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Virologic and Immunologic Monitoring in HIV Care

Updates, Authorship, and Related Guidelines

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Contents

Purpose of This Guideline

Periodic laboratory tests are necessary to evaluate a patient's response to antiretroviral therapy (ART). Monitoring HIV-1 RNA levels (viral load) to confirm appropriate response to treatment and durable viral suppression is the most accurate and meaningful measure of the effectiveness of ART [Gale, et al. 2013]. HIV suppression is essential to the health of the individual with HIV and to preventing HIV transmission through sex.

Regular immunologic monitoring in patients with consistently undetectable HIV viral loads and CD4 counts >200 cells/mm^3 offers little utility in clinical practice today. Clinicians rarely use this information to guide decision-making for clinically stable, virologically suppressed patients.

The New York State Department of Health AIDS Institute has developed these evidence-based recommendations for ambulatory care of patients with HIV to accomplish the following:

- Guide clinicians in the use of HIV viral load testing at appropriate times and intervals to assess initial and ongoing ART responses.
- Clarify the appropriate use of immunologic (CD4 count) monitoring in the care of patients with HIV.

Note on "experienced" and "expert" HIV care providers: Throughout this guideline, when reference is made to "experienced HIV care provider" or "expert HIV care provider," those terms are referring to the following 2017 NYSDOH AI definitions:

- Experienced HIV care provider: Practitioners who have been accorded HIV Experienced Provider status by the American Academy of HIV Medicine or have met the HIV Medicine Association's definition of an experienced provider are eligible for designation as an HIV Experienced Provider in New York State. Nurse practitioners and licensed midwives who provide clinical care to individuals with HIV in collaboration with a physician may be considered HIV Experienced Providers as long as all other practice agreements are met (8 NYCRR 79-5:1; 10 NYCRR 85.36; 8 NYCRR 139-6900). Physician assistants who provide clinical care to individuals with HIV under the supervision of an HIV Specialist physician may also be considered HIV Experienced Providers (10 NYCRR 94.2)
- Expert HIV care provider: A provider with extensive experience in the management of complex patients with HIV.

Viral Load and CD4 Count Monitoring Intervals

☑ RECOMMENDATIONS

Monitoring Intervals

- To assess a patient's response to antiretroviral therapy (ART) and immunologic status and to identify when a change in antiretroviral therapy (ART) regimen is needed, clinicians should perform plasma HIV-1 RNA level (viral load) and CD4 count testing as detailed in Table 1: Recommended Viral Load and CD4 Count Monitoring in Nonpregnant Patients With HIV. (A1)
- Clinicians should address modifiable barriers to adherence and engagement in care to help ensure optimal virologic suppression. Modifiable barriers may include but are not limited to, substance use, mental illness, other chronic medical conditions, ART-associated adverse medication effects, unstable housing, or low health literacy. (A2)
- Quarterly CD4 count monitoring is *no longer recommended* for nonpregnant patients receiving ART who have consistently undetectable viral load levels and CD4 counts >200 cells/mm^3 (see Table 1 for recommended intervals). (A2)

Very few studies address the appropriate frequency of viral load monitoring. A retrospective study noted that the strongest predictor of virologic failure at 12 months was a missed or canceled appointment rather than the interval of follow-up [Buscher, et al. 2013]. However, this and other similar studies [Romih, et al. 2010; Reekie, et al. 2008] have significant limitations, including their retrospective nature and short follow-up periods. Data indicate that the linked sexual transmission of HIV in serodiscordant couples in which the partner with HIV maintains sustained viral suppression is negligible [Rodger, et al. 2016].

Based on this information, those with HIV may rely on ART as a strategy to prevent viral transmission to an uninfected partner. Studies do not indicate the appropriate interval for viral suppression monitoring for ongoing transmission prevention. Until more definitive data are available, the decision to lengthen monitoring intervals for HIV RNA levels should be individualized. Patients who are monitored at longer intervals should be carefully selected based on length of viral suppression, CD4 count, use of ART for transmission prevention, and adherence to medical care, including visit attendance and retention in care.

→ KEY POINT

- Quarterly HIV RNA monitoring remains appropriate for patients with a recent history of nonadherence, mental health disorders, substance use, homelessness, poor social support system, or other major medical conditions. Semiannual monitoring may be appropriate for patients with persistently undetectable HIV RNA and none of the above characteristics.

Table 1, below, provides a guide for monitoring HIV RNA levels and CD4 counts.

