as for RNA testing—testing at birth will not detect infection in those infants who acquire HIV during the intrapartum period. This percentage increases to >90% by age 2 weeks to 4 weeks and to 100% at age 3 months and 6 months.[3,5]

Two studies provided data on diagnostic testing at different time points in infants with confirmed HIV infection, including those who had negative test results at birth. One study noted that among 47 infants with HIV infection who had negative DNA PCR test results at birth, 68% were identified during the period of neonatal ARV prophylaxis at 4 to 6 weeks; by 3 months, all 47 infants were identified.[12] Another study from Cape Town evaluated the sensitivity of HIV DNA assays within 8 days of life during and after initiating ART in infants with HIV. The infants had been exposed to ART *in utero*, as well as ARV drugs for prophylaxis and treatment. In seven infants who achieved virologic suppression (defined as a continuous downward trend in plasma HIV RNA, with <100 copies/mL after 6 months), total HIV DNA continued to decay over 12 months. The authors noted that one infant had undetectable HIV DNA after 6 days on treatment, another had undetectable HIV DNA after 3 months, and a third had undetectable HIV DNA after 4 months, suggesting that rapid decline of HIV-1 RNA and DNA may complicate definitive diagnosis.[42]

The AMPLICOR® HIV-1 DNA test has been used widely for diagnosis of HIV in infants perinatally exposed to HIV-1 infection since it was introduced in 1992. However, it is no longer commercially available in the United States. The sensitivity and specificity of noncommercial HIV-1 DNA tests that use individual laboratory reagents may differ from the sensitivity and specificity of FDA-approved commercial tests. These considerations underscore the importance of testing with HIV NATs in non-breastfed infants at 4 months—well after ARV and possible exposures have stopped (e.g., neonatal ARV prophylaxis, presumptive HIV therapy, breastfeeding).

Other Issues

Additional Considerations in HIV Testing

Early HIV NATs were developed using HIV-1 Group M subtype B, the predominant viral subtype found in the United States, but current HIV NATs detect all HIV-1 subtypes. Almost all platforms increase sensitivity by amplifying more than one highly conserved region of the HIV genome. However, if results of testing suggest HIV infection but virologic tests do not amplify HIV, then HIV-2 testing is indicated (see below). If HIV-2 testing is also negative, then the possibility of a new variant of HIV that does not amplify should be considered, and discussion with an HIV expert recommended.

Chimeric Antigen Receptor T-Cell and Lentiviral-Based Gene Therapy May Give Rise to False-Positive HIV Nucleic Acid Test Results

Chimeric antigen receptor (CAR) T-cell immunotherapy is a major advancement in cancer therapeutics, including for pediatric B-cell acute lymphoblastic leukemia. Reprogramming of T cells is achieved by using gammaretroviral or lentiviral vectors. Reports indicate that these vectors may interfere with long terminal repeat genomes in HIV NAT results and, thus, produce false-positive results. As CAR T-cell therapy becomes more widely available for multiple indications, it will be important for clinicians to recognize that routine HIV-1 NAT results may give rise to false results. In addition, lentiviral vector–based gene therapy as treatment for severe combined immunodeficiency can give rise to false-positive HIV NAT results. Laboratories should, therefore, have appropriate alternate HIV-1 NAT resulting platforms made available for this emerging patient population.[43-47]

Virologic Assays to Diagnose HIV-2 Infections

HIV-2 infection is endemic in Angola; Mozambique; West African countries, including Benin, Burkina Faso, Cape Verde, the Gambia, Ghana, Guinea, Guinea-Bissau, Ivory Coast, Liberia, Mali, Mauritania, Niger, Nigeria, Sao Tome, Senegal, Sierra Leone, and Togo; and parts of India.[48-50] HIV-2 infection also is well documented in France and Portugal, which have large numbers of immigrants from these regions.[51,52] HIV-1 and HIV-2 coinfection may occur, but this rarely is described outside areas where HIV-2 is endemic. HIV-2 is rare in the United States. Although accurately diagnosing HIV-2 can be difficult, it is clinically important because HIV-2 strains are resistant to several ARV drugs that were developed to suppress HIV-1.[53-55] (See HIV-2 Infection and Pregnancy.)

