Guidelines for the Use of Antiretroviral Agents in HIV-1-Infected Adults and Adolescents

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Guidelines for the Use of Antiretroviral Agents in HIV-1-Infected Adults and Adolescents

Developed by the DHHS Panel on Antiretroviral Guidelines for Adults and Adolescents – A Working Group of the Office of AIDS Research Advisory Council (OARAC)

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It is emphasized that concepts relevant to HIV management evolve rapidly. The Panel has a mechanism to update recommendations on a regular basis, and the most recent information is available on the AIDS*info* Web site (http://aidsinfo.nih.gov).

access AIDS*info* mobile site

What's New in the Guidelines? (Last updated April 8, 2015; last reviewed April 8, 2015)

Revisions to the May 1, 2014, version of the guidelines include key updates to several existing sections and the addition of two new tables. Significant updates are highlighted throughout the document.

Key Updates

The following are key updates to existing sections of the guidelines.

What to Start: Initial Combination Regimens for the Antiretroviral-Naive Patient

Since the last version of these guidelines, data from clinical trials and cohort studies, as well as experience in clinical practice, have prompted significant changes to the list of Recommended, Alternative, and Other regimens for treatment-naive patients (Table 6). Additionally, a new table, titled "Antiretroviral (ARV) Regimen Considerations as Initial Therapy Based on Specific Clinical Scenarios," has been created to guide clinicians on the selection of an initial ARV regimen based on specific clinical scenarios and ARV-related considerations (Table 7).

- There are now five Recommended regimens for antiretroviral therapy (ART)-naive patients—four integrase strand transfer inhibitor (INSTI)-based regimens and one ritonavir-boosted protease inhibitor (PI/r)-based regimen, as listed below:

  INSTI-Based Regimens:

  - Dolutegravir/abacavir/lamivudine (DTG/ABC/3TC)—**only** for patients who are HLA-B*5701 negative **(AI)**
  - DTG plus tenofovir disoproxil fumarate/emtricitabine (TDF/FTC) **(AI)**
  - Elvitegravir/cobicistat/TDF/FTC (EVG/c/TDF/FTC)—**only** for patients with pre-ART CrCl >70 mL/min **(AI)**
  - Raltegravir (RAL) plus TDF/FTC **(AI)**

  PI/r-Based Regimen:

  - Darunavir/ritonavir (DRV/r) plus TDF/FTC **(AI)**
- Two regimens previously classified as Recommended regimens have been moved to the Alternative regimens category, with the rationale stated below:
  - Atazanavir/ritonavir (ATV/r) plus TDF/FTC **(BI)**—Based on the results of a large comparative clinical trial showing a greater rate of discontinuation with ATV/r plus TDF/FTC because of toxicities when compared to (DRV/r or RAL) plus TDF/FTC
  - Efavirenz/TDF/FTC (EFV/TDF/FTC) **(BI)**—Based on concerns about the tolerability of EFV in clinical trials and practice, especially the high rate of central nervous system (CNS)-related toxicities and a possible association with suicidality
- Three regimens (ATV/r plus ABC/3TC, EFV plus ABC/3TC, and rilpivirine/TDF/FTC) that were previously listed as Recommended regimens for baseline HIV RNA <100,000 copies/mL or CD4 T lymphocyte (CD4) count >200 cells/mm^3 are now in the Alternative or Other category, with the same caveat about limiting their use in these populations.
- Two regimens that use fewer than two nucleoside reverse transcriptase inhibitors (DRV/r plus RAL and lopinavir/ritonavir plus 3TC) are now listed among the Other regimens, with the caveat that their use would be limited to those patients who cannot take either TDF or ABC.

- Coformulations of atazanavir (ATV) and darunavir (DRV) with the pharmacokinetic (PK) enhancer cobicistat (COBI) have been added to the Alternative regimen options.

Virologic Failure

The following key updates have been made to this section:

- The Management of Virologic Failure in Different Clinical Scenarios subsection has been expanded to provide guidance on the management of patients failing first and second ART regimens.
- A new subsection on Isolated CNS Virologic Failure and New Onset Neurologic Symptoms has been added.
- The Suboptimal Immunologic Response Despite Viral Suppression subsection has been moved from this section to become a stand-alone section (see below).

