

# Clinical and Laboratory Monitoring of Pediatric HIV Infection

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## Panel's Recommendations

- Absolute CD4 T lymphocyte (CD4) cell count and plasma HIV RNA (viral load) should be measured at the time of HIV diagnosis and, if a child is not started on antiretroviral therapy (ART) after diagnosis, this monitoring should be repeated at least every 3 to 4 months thereafter **(AIII)**.
- Absolute CD4 count is recommended for monitoring immune status in children with HIV of all ages, with CD4 percentage as an alternative for children aged <5 years **(AII)**.
- Antiretroviral (ARV) drug-resistance testing is recommended at the time of HIV diagnosis, before initiation of therapy in all ART-naive patients, and before switching regimens in patients with treatment failure **(AII)**. Genotypic resistance testing is preferred for this purpose **(AIII)**.
- After initiation of ART or after a change in ARV regimen, children should be evaluated for clinical adverse effects and should receive support for treatment adherence within 1 week to 2 weeks; laboratory testing for toxicity and viral load response is recommended at 2 to 4 weeks after treatment initiation or change in ARV regimen **(AIII)**.
- Children on ART should be monitored for therapy adherence, effectiveness, and toxicities routinely (every 3–4 months) **(AII\*)**. See the sections on [Adherence to Antiretroviral Therapy in Children and Adolescents with HIV](#) and [Management of Medication Toxicity or Intolerance](#).
- Additional CD4 count and plasma viral load monitoring should be performed to evaluate children with suspected clinical, immunologic, or virologic deterioration or to confirm an abnormal value **(AIII)**. CD4 count can be monitored less frequently (every 6–12 months) in children and adolescents who are adherent to therapy, who have sustained virologic suppression and CD4 count values that are well above the threshold for opportunistic infection risk, and who have stable clinical status **(AII)**. Viral load measurement every 3 to 4 months is generally recommended to monitor ART adherence **(AIII)**.
- Phenotypic resistance testing should be considered (usually in addition to genotypic resistance testing) for patients with known or suspected complex drug resistance mutation patterns, which generally arise after a patient has experienced virologic failure on multiple ARV regimens **(CIII)**.
- Review the history of all previously used ARVs and available resistance test results when making decisions about choice of new ARVs, because mutations may not be detected once the prior drugs have been discontinued **(AII)**.
- Viral co-receptor tropism assays are recommended whenever a CCR5 antagonist is being considered for treatment **(AI\*)**. The use of tropism assays also should be considered for patients who demonstrate virologic failure while receiving therapy that contains a CCR5 antagonist **(AI\*)**.

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

**Rating of Evidence:** I = One or more randomized trials in children<sup>†</sup> 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<sup>†</sup> 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<sup>†</sup> 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<sup>†</sup> from one or more similar nonrandomized trials or cohort studies with clinical outcome data; III = Expert opinion

<sup>†</sup>Studies that include children or children/adolescents, but not studies limited to post-pubertal adolescents

Laboratory monitoring of children living with HIV poses unique and challenging issues. In particular, the normal ranges of CD4 T lymphocyte (CD4) counts and plasma HIV RNA concentrations (viral loads) can vary significantly by age. The CD4 counts and viral load values that predict the risk of disease progression also change as a child ages. This section will address immunologic, virologic, general laboratory, and clinical monitoring of children with HIV, with information that is relevant to both those who have recently received an HIV diagnosis and those who are receiving antiretroviral therapy (ART).

## Clinical and Laboratory Monitoring of Children with HIV

### ***Initial Evaluation of Children Who Recently Received an HIV Diagnosis, or Entering or Transferring to a New Care Setting***

Children who have recently received an HIV diagnosis should have their CD4 counts and plasma viral loads measured, their growth and development should be evaluated for signs of HIV-associated abnormalities, and a complete physical examination should be performed to identify physical findings of HIV disease (e.g., lymphadenopathy, hepatosplenomegaly, hyperreflexia, ankle clonus). Testing also should be performed to assess for HIV-associated conditions, including anemia, leukopenia, thrombocytopenia, hypoalbuminemia, nephropathy (urinalysis), hyperglycemia, hepatic transaminitis, and renal insufficiency (creatinine). In addition, children with HIV should have a complete, age-appropriate medical history and physical examination (see Table 5 below). Opportunistic infection (OI) monitoring should follow the guidelines that are appropriate for the child's exposure history and clinical setting (see the [Pediatric Opportunistic Infection Guidelines](#)). Children with HIV who are relocating from outside the United States may benefit from additional evaluations—such as screening for tuberculosis, gastrointestinal parasites, hepatitis infection, lead level—and thyroid function studies.