HIV-2 should be suspected if HIV infection is linked to an area that is endemic for HIV-2 infection or if HIV test results are suggestive of HIV-2 infection (i.e., positive initial HIV 1/2 immunoassay test result and HIV-1 RNA viral loads that are at or below the limit of detection in the absence of treatment). The current recommendation is to use an HIV-1/HIV-2 antibody differentiation immunoassay for supplemental testing.[1]

Between 2010 and 2017, the number of HIV-1/HIV-2 differentiation test results reported to the Centers for Disease Control and Prevention (CDC's) National HIV Surveillance System increased. More than 99.9% of all HIV infections identified in the United States were categorized as HIV-1, and the number of HIV-2 diagnoses (mono-infection or dual-infection) remained extremely low (<0.03% of all HIV infections).[56]

Infant testing with HIV-2–specific DNA PCR tests or HIV-1/HIV-2 qualitative RNA PCR tests should be performed at time points similar to those used for HIV-1 testing when evaluating an infant exposed to known or suspected HIV-2 infection. HIV-2 DNA PCR testing can be arranged by the HIV surveillance program of the state or local health department through their public health laboratory or the CDC because this assay is not commercially available.[57,58] Clinicians should consult with an expert in pediatric HIV infection when caring for infants with suspected or known exposure to HIV-2.[48,59]

The diagnosis of HIV-2 in children with only non-perinatal exposure or in children with perinatal exposure aged ≥18 months should also follow the CDC and Association of Public Health Laboratories 2014 laboratory testing guidelines, which recommend using an HIV-1/HIV-2 antibody differentiation immunoassay that distinguishes between HIV-1 and HIV-2 antibodies for supplemental testing. All HIV-2 cases should be reported to the HIV surveillance program of the state or local health department; additional HIV-2 DNA PCR testing can be arranged by a local

public health laboratory or by CDC if an HIV-1/HIV-2 antibody differentiation immunoassay is inconclusive. HIV-2 DNA PCR testing may be necessary for definitive diagnosis, although this assay is not commercially available.[57,58]

Knowledge Gaps

- Research is needed for the development of improved HIV NAT diagnostics for infant testing with rapid turnaround times.
- Further studies are necessary to evaluate the sensitivity of HIV RNA/DNA assays during ARV prophylaxis and treatment in both mothers and infants.
- Research is needed to determine the optimal length between cessation of infant ARV prophylaxis and HIV testing with newer, long-acting agents.
- Research is needed to determine the optimal timing and frequency of infant HIV testing during breastfeeding.

References

1. Centers for Disease Control and Prevention and Association of Public Health Laboratories. Laboratory testing for the diagnosis of HIV infection: updated recommendations. June 27, 2014. Available at: https://dx.doi.org/10.15620/cdc.23447.

2. Donovan M, Palumbo P. Diagnosis of HIV: challenges and strategies for HIV prevention and detection among pregnant women and their infants. *Clin Perinatol*. 2010;37(4):751-763, viii. Available at: https://pubmed.ncbi.nlm.nih.gov/21078448.

3. Lilian RR, Kalk E, Bhowan K, et al. Early diagnosis of in utero and intrapartum HIV infection in infants prior to 6 weeks of age. *J Clin Microbiol*. 2012;50(7):2373-2377. Available at: https://pubmed.ncbi.nlm.nih.gov/22518871.

4. Mitchell C, Dross S, Beck IA, et al. Low concentrations of HIV-1 DNA at birth delays diagnosis, complicating identification of infants for antiretroviral therapy to potentially prevent the establishment of viral reservoirs. *Clin Infect Dis*. 2014;58(8):1190-1193. Available at: https://pubmed.ncbi.nlm.nih.gov/24501389.

5. Chadwick EG, Ezeanolue EE, Committee on Pediatric AIDS. Evaluation and management of the Infant exposed to HIV in the United States. *Pediatrics*. 2020;146(5). Available at: https://pubmed.ncbi.nlm.nih.gov/33077537.