Poor CD4 Cell Recovery and Persistent Inflammation Despite Viral Suppression

- This new section describes the role of persistently low CD4 cell count (<200 cells/mm^3) and persistent inflammation/immune activation on the increased risk of AIDS- and non-AIDS-related morbidity.
- The Panel emphasizes that currently no therapeutic intervention designed to improve CD4 cell recovery or immune activation has been proven to improve health.

Acute/Early HIV Infection

- This section has been updated to include the 2014 Centers for Disease Control and Prevention's recommendation for diagnosis of HIV infection, including in individuals with acute/early HIV infection.

HIV-2 Infection

- This section has been updated with the most recent literature on ARV use in HIV-2-infected patients.

HIV/Hepatitis C Virus (HCV) Coinfection

- The text and table (Table 12) in this section have been updated with information on the concomitant use of different ARV drugs with the new HCV drug combination of ombitasvir, paritaprevir, ritonavir, and dasabuvir.

Drug Interaction

- The text of this section has been updated to focus on mechanisms of interaction of ARV drugs.
- A new table, titled "Mechanisms of Antiretroviral Associated Drug Interactions," has been developed to provide clinicians with information on clinically relevant mechanisms of PK-associated interactions for individual ARV drugs (Table 17).
- All the Drug Interaction tables have been updated; in particular, interactions related to ATV/c, DRV/c, and EVG plus PI/r have been added to these tables (see Tables 19a–e, 20a, and 20b).

Additional Updates

Minor revisions have also been made to the following sections:

- Discontinuation or Interruption of Antiretroviral Therapy
- Exposure-Response Relationship and Therapeutic Drug Monitoring (TDM) for Antiretroviral Agents
- Monthly Average Wholesale Price of Antiretroviral Drugs (Table 16)
- Drug Characteristics tables (Appendix B, Tables 1–7)

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HHS Panel on Antiretroviral Guidelines for Adults and Adolescents
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Special Thanks

The Panel would also like to acknowledge Lucila Suarez for administrative support in preparation of these guidelines.

Health and Human Services Panel on Antiretroviral Guidelines for Adults and Adolescents Financial Disclosure (Reporting Period: February 2014 to February 2015) (page 1 of 3)

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Health and Human Services Panel on Antiretroviral Guidelines for Adults and Adolescents Financial Disclosure (Reporting Period: February 2014 to February 2015) (page 2 of 3)

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Key to Abbreviations: C = Co-Chair; DSMB = Data Safety Monitoring Board; ES = Executive Secretary; M = Member; N/A = Not Applicable

Introduction (Last updated February 12, 2013; last reviewed February 12, 2013)

Antiretroviral therapy (ART) for the treatment of HIV infection has improved steadily since the advent of potent combination therapy in 1996. New drugs that offer new mechanisms of action, improvements in potency and activity even against multidrug-resistant viruses, dosing convenience, and tolerability have been approved. ART has dramatically reduced HIV-associated morbidity and mortality and has transformed HIV disease into a chronic, manageable condition. In addition, effective treatment of HIV-infected individuals with ART is highly effective at preventing transmission to sexual partners.[1] However, less than one-third of HIV-infected individuals in the United States have suppressed viral loads,[2] which is mostly a result of undiagnosed HIV infection and failure to link or retain diagnosed patients in care. Despite remarkable improvements in HIV treatment and prevention, economic and social barriers that result in continued morbidity, mortality, and new HIV infections persist.

The Department of Health and Human Services (HHS) Panel on Antiretroviral Guidelines for Adults and Adolescents (the Panel) is a working group of the Office of AIDS Research Advisory Council (OARAC). The primary goal of the Panel is to provide HIV care practitioners with recommendations based on current knowledge of antiretroviral (ARV) drugs used to treat adults and adolescents with HIV infection in the United States. The Panel reviews new evidence and updates recommendations in these guidelines when needed. The Panel's primary areas of attention have included baseline assessment, treatment goals, indications for initiation of ART, choice of the initial regimen for ART-naive patients, drugs or combinations to avoid, management of adverse effects and drug interactions, management of treatment failure, and special ART-related considerations in specific patient populations. For recommendations related to pre-exposure HIV prophylaxis (PrEP) for HIV-uninfected persons, please refer to recommendations from the Centers for Disease Control and Prevention (CDC).[3, 4]