Laboratory confirmation of HIV infection should be obtained when available documentation is incomplete (see [Diagnosis of HIV Infection in Infants and Children](#)). Genotypic resistance testing should be performed, even if ART is not initiated immediately. In addition, a full antiretroviral (ARV) drug history should be obtained; this history should include any exposure to ARV drugs for the prevention of perinatal HIV transmission (see [Drug-Resistance Testing](#) in the [Adult and Adolescent Antiretroviral Guidelines](#)). If abacavir (ABC) is being considered as a component of the regimen, HLA-B\*5701 testing should be conducted prior to initiating ABC, and an alternative ARV drug should be used if the HLA-B\*5701 test result is positive<sup>1</sup> (see the [Abacavir](#) section in [Appendix A: Pediatric Antiretroviral Drug Information](#)).

Before initiating therapy or making changes to a patient's ARV regimen, a clinician and multidisciplinary team members (where available) should assess potential barriers to adherence and

discuss the importance of adherence with the patient and/or their caregiver (see [Adherence to Antiretroviral Therapy in Children and Adolescents with HIV](#)).

If a child does not initiate ART after receiving an HIV diagnosis, the child's CD4 count and plasma viral load should be monitored at least every 3 to 4 months.

### ***Evaluation at Initiation of Antiretroviral Therapy***

At the time of ART initiation, a physical examination should be performed, including assessment of weight and height, and baseline labs for CD4 count and plasma viral load should be obtained to monitor ART response (see Table 5 below). To set the baseline for monitoring ART toxicity (see [Management of Medication Toxicity or Intolerance](#)), a complete blood count, urinalysis, and serum chemistry panel (including levels of electrolytes, creatinine, glucose, and hepatic transaminases) should be performed (see Table 5 below). The levels of serum lipids (cholesterol and triglycerides) also should be measured. For information about the adverse effects (AEs) associated with a specific ARV drug, see Tables 15a–15k in [Management of Medication Toxicity or Intolerance](#) and [Appendix A: Pediatric Antiretroviral Drug Information](#) for complete information on each drug.

### ***Clinical and Laboratory Monitoring After Initiating or Changing an Antiretroviral Regimen***

Children who start ART or who change to a new regimen should be monitored to assess the effectiveness, tolerability, and AEs of the regimen and to evaluate medication adherence. Clinicians and multidisciplinary teams should schedule frequent clinical in-person and/or telemedicine visits to monitor patients closely during the first few months after initiating a new ARV regimen.

Telemedicine visits and telehealth communication platforms are particularly relevant to the care of adolescent patients based on their technology access and habits.<sup>2</sup> Additional check-ins via telephone and/or telehealth (emails, text messaging, app-based communications) may support adherence and early identification of medication side effects. The continuity of patient and caregiver interactions is an opportunity for clinicians and the multidisciplinary team to provide support and discuss adherence with patients and their caregivers.

A recent systematic review of randomized controlled trials from the last 10 years that used a telemedicine approach as a study intervention or assessed telemedicine as a subspecialty of pediatric care found that telemedicine services for the general public and pediatric care are comparable to or better than in-person services.<sup>3</sup> Use of telemedicine as a remote, technology-based access to clinical services in HIV care is growing and has been shown to achieve similar outcomes as those associated with in-person care. People with HIV on ART achieve similar clinical responses to therapy, adherence to treatment, quality-of-life scores, and psychological and emotional status, whether treated through telemedicine or in person.<sup>4,6</sup> When selecting the format for clinical follow-up, it is important to recognize differences and similarities between in-person and telemedicine visits (see Table 4 below). The benefits of telemedicine visits include patient and caregiver convenience, lack of travel, flexibility, and ability to visualize ART handling/swallowing and conduct directly observed therapy in the home setting. Telemedicine visits, however, require technological access/capacity and limit the provider's ability to conduct physical examinations and obtain laboratory testing on site.<sup>4,5</sup> Periodic measurements of body weight, which are important for dose modification in rapidly growing infants and to monitor for excessive weight gain as a possible AE of some ARVs, are not possible with telemedicine visits. Additionally, providers need to arrange and coordinate access to the laboratory testing and be familiar with state and local requirements for carrying out, documenting, and billing telemedicine visits. Although both in-person and telemedicine visits involve considerations for stigma, privacy, and confidentiality, these considerations differ between