Table 1: Recommended Viral Load and CD4 Count Monitoring in Nonpregnant Patients With HIV [a]

Event	HIV RNA Viral Load	CD4 Count	Comments
Entry into care	Baseline viral load (A1)	Baseline CD4 count (A1)	• If a patient is not taking ART, recommend initiation [b] (A1) • Monitor as below
Patients Taking ART			
ART initiation or change to address virologic failure	• Within 4 weeks after ART start or change (A3) • At least every 8 weeks until complete virologic suppression is documented (A3)	• 12 weeks after ART initiation • Every 4 months until CD4 count >200 cells/mm^3 is obtained on 2 measurements at least 4 months apart (A2), then monitor as below once virologic suppression is achieved	• Virologic failure occurs when a viral load <200 copies/mL is either not achieved or not maintained • Virologic suppression is defined as a viral load <20 to <50 copies/mL obtained with a highly sensitive assay

Table 1: Recommended Viral Load and CD4 Count Monitoring in Nonpregnant Patients With HIV [a]			
Event	**HIV RNA Viral Load**	**CD4 Count**	**Comments**
ART change for simplification or due to adverse effects	Within 4 weeks after ART change, then as below (A3)	Monitor as below for documented virologic suppression	—
Documented viral suppression	• At least every 4 months (A3) • May extend interval to 6 months in patients stable on ART with CD4 count >200 cells/mm^3 and complete viral suppression for 1 year (B2)	• At least every 6 months if CD4 count is ≤350 cells/mm^3 (B2) • Optional if CD4 count is >350 cells/mm^3 (B2)	—
New HIV RNA ≥500 copies/mL after previous viral suppression	Repeat viral load test 2 weeks after first result (A2)	Obtain CD4 count if previous result is >6 months old (B3)	• Assess for adherence and drug-drug interactions (A3) • Obtain resistance testing (A1)
New HIV RNA level over the limit of detection of sensitive assays, 20 to 50 copies/mL, but <500 copies/mL after previous viral suppression	Repeat viral load test within 4 weeks to differentiate low-level transient viremia ("blip") from virologic failure [c] (A2)	If repeat viral load is detectable, obtain CD4 count if previous result is >6 months old (B3)	• Assess for adherence and drug-drug interactions (A3) • If repeat viral load is detectable, consider resistance testing [d] (B3) • Patients with low-level viremia ≤200 copies/mL over a period of 12 months without demonstrated failure may continue routine testing intervals of at least every 4 months [e]
Patients Not Taking ART			
CD4 count ≤500 cells/mm^3 (A2)	At least every 4 months	At least every 4 months	At every visit, recommend ART initiation [b]
CD4 count >500 cells/mm^3 (A2)	At least every 6 months	At least every 6 months	At every visit, recommend ART initiation [b]

Abbreviations ART, antiretroviral therapy.

Notes:

a. For recommendations on virologic monitoring in pregnancy, see DHHS: Recommendations for the Use of Antiretroviral Drugs During Pregnancy and Interventions to Reduce Perinatal HIV Transmission in the United States.
b. See NYSDOH AI guideline Rapid ART Initiation.
c. An ART regimen should not be changed based on a single viral load elevation. The risk of virologic rebound (breakthrough) increases when values are ≥500 copies/mL [Grennan, et al. 2012].
d. Standard genotypic tests may not provide resistance results when viral load is low. For repeated low-level viremia, an assay that detects resistance mutations in archived proviral DNA is available; however, clinical data are insufficient to recommend for or against its use in the patient care setting.
e. In patients with low-level viremia, clinicians should consult with an experienced HIV care provider; low-level viremia can be due to multiple causes, and its clinical effect is not clear.

Virologic Monitoring (HIV Viral Load)

Plasma HIV-1 RNA level (viral load): Plasma levels of viral RNA have been shown to correlate with clinical outcomes, including overall mortality, and measurement of HIV RNA levels provides the most precise means of establishing whether a response to antiretroviral therapy (ART) has occurred [HIV Surrogate Marker Collaborative Group 2000; Thiebaut, et al. 2000; Murray, et al. 1999; Marschner, et al. 1998; Mellors, et al. 1997].

HIV RNA levels should be obtained from all patients at baseline [Porter, et al. 2015; Behrens, et al. 2014; Molina, et al. 2013; Tarwater, et al. 2004; Gulick, et al. 2003; Wu, et al. 2003].