6. Tamhane M, Gautney B, Shiu C, et al. Analysis of the optimal cut-point for HIV-p24 antigen testing to diagnose HIV infection in HIV-exposed children from resource-constrained settings. *J Clin Virol*. 2011;50(4):338-341. Available at: https://pubmed.ncbi.nlm.nih.gov/21330193.

7. Wessman MJ, Theilgaard Z, Katzenstein TL. Determination of HIV status of infants born to HIV-infected mothers: a review of the diagnostic methods with special focus on the applicability of p24 antigen testing in developing countries. *Scand J Infect Dis*. 2012;44(3):209-215. Available at: https://pubmed.ncbi.nlm.nih.gov/22074445.

8. Bhowan K, Sherman GG. Performance of the first fourth-generation rapid human immunodeficiency virus test in children. *Pediatr Infect Dis J*. 2013;32(5):486-488. Available at: https://pubmed.ncbi.nlm.nih.gov/23190776.

9. Panel on Opportunistic Infections in Children With HIV. Guidelines for the prevention and treatment of opportunistic infections in children with and exposed to HIV. Department of Health and Human Services. 2025. Available at: https://clinicalinfo.hiv.gov/en/guidelines/hiv-clinical-guidelines-pediatric-opportunistic-infections.

10. Jourdain G, Mary JY, Coeur SL, et al. Risk factors for in utero or intrapartum mother-to-child transmission of human immunodeficiency virus type 1 in Thailand. *J Infect Dis*. 2007;196(11):1629-1636. Available at: https://pubmed.ncbi.nlm.nih.gov/18008246.

11. Lilian RR, Kalk E, Technau KG, Sherman GG. Birth diagnosis of HIV infection on infants to reduce infant mortality and monitor for elimination of mother-to-child transmission. *Pediatr Infect Dis J*. 2013;32(10):1080-1085. Available at: https://pubmed.ncbi.nlm.nih.gov/23574775.

12. Nielsen-Saines K, Watts DH, Veloso VG, et al. Three postpartum antiretroviral regimens to prevent intrapartum HIV infection. *N Engl J Med*. 2012;366(25):2368-2379. Available at: https://pubmed.ncbi.nlm.nih.gov/22716975.

13. Burgard M, Blanche S, Jasseron C, et al. Performance of HIV-1 DNA or HIV-1 RNA tests for early diagnosis of perinatal HIV-1 infection during anti-retroviral prophylaxis. *J Pediatr*. 2012;160(1):60-66 e61. Available at: https://pubmed.ncbi.nlm.nih.gov/21868029.

14. Kuhn L, Schramm DB, Shiau S, et al. Young age at start of antiretroviral therapy and negative HIV antibody results in HIV-infected children when suppressed. *AIDS*. 2015;29(9):1053-1060. Available at: https://pubmed.ncbi.nlm.nih.gov/25870988.

15. Payne H, Mkhize N, Otwombe K, et al. Reactivity of routine HIV antibody tests in children who initiated antiretroviral therapy in early infancy as part of the children with HIV early antiretroviral therapy (CHER) trial: a retrospective analysis. *Lancet Infect Dis*. 2015;15(7):803-809. Available at: https://pubmed.ncbi.nlm.nih.gov/26043884.

16. Levison J, McKinney J, Duque A, et al. Breastfeeding among people with HIV in North America: a multisite study. *Clin Infect Dis*. 2023. Available at: https://pubmed.ncbi.nlm.nih.gov/37078712.

17. Swain CA, Kaufman S, Miranda W, et al. Postpartum mother-to-child transmission of HIV in a breastfeeding infant. *Pediatrics*. 2022;149(2). Available at: https://pubmed.ncbi.nlm.nih.gov/35043205.

18. Centers for Disease Control and Prevention. Premastication of food by caregivers of HIV-exposed children--nine U.S. sites, 2009–2010. *MMWR Morb Mortal Wkly Rep*. 2011;60(9):273-275. Available at: https://pubmed.ncbi.nlm.nih.gov/21389930.

19. Gaur AH, Freimanis-Hance L, Dominguez K, et al. Knowledge and practice of prechewing/prewarming food by HIV-infected women. *Pediatrics*. 2011;127(5):e1206-1211. Available at: https://pubmed.ncbi.nlm.nih.gov/21482608.