These guidelines generally represent the state of knowledge regarding the use of ARV agents. However, because the science of HIV evolves rapidly, the availability of new agents and new clinical data may change therapeutic options and preferences. Information included in these guidelines may not be consistent with approved labeling for the particular products or indications in question, and the use of the terms "safe" and "effective" may not be synonymous with the Food and Drug Administration (FDA)-defined legal standards for product approval. The Panel frequently updates the guidelines (current and archived versions of the guidelines are available on the AIDS*info* website at http://www.aidsinfo.nih.gov). However, the guidelines cannot always be updated apace with the rapid evolution of new data in the field of HIV and cannot offer guidance on care for all patients. Clinicians should exercise clinical judgment in management decisions tailored to unique patient circumstances.

The Panel recognizes the importance of clinical research in generating evidence to address unanswered questions related to the optimal safety and efficacy of ART. The Panel encourages both the development of protocols and patient participation in well-designed, Institutional Review Board (IRB)-approved clinical trials.

Guidelines Development Process

Table 1. Outline of the Guidelines Development Process

Topic	Comment
Goal of the guidelines	Provide guidance to HIV care practitioners on the optimal use of antiretroviral (ARV) agents for the treatment of HIV infection in adults and adolescents in the United States.
Panel members	The Panel is composed of approximately 40 voting members who have expertise in HIV care and research. The Panel includes at least one representative from each of the following U.S. Department of Health and Human Services (HHS) agencies: Centers for Disease Control and Prevention (CDC), Food and Drug Administration (FDA), Health Resource Services Administration (HRSA), and National Institutes of Health (NIH). Approximately two-thirds of the Panel members are non-governmental scientific members. The Panel also includes four to five community members with knowledge in HIV treatment and care. The U.S. government representatives are appointed by their respective agencies; other Panel members are selected after an open announcement to call for nominations. Each member serves on the Panel for a 4-year term with an option for reappointment for an additional term. A list of current members can be found in the Panel Roster.
Financial disclosure	All members of the Panel submit financial disclosure in writing annually, reporting any association with manufacturers of ARV drugs or diagnostics used for management of HIV infections. A list of the latest disclosures is available on the AIDS*info* website (http://aidsinfo.nih.gov/contentfiles/AA_financialDisclosures.pdf).
Users of the guidelines	HIV treatment providers
Developer	Panel on Antiretroviral Guidelines for Adults and Adolescents—a working group of the Office of AIDS Research Advisory Council (OARAC)
Funding source	Office of AIDS Research, NIH
Evidence collection	The recommendations in the guidelines are generally based on studies published in peer-reviewed journals. On some occasions, particularly when new information may affect patient safety, unpublished data presented at major conferences or prepared by the FDA and/or manufacturers as warnings to the public may be used as evidence to revise the guidelines.
Recommendation grading	As described in Table 2
Method of synthesizing data	Each section of the guidelines is assigned to a working group of Panel members with expertise in the area of interest. The working groups synthesize the available data and propose recommendations to the Panel. The Panel discusses all proposals during monthly teleconferences. Recommendations endorsed by the Panel are included in the guidelines as official recommendations.
Other guidelines	These guidelines focus on treatment for HIV-infected adults and adolescents. Included is a brief discussion on the management of women of reproductive age and pregnant women. For more detailed and up-to-date discussion on the use of antiretroviral therapy (ART) for these women, as well as for children, and other special populations, please refer to guidelines specific to these groups. The guidelines are also available on the AIDS*info* website (http://www.aidsinfo.nih.gov).
Update plan	The Panel meets monthly by teleconference to review data that may warrant modification of the guidelines. Updates may be prompted by new drug approvals (or new indications, dosing formulations, or frequency of dosing), new significant safety or efficacy data, or other information that may have a significant impact on the clinical care of patients. In the event of significant new data that may affect patient safety, the Panel may post a warning announcement with recommendations on the AIDS*info* website in the interim until the guidelines can be updated with the appropriate changes. Updated guidelines are available on the AIDS*info* website (http://www.aidsinfo.nih.gov).
Public comments	A 2-week public comment period follows release of the updated guidelines on the AIDS*info* website. The Panel reviews comments received to determine whether additional revisions to the guidelines are indicated. The public may also submit comments to the Panel at any time at contactus@aidsinfo.nih.gov.