For patients beginning ART, or those changing therapy as a result of virologic failure, HIV RNA should be measured at 4 weeks after initiation of ART and should decrease by at least 1 log (10-fold) in the presence of effective therapy [Haubrich, et al. 2011] (see Table 2, below). For patients who do not have background antiretroviral resistance, an undetectable viral load (<50 copies/mL) is usually achieved within 3 months. Patients with a baseline HIV viral load >100,000 copies/mL can be expected to achieve an undetectable viral load within 6 months of effective treatment.

Table 2: Interpretation of Viral Load

HIV-1 RNA Copy Number

Copies/mL	Log^{10}
1,000,000	6.0
100,000	5.0
10,000	4.0
1,000	3.0
100	2.0

Reduction With ART If Patient Has 100,000 copies/mL

Log Change	Percent Decrease	Fold Reduction	Resultant Copy Number
0.5	68.38	3	33,000
1.0	90.00	10	10,000
2.0	99.00	100	1,000
3.0	99.90	1,000	100

Abbreviation: ART, antiretroviral therapy.

An absent or incomplete response of viral load to ART should raise concerns about poor adherence to therapy and/or viral resistance [Townsend, et al. 2009; Baxter, et al. 2000].

Blips: Patients on previously suppressive ART with newly detectable HIV RNA levels of 50 to 500 copies/mL may be experiencing low-level transient viremia (“blip”) and not virologic failure. A blip by definition means that the viral load is again below the level of quantification on repeat testing performed promptly after a detectable result in someone previously suppressed. Persistent elevation, even at low levels, warrants further investigation. Acute concurrent illness and/or recent vaccination may cause this transient rise; however, studies have suggested that low-level transient viremia represents random biologic and statistical variation or false elevations of viral load resulting from laboratory processing [Lee, et al. 2006; Nettles, et al. 2005]. Blips are not known to be associated with the development of resistance mutations or virologic failure and do not require a change in ART [Lee, et al. 2006]. Retesting should be performed within 4 weeks to differentiate low-level transient viremia (a blip) from sustained viremia and possible virologic failure. The risk of virologic rebound (breakthrough) increases when values are >500 copies/mL [Grennan, et al. 2012]. However, ART should not be changed based on a single viral load elevation.

Advances in molecular detection technology have led to the development of HIV nucleic acid tests that are highly sensitive and more reliable than earlier versions. Real-time polymerase chain reaction (PCR) technology has been widely adopted for HIV-1 RNA quantification, but new technologies are continually emerging and being adapted to viral detection and quantification. The currently available HIV-1 viral load tests that use real-time PCR technology offer a larger dynamic range of quantification than early-version viral load tests. The lower and upper limits of quantification of the

currently available U.S. Food and Drug Administration (FDA)-approved HIV-1 viral load tests are shown in Table 3, below. Several different HIV viral load tests have been developed, and 4 are currently approved for use in the United States.

Table 3: FDA-Approved Quantitative HIV-1 RNA Assays for Viral Load Monitoring

Test Name	Method	Lower and Upper LOQ
Abbott RealTime HIV-1 (Abbott Laboratories)	Real-time PCR	• 40 copies/mL [a] • 10,000,000 copies/mL
Cobas AmpliPrep/Cobas TaqMan HIV-1 Test, version 2.0 (Roche Diagnostics)	Real-time PCR	• 20 copies/mL • 10,000,000 copies/mL
Cobas HIV-1 quantitative NAT for use on Cobas 6800/8800 systems (Roche Diagnostics)	Real-time PCR	• 20 copies/mL • 10,000,000 copies/mL
Cobas TaqMan HIV-1 Test, v2.0 for use with the high pure system (Roche Diagnostics)	Real-time PCR	• 34 copies/mL • 10,000,000 copies/mL

Abbreviations: FDA, U.S. Food and Drug Administration; LOQ, limit of quantification; NAT, nucleic acid test, PCR, polymerase chain reaction.

Note:

a. This lower LOQ applies when 1.0 mL of plasma is used. When 0.5 and 0.2 mL of plasma are used, the lower LOQ is 75 copies/mL and 150 copies/mL, respectively.