20. Hafeez S, Salami O, Alvarado M, et al. Infant feeding practice of premastication: an anonymous survey among human immunodeficiency virus-infected mothers. *Arch Pediatr Adolesc Med*. 2011;165(1):92-93. Available at: https://pubmed.ncbi.nlm.nih.gov/21199989.

21. Maritz ER, Kidd M, Cotton MF. Premasticating food for weaning African infants: a possible vehicle for transmission of HIV. *Pediatrics*. 2011;128(3):e579-590. Available at: https://pubmed.ncbi.nlm.nih.gov/21873699.

22. Ivy W, 3rd, Dominguez KL, Rakhmanina NY, et al. Premastication as a route of pediatric HIV transmission: case-control and cross-sectional investigations. *J Acquir Immune Defic Syndr*. 2012;59(2):207-212. Available at: https://pubmed.ncbi.nlm.nih.gov/22027873.

23. Gaur AH, Cohen RA, Read JS, et al. Prechewing and prewarming food for HIV-exposed children: a prospective cohort experience from Latin America. *AIDS Patient Care STDS*. 2013;27(3):142-145. Available at: https://pubmed.ncbi.nlm.nih.gov/23477456.

24. Nash SH, Rutledge M, Frenkel LM, et al. HIV transmission through premastication. *Pediatrics*. 2022;150(4). Available at: https://pubmed.ncbi.nlm.nih.gov/36052601.

25. Stadelman-Behar AM, Gehre MN, Atallah L. Investigation of presumptive HIV transmission associated with receipt of platelet-rich plasma microneedling facials at a spa among former spa clients — New Mexico, 2018–2023. *MMWR Morb Mortal Wkly Rep*. 2024;73(372-376). Available at: https://pubmed.ncbi.nlm.nih.gov/11718473.

26. Centers for Disease Control and Prevention. How HIV spreads. 2024. Available at: https://www.cdc.gov/hiv/causes/index.html.

27. Alexander TS. Human immunodeficiency virus diagnostic testing: 30 years of evolution. *Clin Vaccine Immunol*. 2016;23(4):249-253. Available at: https://pubmed.ncbi.nlm.nih.gov/26936099.

28. Puthanakit T, Ananworanich J, Akapirat S, et al. Pattern and frequency of seroreactivity to routinely used serologic tests in early-treated infants with HIV. *J Acquir Immune Defic Syndr*. 2020;83(3):260-266. Available at: https://pubmed.ncbi.nlm.nih.gov/31917751.

29. Sohn AH, Thanh TC, Thinh le Q, et al. Failure of human immunodeficiency virus enzyme immunoassay to rule out infection among polymerase chain reaction-negative Vietnamese infants at 12 months of age. *Pediatr Infect Dis J*. 2009;28(4):273-276. Available at: https://pubmed.ncbi.nlm.nih.gov/19289981.

30. Gulia J, Kumwenda N, Li Q, Taha TE. HIV seroreversion time in HIV-1-uninfected children born to HIV-1-infected mothers in Malawi. *J Acquir Immune Defic Syndr*. 2007;46(3):332-337. Available at: https://pubmed.ncbi.nlm.nih.gov/17786126.

31. Alcantara KC, Pereira GA, Albuquerque M, Stefani MM. Seroreversion in children born to HIV-positive and AIDS mothers from Central West Brazil. *Trans R Soc Trop Med Hyg*. 2009;103(6):620-626. Available at: https://pubmed.ncbi.nlm.nih.gov/19339030.

32. Gutierrez M, Ludwig DA, Khan SS, et al. Has highly active antiretroviral therapy increased the time to seroreversion in HIV exposed but uninfected children? *Clin Infect Dis*. 2012;55(9):1255-1261. Available at: https://pubmed.ncbi.nlm.nih.gov/22851494.

33. Kline NE, Schwarzwald H, Kline MW. False negative DNA polymerase chain reaction in an infant with subtype C human immunodeficiency virus 1 infection. *Pediatr Infect Dis J*. 2002;21(9):885-886. Available at: https://pubmed.ncbi.nlm.nih.gov/12380591.