health care and home/community-based settings. For example, the caregiver who has not disclosed the HIV and ART status of the child at home might prefer in-person visits at the clinic or specific hours and/or alternative locations for a telemedicine visit.

**Table 4. Characteristics and Requirements for In-Person Clinic Visits vs. Telemedicine Visits**

	In-Person Visits	Telemedicine Visits
Patient/caregiver convenience		✓
Flexibility (time and locations) of appointments		✓
Confidentiality concerns	✓	✓
Directly observed therapy in home settings		✓
Physical assessment (e.g., skin rashes)	✓	✓
Physical exam, including weight and height	✓	
Adherence support and counseling	✓	✓
Mental health assessment and counseling	✓	✓
Multidisciplinary support (assessment and coordination of nutritional and social services)	✓	✓
Laboratory testing on site	✓	
Travel to clinic	✓	
Technology requirements (internet access, equipment, skills)		✓
Legal and administrative guidelines for visit documentation and billing	✓	✓

The first few weeks of ART can be particularly difficult for children and their caregivers; they must adjust their schedules to allow consistent and routine administration of medication doses. Children also may experience the AEs of medications, and both children and their caregivers need assistance to determine whether the effects are temporary and tolerable or whether they are more serious or long term and require a clinical visit. It is critical that providers communicate with caregivers and children in a supportive, nonjudgmental manner and use plain language. This approach promotes interactive reporting and ensures that providers can have a productive dialogue with both children and their caregivers, particularly in situations where medication adherence is reported to be inconsistent.

### **Within 1 Week to 2 Weeks of Initiating Antiretroviral Therapy**

Within 1 week to 2 weeks of initiating ARV therapy, children should be evaluated either in person, through telemedicine, or by telephone. During this evaluation, clinicians should identify clinical AEs and provide support for adherence. Many clinicians plan additional contacts (in person, through telemedicine, by telephone, or via email/texts/apps) with children and caregivers to support adherence during the first few weeks of therapy.

### **2 to 4 Weeks After Initiating Antiretroviral Therapy**

Most experts recommend performing laboratory testing at 2 to 4 weeks (but no later than 8 weeks) after initiating ART to assess virologic response and laboratory toxicity, although this recommendation is based on limited data. The laboratory chemistry tests that a patient requires will

depend on the ARV regimen that the patient is receiving (see Table 5 below). Plasma viral load monitoring is important as a marker of response to ART, because a decline in viral load suggests that the patient is adherent to the regimen, that the appropriate doses are being administered, and that the virus is susceptible to the drugs in the regimen. Some experts favor measuring viral load at 2 weeks to ensure that viral load is declining. A significant decrease in viral load should be observed 4 to 8 weeks after initiation of ART.

### ***Clinical and Laboratory Monitoring for Children Who Are Stable on Long-Term Antiretroviral Therapy***

After the initial phase of ART initiation (1–3 months), clinicians should assess a patient’s adherence to the regimen and the regimen’s effectiveness (as measured by CD4 count and plasma viral load) every 3 to 4 months. Additionally, clinicians should review a patient’s history of drug toxicities and evaluate each patient for any new AEs using physical examinations and the relevant laboratory tests. If laboratory evidence of toxicity is identified, testing should be performed more frequently until the toxicity resolves.

Table 5 below provides one proposed general monitoring schedule, which should be adjusted based on the specific ARV regimen that a child is receiving.