All of the current FDA-approved viral load assays quantify the level of cell-free virus in an individual's plasma and are approved for monitoring response to ART, tracking viral suppression, and detecting treatment failure. Successful ART should decrease the viral load by 1.5 to 2 logs (30- to 100-fold) within 6 weeks, with the viral load decreasing below the limit of detection within 6 months [DHHS 2022]. Cohort studies strongly suggest that patients with viral loads <50 copies/mL have more sustained viral suppression than patients with viral loads between 50 and 400 copies/mL. Assays that can detect <50 copies/mL are recommended for determining prolonged viral suppression and for monitoring patients who are on ART.

→ KEY POINT

- Achieving and maintaining an undetectable viral load is always the goal of ART.

Immunologic Monitoring (CD4 Count)

Lymphocyte subsets (CD4 count): CD4 lymphocyte count is used to evaluate immunologic staging, predict the risk of clinical progression, and make decisions regarding opportunistic infection prophylaxis [Lopez Bernaldo de Quiros, et al. 2001; El-Sadr, et al. 2000]. Low CD4 counts can be seen in other disease processes and should therefore not be used to diagnose HIV infection. Although CD4 count was used historically to establish a threshold for initiating ART, current guidelines in New York State recommend ART for all patients with HIV regardless of CD4 count. For patients who may not be ready to initiate ART, CD4 count can be used to guide discussions between patient and care provider regarding the urgency of initiating ART.

Although a CD4 count should be obtained at baseline [Moore and Keruly 2007; Oldfield, et al. 1998; Havlir, et al. 1996; Schneider, et al. 1992; Fischl, et al. 1988], clinicians are unlikely to use it to guide clinical decision-making in practice for virologically suppressed patients once their CD4 count remains above 200 cells/mm^3. However, for those infected with HIV-2 or HIV-1 variants that cannot be accurately quantified using viral load assays, CD4 count remains the most effective tool for monitoring disease progression.

Although a significant CD4 count increase often occurs among patients treated with effective ART, the absence of such an increase should not be interpreted as treatment failure if the viral load declines appropriately. ART regimens are generally

not changed in patients with undetectable viral loads who experience immunologic failure, although patients should remain on appropriate prophylaxis for opportunistic infections based on CD4 count. One study of a cohort of more than 62,000 individuals in New York City over 1.9 years of observation reported that in those who entered the cohort with a CD4 count ≥350 cells/mm^3, there was a >90% likelihood of sustaining a CD4 count >200 cells/mm^3 during that period of time [Myers, et al. 2016]. Reassuringly, other data suggest that in patients with sustained viral suppression and CD4 counts between 100 and 200 cells/mm^3, the risk of pneumocystis pneumonia is very low even in the absence of prophylaxis [Chaiwarith, et al. 2013; Mocroft, et al. 2010; D'Egidio, et al. 2007].

Lack of correlation between viral load and CD4 count response is particularly common among patients ≥50 years old [Sabin, et al. 2008; Gras, et al. 2007] and patients with low initial CD4 counts (<100 cells/mm^3) [Kelley, et al. 2009; Moore and Keruly 2007; Garcia, et al. 2004].

Absolute CD4 counts are calculated values that may fluctuate widely. The calculation is made by multiplying the total white blood cell count (in thousands) by the percentage of total lymphocytes and then by the percentage of CD4 lymphocytes. Therefore, any change in one of these three parameters will cause the absolute CD4 count to vary. CD4 percentage is a direct measurement and more reliable than the calculated absolute CD4 value, especially over time. A stable CD4 percentage, even when fluctuations occur in the absolute CD4 count, can reassure both the patient and the clinician that immunologic stability is present.

Some factors that can cause these fluctuations include sex, age, race, drugs (zidovudine, cephalosporins, cancer chemotherapy, nicotine, interferon, and corticosteroids), anti-lymphocyte antibodies, and splenectomy. Differences in reagents and equipment both within a laboratory and between laboratories may further contribute to variations in CD4 counts. There is also interlaboratory variation of normal range.