34. Zaman MM, Recco RA, Haag R. Infection with non-B subtype HIV type 1 complicates management of established infection in adult patients and diagnosis of infection in newborn infants. *Clin Infect Dis*. 2002;34(3):417-418. Available at: https://pubmed.ncbi.nlm.nih.gov/11774090.

35. Obaro SK, Losikoff P, Harwell J, Pugatch D. Failure of serial human immunodeficiency virus type 1 DNA polymerase chain reactions to identify human immunodeficiency virus type 1 clade A/G. *Pediatr Infect Dis J*. 2005;24(2):183-184. Available at: https://pubmed.ncbi.nlm.nih.gov/15702052.

36. Saitoh A, Hsia K, Fenton T, et al. Persistence of human immunodeficiency virus (HIV) type 1 DNA in peripheral blood despite prolonged suppression of plasma HIV-1 RNA in children. *J Infect Dis*. 2002;185(10):1409-1416. Available at: https://pubmed.ncbi.nlm.nih.gov/11992275.

37. Food and Drug Administration. APTIMA HIV-1 RNA qualitative assay. 2006. Available at: https://www.fda.gov/BiologicsBloodVaccines/BloodBloodProducts/ApprovedProducts/LicensedProductsBLAs/BloodDonorScreening/InfectiousDisease/ucm149922.htm.

38. Pierce VM, Neide B, Hodinka RL. Evaluation of the gen-probe aptima HIV-1 RNA qualitative assay as an alternative to Western blot analysis for confirmation of HIV infection. *J Clin Microbiol*. 2011;49(4):1642-1645. Available at: https://pubmed.ncbi.nlm.nih.gov/21346052.

39. Fiscus SA, McMillion T, Nelson JA, Miller WC. Validation of the gen-probe aptima qualitative HIV-1 RNA assay for diagnosis of human immunodeficiency virus infection in infants. *J Clin Microbiol*. 2013;51(12):4137-4140. Available at: https://pubmed.ncbi.nlm.nih.gov/24088864.

40. Nelson JA, Hawkins JT, Schanz M, et al. Comparison of the gen-probe aptima HIV-1 and abbott HIV-1 qualitative assays with the roche amplicor HIV-1 DNA assay for early infant diagnosis using dried blood spots. *J Clin Virol*. 2014;60(4):418-421. Available at: https://pubmed.ncbi.nlm.nih.gov/24929752.

41. Hans L, Allmen NV, Edelmann A, et al. Early diagnosis of HIV-1 and HIV-2 using Cobas HIV-1/HIV-2 qualitative test: a novel qualitative nucleic acid amplification test for plasma, serum, and dried blood spot specimens. *J Acquir Immune Defic Syndr*. 2021;87(5):1187-1195. Available at: https://pubmed.ncbi.nlm.nih.gov/33883470.

42. Veldsman KA, Maritz J, Isaacs S, et al. Rapid decline of HIV-1 DNA and RNA in infants starting very early antiretroviral therapy may pose a diagnostic challenge. *AIDS*. 2018;32(5):629-634. Available at: https://pubmed.ncbi.nlm.nih.gov/29334551.

43. Hauser JR, Hong H, Babady NE, et al. False-positive results for human immunodeficiency virus type 1 nucleic acid amplification testing in chimeric antigen receptor T cell therapy. *J Clin Microbiol*. 2019;58(1):e01420-01419. Available at: https://www.ncbi.nlm.nih.gov/pubmed/31694968.

44. Laetsch TW, Maude SL, Milone MC, et al. False-positive results with select HIV-1 NAT methods following lentivirus-based tisagenlecleucel therapy. *Blood*. 2018;131(23):2596-2598. Available at: https://pubmed.ncbi.nlm.nih.gov/29669777.

45. Ariza-Heredia EJ, Granwehr BP, Viola GM, et al. False-positive HIV nucleic acid amplification testing during CAR T-cell therapy. *Diagn Microbiol Infect Dis*. 2017;88(4):305-307. Available at: https://pubmed.ncbi.nlm.nih.gov/28610774.