A patient’s baseline CD4 count affects how rapidly CD4 count improves after ART initiation; children with very low CD4 counts may take longer than 1 year to achieve their highest values after viral load suppression.<sup>7</sup>

Studies that have critically evaluated the frequency of laboratory monitoring in both adults and children, particularly CD4 count and plasma viral load, support less frequent monitoring in stable patients who have been consistently virologically suppressed for  $\geq 1$  year.<sup>8-14</sup>

The [Adult and Adolescent Antiretroviral Guidelines](#) currently support performing plasma viral load testing every 6 months for individuals who have both—

- Consistent virologic suppression  $\geq 2$  years; *and*
- CD4 counts that are consistently  $>300$  cells/mm<sup>3</sup>.

The Panel on Antiretroviral Therapy and Medical Management of Children Living with HIV finds value in continuing to perform viral load testing every 3 to 4 months to provide enhanced monitoring of adherence or disease progression among children and adolescents. Some experts monitor CD4 count less frequently (e.g., every 6–12 months) in children and adolescents who are adherent to therapy, who have CD4 count values well above the threshold for OI risk, and who have had sustained virologic suppression and stable clinical status for  $>2$  to 3 years.<sup>15</sup> Some clinicians find value in scheduling visits every 3 months, even when laboratory testing is not performed, in order to review adherence and update drug doses for interim growth. Follow-up clinical and laboratory monitoring can be conducted through in-person and/or telemedicine visits. Additional arrangements, coordination, and follow-up of the laboratory testing (e.g., using local laboratory or primary care provider’s office) may be required for telemedicine visits.

### ***Testing at the Time of Switching Antiretroviral Regimens***

When a patient switches regimens to simplify ART, clinicians should obtain the appropriate laboratory test results at baseline for the toxicity profile of the new regimen. Follow-up should include a measurement of plasma viral load at 4 weeks (and not  $>8$  weeks) after the switch to ensure

that the new regimen is effective. If the regimen is switched because the regimen is failing (see [Recognizing and Managing Antiretroviral Treatment Failure](#)), resistance testing should be performed while a patient is still receiving the failing regimen. This optimizes the chance of identifying resistance mutations, because resistant strains may revert to wild type within a few weeks of stopping ARV drugs (see [Drug-Resistance Testing](#) in the [Adult and Adolescent Antiretroviral Guidelines](#)). Clinicians should consider performing phenotypic resistance testing, including co-receptor tropism testing, in addition to genotypic viral resistance testing in children who have experienced prolonged or repeated periods of viral nonsuppression on multiple ARV regimens.<sup>16</sup>

## Immunologic Monitoring in Children: General Considerations

When interpreting CD4 counts and percentages in children, clinicians must consider age as a factor. CD4 count and percentage values in healthy infants without HIV are considerably higher than values observed in adults without HIV; these infant values slowly decline to adult values by age 5 years. An analysis from the HIV Paediatric Prognostic Markers (HPPM) Collaborative Study found that CD4 percentage provided little or no additional prognostic value compared with CD4 count regarding short-term disease progression in children aged <5 years; similar results were reported in a study of older children.<sup>17</sup> The current pediatric HIV disease classification is based on absolute CD4 count, which is the preferred assay for monitoring and estimating the risk for disease progression and OIs<sup>18</sup> (see Table A. HIV Infection Stage Based on Age-Specific CD4 Count or Percentage in Appendix C: CDC Pediatric HIV CD4 Cell Count/Percentage and HIV-Related Diseases Categorization).

In children with HIV, as in adults with HIV, CD4 count and percentage decline as HIV infection progresses; patients with lower CD4 counts or percentage values have a poorer prognosis than patients with higher values (see Tables A–C in Appendix D: Supplemental Information).

Medical practice guidelines now recommend that all people with HIV receive ART, regardless of their CD4 count and clinical stage. However, CD4 counts are used to determine risk profiles that affect the urgency of recommendations for when to initiate therapy in an ART-naïve child with HIV infection and when to initiate OI prophylaxis (see [When to Initiate Therapy in Antiretroviral-Naïve Children](#)). A meta-analysis from the HPPM Collaborative Study generated plots that can be used to estimate the short-term risk of progression to AIDS or death in the absence of effective ART, according to age and the most recent CD4 percentage/absolute CD4 count or HIV RNA viral load measurement.<sup>19</sup>

CD4 counts and percentages can show considerable inpatient variation.<sup>20</sup> Mild intercurrent illness, the receipt of vaccinations, or exercise can produce a transient decrease in CD4 count and percentage; thus, CD4 count and percentage are best measured when patients are clinically stable. Clinical decisions, especially those regarding therapy changes, should be made in response to confirmed changes in CD4 count or percentage in conjunction with a confirmed viral load determination. The CD4 count or percentage and viral load measurement should be confirmed by performing these tests a second time, at least 1 week after the first tests.