Basis for Recommendations

Recommendations in these guidelines are based upon scientific evidence and expert opinion. Each recommended statement includes a letter (**A**, **B**, or **C**) that represents the strength of the recommendation and with a Roman numeral (**I**, **II**, or **III**) that represents the quality of the evidence that supports the recommendation (see Table 2).

Table 2. Rating Scheme for Recommendations

Strength of Recommendation	Quality of Evidence for Recommendation
A: Strong recommendation for the statement	**I:** One or more randomized trials with clinical outcomes and/or validated laboratory endpoints
B: Moderate recommendation for the statement	**II:** One or more well-designed, non-randomized trials or observational cohort studies with long-term clinical outcomes
C: Optional recommendation for the statement	**III:** Expert opinion

HIV Expertise in Clinical Care

Many studies have demonstrated that outcomes achieved in HIV-infected outpatients are better when care is delivered by a clinician with HIV expertise,[5-10] which reflects the complexity of HIV infection and its treatment. Thus, appropriate training and experience, as well as ongoing continuing education, are important components of optimal care. Primary care providers without HIV experience, such as those who provide service in rural or underserved areas, should identify experts in their regions who will be available for consultation when needed.

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Baseline Evaluation (Last updated May 1, 2014; last reviewed May 1, 2014)

Every HIV-infected patient entering into care should have a complete medical history, physical examination, and laboratory evaluation and should be counseled regarding the implications of HIV infection. The goals of the initial evaluation are to confirm the diagnosis of HIV infection, obtain appropriate baseline historical and laboratory data, ensure patient understanding about HIV infection and its transmission, and to initiate care as recommended in HIV primary care guidelines[1] and guidelines for prevention and treatment of HIV-associated opportunistic infections.[2] The initial evaluation also should include introductory discussion on the benefits of antiretroviral therapy (ART) for the patient's health and to prevent HIV transmission. Baseline information then can be used to define management goals and plans. In the case of previously treated patients who present for an initial evaluation with a new health care provider, it is critical to obtain a complete antiretroviral (ARV) history (including drug-resistance testing results, if available), preferably through the review of past medical records. Newly diagnosed patients should also be asked about any prior use of ARV agents for prevention of HIV infection.

The following laboratory tests performed during initial patient visits can be used to stage HIV disease and to assist in the selection of ARV drug regimens:

- HIV antibody testing (if prior documentation is not available or if HIV RNA is below the assay's limit of detection) **(AI)**;
- CD4 T-cell count (CD4 count) **(AI)**;
- Plasma HIV RNA (viral load) **(AI)**;
- Complete blood count, chemistry profile, transaminase levels, blood urea nitrogen (BUN), and creatinine, urinalysis, and serologies for hepatitis A, B, and C viruses **(AIII)**;
- Fasting blood glucose and serum lipids **(AIII)**; and
- Genotypic resistance testing at entry into care, regardless of whether ART will be initiated immediately **(AII)**. For patients who have HIV RNA levels <500 to 1,000 copies/mL, viral amplification for resistance testing may not always be successful **(BII)**.

In addition, other tests (including screening tests for sexually transmitted infections and tests for determining the risk of opportunistic infections and need for prophylaxis) should be performed as recommended in HIV primary care and opportunistic infections guidelines.[1, 2]

Patients living with HIV infection often must cope with many social, psychiatric, and medical issues that are best addressed through a patient-centered, multi-disciplinary approach to the disease. The baseline evaluation should include an evaluation of the patient's readiness for ART, including an assessment of high-risk behaviors, substance abuse, social support, mental illness, comorbidities, economic factors (e.g., unstable housing), medical insurance status and adequacy of coverage, and other factors that are known to impair adherence to ART and increase the risk of HIV transmission. Once evaluated, these factors should be managed accordingly. The baseline evaluation should also include a discussion of risk reduction and disclosure to sexual and/or needle sharing partners, especially with untreated patients who are still at high risk of HIV transmission.

Education about HIV risk behaviors and effective strategies to prevent HIV transmission should be provided at each patient visit (see Preventing Secondary Transmission of HIV).