All Recommendations

☑ ALL RECOMMENDATIONS

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Supplement: Guideline Development and Recommendation Ratings

Table S1: Guideline Development: New York State Department of Health AIDS Institute Clinical Guidelines Program	
Developer	New York State Department of Health AIDS Institute (NYSDOH AI) Clinical Guidelines Program
Funding source	NYSDOH AI
Program manager	Clinical Guidelines Program, Johns Hopkins University School of Medicine, Division of Infectious Diseases. See Program Leadership and Staff.
Mission	To produce and disseminate evidence-based, state-of-the-art clinical practice guidelines that establish uniform standards of care for practitioners who provide prevention or treatment of HIV, viral hepatitis, other sexually transmitted infections, and substance use disorders for adults throughout New York State in the wide array of settings in which those services are delivered.
Expert committees	The NYSDOH AI Medical Director invites and appoints committees of clinical and public health experts from throughout New York State to ensure that the guidelines are practical, immediately applicable, and meet the needs of care providers and stakeholders in all major regions of New York State, all relevant clinical practice settings, key New York State agencies, and community service organizations.
Committee structure	• Leadership: AI-appointed chair, vice chair(s), chair emeritus, clinical specialist(s), JHU Guidelines Program Director, AI Medical Director, AI Clinical Consultant, AVAC community advisor • Contributing members • Guideline writing groups: Lead author, coauthors if applicable, and all committee leaders
Disclosure and management of conflicts of interest	• Annual disclosure of financial relationships with commercial entities for the 12 months prior and upcoming is required of all individuals who work with the guidelines program, and includes disclosure for partners or spouses and primary professional affiliation. • The NYSDOH AI assesses all reported financial relationships to determine the potential for undue influence on guideline recommendations and, when indicated, denies participation in the program or formulates a plan to manage potential conflicts. Disclosures are listed for each committee member.
Evidence collection and review	• Literature search and review strategy is defined by the guideline lead author based on the defined scope of a new guideline or update. • A comprehensive literature search and review is conducted for a new guideline or an extensive update using PubMed, other pertinent databases of peer-reviewed literature, and relevant conference abstracts to establish the evidence base for guideline recommendations. • A targeted search and review to identify recently published evidence is conducted for guidelines published within the previous 3 years. • Title, abstract, and article reviews are performed by the lead author. The JHU editorial team collates evidence and creates and maintains an evidence table for each guideline.

Table S1: Guideline Development: New York State Department of Health AIDS Institute Clinical Guidelines Program	
Recommendation development	• The lead author drafts recommendations to address the defined scope of the guideline based on available published data. • Writing group members review the draft recommendations and evidence and deliberate to revise, refine, and reach consensus on all recommendations. • When published data are not available, support for a recommendation may be based on the committee's expert opinion. • The writing group assigns a 2-part rating to each recommendation to indicate the strength of the recommendation and quality of the supporting evidence. The group reviews the evidence, deliberates, and may revise recommendations when required to reach consensus.
Review and approval process	• Following writing group approval, draft guidelines are reviewed by all contributors, program liaisons, and a volunteer reviewer from the AI Community Advisory Committee. • Recommendations must be approved by two-thirds of the full committee. If necessary to achieve consensus, the full committee is invited to deliberate, review the evidence, and revise recommendations. • Final approval by the committee chair and the NYSDOH AI Medical Director is required for publication.
External reviews	• External review of each guideline is invited at the developer's discretion. • External reviewers recognized for their experience and expertise review guidelines for accuracy, balance, clarity, and practicality and provide feedback.
Update process	• JHU editorial staff ensure that each guideline is reviewed and determined to be current upon the 3-year anniversary of publication; guidelines that provide clinical recommendations in rapidly changing areas of practice may be reviewed annually. Published literature is surveilled to identify new evidence that may prompt changes to existing recommendations or development of new recommendations. • If changes in the standard of care, newly published studies, new drug approval, new drug-related warning, or a public health emergency indicate the need for immediate change to published guidelines, committee leadership will make recommendations and immediate updates and will invite full committee review as indicated.

Table S2: Recommendation Ratings and Definitions		
Strength	**Quality of Evidence**	
A: Strong B. Moderate C: Optional	1	Based on published results of at least 1 randomized clinical trial with clinical outcomes or validated laboratory endpoints.
	*	Based on either a self-evident conclusion; conclusive, published, in vitro data; or well-established practice that cannot be tested because ethics would preclude a clinical trial.
	2	Based on published results of at least 1 well-designed, nonrandomized clinical trial or observational cohort study with long-term clinical outcomes.
	2†	Extrapolated from published results of well-designed studies (including nonrandomized clinical trials) conducted in populations other than those specifically addressed by a recommendation. The source(s) of the extrapolated evidence and the rationale for the extrapolation are provided in the guideline text. One example would be results of studies conducted predominantly in a subpopulation (e.g., one gender) that the committee determines to be generalizable to the population under consideration in the guideline.
	3	Based on committee expert opinion, with rationale provided in the guideline text.