## HIV RNA Monitoring in Children: General Considerations

Quantitative HIV RNA assays measure the plasma concentration of HIV RNA as copies/mL. Without therapy, plasma viral load initially rises to peak level during the period of primary infection in adults and adolescents, and then declines by as much as 2 to 3 log<sub>10</sub> copies to reach a stable lower level (the virologic set point) approximately 6 to 12 months after acute infection.<sup>21,22</sup> In adults with HIV, the virologic set point correlates with the subsequent risk of disease progression or death in the absence of therapy.<sup>23</sup>

The pattern of change in plasma viral load in untreated infants with perinatal HIV differs from that in adults and adolescents with HIV. High plasma viral loads persist in untreated children for prolonged periods.<sup>24,25</sup> In one prospective study of infants with perinatal infection who were born prior to ARV drug availability for children, plasma viral loads generally were low at birth (i.e., <10,000 copies/mL), increased to high values by age 2 months (most infants had values >100,000 copies/mL, ranging from undetectable to nearly 10 million copies/mL), and then decreased slowly with a mean plasma viral load of 185,000 copies/mL during the first year of life.<sup>26</sup> After the first year of life, plasma viral load slowly declined during the next few years.<sup>26-29</sup> Viral load during the first 12 to 24 months after birth showed an average decline of approximately 0.6 log<sub>10</sub> copies/mL per year, followed by an average decline of 0.3 log<sub>10</sub> copies/mL per year until age 4 to 5 years. This pattern probably reflects the lower efficiency of a developing immune system in containing viral replication and, possibly, the rapid expansion of HIV-susceptible cells that occurs with somatic growth.<sup>30</sup>

Despite the established association between high plasma viral load and disease progression, a specific HIV RNA concentration has only moderate predictive value for disease progression and death in an individual child.<sup>28</sup> Plasma viral load may be difficult to interpret during the first year of life, because values are high and are less predictive of disease progression risk than those in older children.<sup>25</sup> In both children and adults with HIV, CD4 count or percentage and plasma viral load are independent predictors of disease progression and mortality risk, and using the two markers together more accurately define prognosis.<sup>28,29,31,32</sup>

### ***Methodological Considerations When Interpreting and Comparing HIV RNA Assays***

Based on accumulated experience with currently available assays, the current definition of virologic suppression is a plasma viral load that is below the quantification limit of the assay used (generally <20 copies/mL to 75 copies/mL). This definition of suppression has been much more thoroughly investigated in adults with HIV than in children with HIV (see the [Adult and Adolescent Antiretroviral Guidelines](#)). Temporary viral load elevations (“blips”) that are between the level of detection and 200 copies/mL to 500 copies/mL are often detected in adults<sup>33</sup> and children who are on ART<sup>34</sup>; these temporary elevations do not represent virologic failure as long as the values have returned to below the level of detection when testing is repeated. For definitions and management of virologic treatment failure, see [Recognizing and Managing Antiretroviral Treatment Failure](#). These definitions of virologic suppression and virologic failure are recommended for clinical use. Research protocols or surveillance programs may use different definitions.

Several different methods can be used for quantitating HIV RNA, each of which has a different level of sensitivity (see Table 6 below). Although the results of the assays are correlated, the absolute HIV RNA copy number obtained from a single specimen tested by two different assays can differ by 0.3 log<sub>10</sub> copies/mL (a twofold difference) or more.<sup>35-37</sup> Because different assays use different methods to measure HIV RNA, and because the tests have different levels of sensitivity, clinicians should consistently use a single HIV RNA assay method to monitor an individual patient when possible.<sup>38-40</sup>

The predominant HIV-1 subtype in the United States is subtype B, and early assays were designed to detect this subtype. Current kit configurations for all companies have been designed to detect and quantitate essentially all viral subtypes (see [Diagnosis of HIV Infection in Infants and Children](#)). This ability is important in many regions of the world where non-B subtypes are predominant, as well as in the United States where a small subset of individuals contract non-B viral subtypes.<sup>38,41-45</sup> It is

particularly relevant for immigrant and adopted children who are born outside the United States or to non-U.S.-born parents.