References

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Laboratory Testing

Laboratory Testing for Initial Assessment and Monitoring of HIV-Infected Patients on Antiretroviral Therapy (Last updated May 1, 2014; last reviewed May 1, 2014)

A number of laboratory tests are important for initial evaluation of HIV-infected patients upon entry into care; during follow-up if antiretroviral therapy (ART) is not initiated; and before and after initiation or modification of therapy to assess the virologic and immunologic efficacy of ART and to monitor for laboratory abnormalities that may be associated with antiretroviral (ARV) drugs. Table 3 outlines the Panel's recommendations on the frequency of testing. As noted in the table, some tests may be repeated more frequently if clinically indicated.

Two surrogate markers are used routinely to assess immune function and level of HIV viremia: CD4 T-cell count (CD4 count) and plasma HIV RNA (viral load), respectively. Resistance testing should be used to guide selection of an ARV regimen. A viral tropism assay should be performed before initiation of a CCR5 antagonist or at the time of virologic failure that occurs while a patient is receiving a CCR5 antagonist. HLA-B*5701 testing should be performed before initiation of abacavir (ABC). The rationale for and utility of these laboratory tests are discussed in the corresponding sections of the guidelines.

Table 3. Laboratory Monitoring Schedule for HIV-Infected Patients Before and After Initiation of Antiretroviral Therapy[a] (page 1 of 2)

Laboratory Test	Timepoint/Frequency of Testing								
	Entry into Care	Follow Up Before Initiation of ART	ART Initiation or Modification[b]	Follow-Up 2 to 8 Weeks After ART Initiation or Modification	Every 3 to 6 Months	Every 6 Months	Every 12 Months	Treatment Failure	Clinically Indicated
HIV Serology	√ If HIV diagnosis has not been confirmed								
CD4 Count	√	√ Every 3–6 months	√		√ During first 2 years of ART or if viremia develops while patient on ART or CD4 count <300 cells/ mm^3		√ After 2 years on ART with consistently suppressed viral load: *CD4 Count 300–500 cells/mm^3:* • Every 12 months *CD4 Count >500 cells/mm^3:* • CD4 monitoring is optional	√	√
HIV Viral Load	√	Repeat testing is optional	√	√[c]	√[d]	√[d]		√	√
Resistance Testing	√		√[e]					√	√
HLA-B*5701 Testing			√ If considering ABC						
Tropism Testing			√ If considering a CCR5 antagonist					√ If considering a CCR5 antagonist or for failure of CCR5 antagonist-based regimen	√

Table 3. Laboratory Monitoring Schedule for HIV-Infected Patients Before and After Initiation of Antiretroviral Therapy[a] (page 2 of 2)

Laboratory Test	Timepoint/Frequency of Testing								
	Entry into Care	Follow Up Before Initiation of ART	ART Initiation or Modification[b]	Follow-Up 2 to 8 Weeks After ART Initiation or Modification	Every 3 to 6 Months	Every 6 Months	Every 12 Months	Treatment Failure	Clinically Indicated
Hepatitis B Serology[f]	√		√ May repeat if HBsAg (-) and HBsAb (-) at baseline						√
Hepatitis C Serology, with Confirmation of Positive Results	√								√
Basic Chemistry[g,h]	√	√ Every 6–12 months	√	√	√				√
ALT, AST, T. bilirubin	√	√ Every 6–12 months	√	√	√				√
CBC with Differential	√	√ Every 3–6 months	√	√ If on ZDV	√				√
Fasting Lipid Profile	√	√ If normal, annually	√	√ Consider 4–8 weeks after starting new ART regimen that affects lipids		√ If abnormal at last measure-ment	√ If normal at last measurement		√
Fasting Glucose or Hemoglobin A1C	√	√ If normal, annually	√		√ If abnormal at last measure-ment		√ If normal at last measurement		√
Urinalysis[g]	√		√			√ If on TDF[i]	√		√
Pregnancy Test			√ In women with child-bearing potential						√

[a] This table pertains to laboratory tests done to select an ARV regimen and monitor for treatment responses or ART toxicities. Please refer to the HIV Primary Care guidelines for guidance on other laboratory tests generally recommended for primary health care maintenance of HIV patients.[1]

[b] ART may be modified because of treatment failure, adverse effects, or for regimen simplification.