46. Milone MC, O'Doherty U. Clinical use of lentiviral vectors. *Leukemia*. 2018;32(7):1529-1541. Available at: https://pubmed.ncbi.nlm.nih.gov/29654266.

47. De Ravin SS, Gray JT, Throm RE, et al. False-positive HIV PCR test following ex vivo lentiviral gene transfer treatment of X-linked severe combined immunodeficiency vector. *Mol Ther*. 2014;22(2):244-245. Available at: https://pubmed.ncbi.nlm.nih.gov/24487563.

48. Torian LV, Eavey JJ, Punsalang AP, et al. HIV type 2 in New York City, 2000–2008. *Clin Infect Dis*. 2010;51(11):1334-1342. Available at: https://pubmed.ncbi.nlm.nih.gov/21039219.

49. Campbell-Yesufu OT, Gandhi RT. Update on human immunodeficiency virus (HIV)-2 infection. *Clin Infect Dis*. 2011;52(6):780-787. Available at: https://pubmed.ncbi.nlm.nih.gov/21367732.

50. Prince PD, Matser A, van Tienen C, et al. Mortality rates in people dually infected with HIV-1/2 and those infected with either HIV-1 or HIV-2: a systematic review and meta-analysis. *AIDS*. 2014;28(4):549-558. Available at: https://pubmed.ncbi.nlm.nih.gov/23921613.

51. Barin F, Cazein F, Lot F, et al. Prevalence of HIV-2 and HIV-1 group O infections among new HIV diagnoses in France: 2003–2006. *AIDS*. 2007;21(17):2351-2353. Available at: https://pubmed.ncbi.nlm.nih.gov/18090288.

52. Thiebaut R, Matheron S, Taieb A, et al. Long-term nonprogressors and elite controllers in the ANRS CO5 HIV-2 cohort. *AIDS*. 2011;25(6):865-867. Available at: https://pubmed.ncbi.nlm.nih.gov/21358376.

53. Menendez-Arias L, Alvarez M. Antiretroviral therapy and drug resistance in human immunodeficiency virus type 2 infection. *Antiviral Res*. 2014;102:70-86. Available at: https://pubmed.ncbi.nlm.nih.gov/24345729.

54. Tchounga BK, Inwoley A, Coffie PA, et al. Re-testing and misclassification of HIV-2 and HIV-1&2 dually reactive patients among the HIV-2 cohort of the West African database to evaluate AIDS collaboration. *J Int AIDS Soc*. 2014;17:19064. Available at: https://pubmed.ncbi.nlm.nih.gov/25128907.

55. Balestre E, Ekouevi DK, Tchounga B, et al. Immunologic response in treatment-naive HIV-2-infected patients: the IeDEA West Africa cohort. *J Int AIDS Soc*. 2016;19(1):20044. Available at: https://pubmed.ncbi.nlm.nih.gov/26861115.

56. Peruski AH, Wesolowski LG, Delaney KP, et al. Trends in HIV-2 diagnoses and use of the HIV-1/HIV-2 differentiation test - United States, 2010–2017. *MMWR Morb Mortal Wkly Rep*. 2020;69(3):63-66. Available at: https://pubmed.ncbi.nlm.nih.gov/31971928.

57. Shanmugam V, Switzer WM, Nkengasong JN, et al. Lower HIV-2 plasma viral loads may explain differences between the natural histories of HIV-1 and HIV-2 infections. *J Acquir Immune Defic Syndr*. 2000;24(3):257-263. Available at: https://pubmed.ncbi.nlm.nih.gov/10969350.

58. Damond F, Benard A, Balotta C, et al. An international collaboration to standardize HIV-2 viral load assays: results from the 2009 ACHI(E)V(2E) quality control study. *J Clin Microbiol*. 2011;49(10):3491-3497. Available at: https://pubmed.ncbi.nlm.nih.gov/21813718.

59. Burgard M, Jasseron C, Matheron S, et al. Mother-to-child transmission of HIV-2 infection from 1986 to 2007 in the ANRS French Perinatal Cohort EPF-CO1. *Clin Infect Dis*. 2010;51(7):833-843. Available at: https://pubmed.ncbi.nlm.nih.gov/20804413.