Biologic variation in plasma viral load within one person is well documented. In adults, repeated measurements of plasma viral load using the same assay can produce results that vary by as much as 0.5 log<sub>10</sub> copies/mL (a threefold difference) in either direction during the course of a day or on different days.<sup>31,36</sup> This biologic variation may be greater in infants and young children with HIV. This inherent biologic variability must be considered when interpreting changes in plasma viral load in children. Thus, after repeated testing, only differences >0.7 log<sub>10</sub> copies/mL (a fivefold difference) in infants aged <2 years and differences >0.5 log<sub>10</sub> copies/mL (a threefold difference) in children aged ≥2 years should be considered reflective of plasma viral load changes that are biologically and clinically significant.

Generally, no change in ARV treatment should be made as a result of a change in plasma viral load, unless the change is confirmed by a second measurement. Because of the complexities of HIV RNA testing and the age-related changes in plasma viral load in children, clinicians should consult an expert in pediatric HIV infection when making clinical decisions based on plasma viral loads.

## Genetic Testing for Management of HIV

Modern disease intervention strategies often employ genetic testing to evaluate the genes of humans and pathogens. This approach to treatment is an important component in the rise of precision medicine. Clinicians who manage HIV have routinely probed HIV genetic sequences for mutations that are associated with HIV drug resistance. Some ARV drugs are metabolized differently based on specific human genotypes. For example, studies have shown that certain genotypes can affect efavirenz exposure in young children.<sup>46,47</sup> In addition, some human genetic polymorphisms are associated with drug toxicity or AEs (e.g., using HLA-B\*5701 testing to predict ABC hypersensitivity)<sup>48</sup>; for more information, see the [Abacavir](#) section in [Appendix A: Pediatric Antiretroviral Drug Information](#). Future clinical practice will likely feature broader applications of multiple forms of genetic testing to guide management of health and disease.

**Table 5. Sample Schedule for Clinical and Laboratory Monitoring of Children Before and After Initiation of Antiretroviral Therapy<sup>a</sup>**

Laboratory Testing	Entry Into Care <sup>a</sup>	Pre-Therapy <sup>b</sup>	ART Initiation <sup>c</sup>	Weeks 1–2 on Therapy	Weeks 2–4 on Therapy	Every 3–4 Months <sup>d</sup>	Every 6–12 Months <sup>e</sup>	Virologic Failure (Prior to Switching ARV Regimens)
Medical History and Physical Examination <sup>f,g</sup>	✓	✓	✓	✓	✓	✓		✓
Adherence Evaluation <sup>g</sup>		✓	✓	✓	✓	✓		✓
CD4 Count	✓	✓	✓			✓		✓
Plasma Viral Load	✓	✓	✓		✓	✓		✓
Resistance Testing	✓							✓
CBC with Differential <sup>d</sup>	✓	✓	✓		✓	✓		✓



<b>Chemistries<sup>d,h</sup></b>	✓	✓	✓		✓	✓		✓
<b>Lipid Panel<sup>e</sup></b>	✓		✓				✓	
<b>Random Plasma Glucose<sup>i</sup></b>			✓				✓	
<b>Urinalysis</b>	✓		✓				✓	
<b>HBV Screening<sup>j</sup></b>		✓						✓
<b>Pregnancy Test for Girls and Young Women of Childbearing Potential<sup>k</sup></b>	✓	✓	✓					✓

<sup>a</sup> See the texts on immunologic, virologic, general laboratory, and clinical monitoring of children with HIV for details on recommended laboratory tests to perform.

<sup>b</sup> When abacavir (ABC) is being considered as part of the regimen, conduct HLA-B\*5701 testing prior to initiating ABC and choose an alternative ARV drug if the patient is HLA-B\*5701 positive (see the [Abacavir](#) section in [Appendix A: Pediatric Antiretroviral Drug Information](#)). Genotype resistance testing is recommended if it has not already been performed (see [Drug-Resistance Testing](#) in the [Adult and Adolescent Antiretroviral Guidelines](#)). Send tests that are appropriate for the toxicity profile, which is associated with the patient's ARV regimen and the patient's medical history.

<sup>c</sup> If ART is initiated within 30 to 90 days of a pre-therapy laboratory result, repeat testing may not be necessary.

<sup>d</sup> CD4 count, CBC, and chemistries can be monitored less frequently (every 6–12 months) in children and youth who are adherent to therapy, who have CD4 count values that are well above the threshold for opportunistic infection risk, and who have had sustained virologic suppression and stable clinical status for more than 2 to 3 years. Viral load testing every 3 to 4 months is generally recommended to monitor ARV adherence.

<sup>e</sup> If lipid levels have been abnormal in the past, more frequent monitoring may be needed. For patients treated with TDF, more frequent urinalysis should be considered.

<sup>f</sup> Pay special attention to changes in weight that might occur after altering an ARV regimen. Weight gain or weight loss may occur when using some ARV drugs (see [Table 15h. Lipodystrophies and Weight Gain](#)).

<sup>g</sup> Virtual visits may be appropriate at some time points, particularly for adherence assessments and for visits for established patients, see [Table 4 above](#).

<sup>h</sup> Chemistries refer to a comprehensive metabolic panel. **Some experts perform a comprehensive panel at entry and routinely test Cr, ALT, AST and with additional tests tailored to the history of the individual patient.**

<sup>i</sup> Random plasma glucose is collected in a gray-top blood collection tube or other designated tube. **Some experts would consider monitoring HgbA1C in children at risk for prediabetes/diabetes rather than routine blood glucose.**

<sup>j</sup> This screening is only recommended for individuals who have previously demonstrated no immunity to HBV and who are initiating a regimen that contains ARV drugs with activity against HBV, specifically 3TC, FTC, TAF, or TDF.

<sup>k</sup> See the [Pregpregnancy Counseling and Care for Persons of Childbearing Age with HIV](#) in the [Perinatal Guidelines](#).

**Key:** 3TC = lamivudine; ABC = abacavir; **ALT = alanine aminotransferase**; ART = antiretroviral therapy; ARV = antiretroviral; **AST = aspartate aminotransferase**; CBC = complete blood count; CD4 = CD4 T lymphocyte; **Cr = creatinine**; FTC = emtricitabine; HBV = hepatitis B virus; **HgbA1C = glycosylated hemoglobin**; OI = opportunistic infection; TAF = tenofovir alafenamide; TDF = tenofovir disoproxil fumarate

**Table 6. Primary Food and Drug Administration-Approved Assays for Monitoring Viral Load**

Assay	Abbott Real Time	NucliSens EasyQ v2.0	COBAS AmpliPrep/ TaqMan v2.0	Versant v1.0	Aptima HIV-1 Quant Assay
<b>Method</b>	Real-time RT-PCR	Real-time NASBA	Real-time RT-PCR	Real-time RT-PCR	Real-time TMA
<b>Dynamic Range</b>	40–10 <sup>7</sup> copies/mL	25–10 <sup>7</sup> copies/mL	20–10 <sup>7</sup> copies/mL	37–11×10 <sup>7</sup> copies/mL	30–10 <sup>7</sup> copies/mL
<b>Specimen Volume<sup>a</sup></b>	0.2–1 mL	0.1–1 mL	1 mL	0.5 mL	≥0.4 mL
<b>Manufacturer</b>	Abbott Laboratories	bioMérieux	Roche	Siemens	Hologic, Inc.

<sup>a</sup> Laboratories often request large blood volumes for standard viral load testing. Consider contacting the local laboratory to determine minimum blood volume required to run the assay. Smaller volumes for children can be accommodated.

**Key:** NASBA = nucleic acid sequence-based amplification; RT-PCR = reverse transcription-polymerase chain reaction; TMA = transcription-mediated amplification

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