[c] If HIV RNA is detectable at 2 to 8 weeks, repeat every 4 to 8 weeks until viral load is suppressed to <200 copies/mL, and thereafter, every 3 to 6 months.

[d] In patients on ART, viral load typically is measured every 3 to 4 months. However, for adherent patients with consistently suppressed viral load and stable immunologic status for more than 2 years, monitoring can be extended to 6 month intervals.

[e] In ART-naive patients, if resistance testing was performed at entry into care, repeat testing before initiation of ART is optional. The exception is pregnant women; repeat testing is recommended in this case. In virologically suppressed patients who are switching therapy because of toxicity or for convenience, viral amplification will not be possible; therefore, resistance testing should not be performed. Results from prior resistance testing can be helpful in constructing a new regimen.

[f] If HBsAg is positive at baseline or before initiation of ART, TDF plus either FTC or 3TC should be used as part of the ARV regimen to treat both HBV and HIV infections. If HBsAg, and HBsAb, and anti-HBc are negative at baseline, hepatitis B vaccine series should be administered. Refer to HIV Primary Care guidelines for more detailed recommendations.[1]

[g] Serum Na, K, HCO_3, Cl, BUN, creatinine, glucose (preferably fasting). Some experts suggest monitoring the phosphorus levels of patients on TDF. Determination of renal function should include estimation of CrCl using the Cockcroft-Gault equation or estimation of glomerular filtration rate using the MDRD equation.

[h] For patients with renal disease, consult the Guidelines for the Management of Chronic Kidney Disease in HIV-Infected Patients: Recommendations of the HIV Medicine Association of the Infectious Diseases Society of America.[2]

[i] More frequent monitoring may be indicated for patients with evidence of kidney disease (e.g., proteinuria, decreased glomerular dysfunction) or increased risk of renal insufficiency (e.g., patients with diabetes, hypertension).

Key to Acronyms: 3TC = lamivudine, ABC = abacavir, ALT = alanine aminotransferase, ART = antiretroviral therapy, AST = aspartate aminotranserase, CBC = complete blood count, CrCl = creatinine clearance, EFV = efavirenz, FTC = emtricitabine, HBsAb = hepatitis B surface antibody, HBsAg = hepatitis B surface antigen, HBV = hepatitis B virus, MDRD = modification of diet in renal disease (equation), TDF = tenofovir, ZDV = zidovudine

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Plasma HIV-1 RNA (Viral Load) and CD4 Count Monitoring (Last updated May 1, 2014; last reviewed May 1, 2014)

HIV RNA (viral load) and CD4 T lymphocyte (CD4) cell count are the two surrogate markers of antiretroviral treatment (ART) responses and HIV disease progression that have been used for decades to manage and monitor HIV infection.

Viral load is a marker of response to ART. A patient's pre-ART viral load level and the magnitude of viral load decline after initiation of ART provide prognostic information about the probability of disease progression.[1] The key goal of ART is to achieve and maintain durable viral suppression. Thus, the most important use of the viral load is to monitor the effectiveness of therapy **after** initiation of ART.

Measurement of CD4 count is particularly useful **before** initiation of ART. The CD4 cell count provides information on the overall immune function of an HIV-infected patient. The measurement is critical in establishing thresholds for the initiation and discontinuation of opportunistic infection (OI) prophylaxis and in assessing the urgency to initiate ART.

The management of HIV-infected patients has changed substantially with the availability of newer, more potent, and less toxic antiretroviral (ARV) agents. In the United States, ART is now recommended for all HIV-infected patients regardless of their viral load or CD4 count. In the past, clinical practice, which was supported by treatment guidelines, was generally to monitor both CD4 cell count and viral load concurrently. However, because most HIV-infected patients in care now receive ART, the rationale for frequent CD4 monitoring is weaker. The roles and usefulness of these two tests in clinical practice are discussed in the following sections.

Plasma HIV-1 RNA (Viral Load) Monitoring

Viral load is the most important indicator of initial and sustained response to ART **(AI)** and should be measured in all HIV-infected patients at entry into care **(AIII)**, at initiation of therapy **(AIII)**, and on a regular basis thereafter. For those patients who choose to delay therapy, repeat viral load testing while not on ART is optional **(CIII)**. Pre-treatment viral load level is also an important factor in the selection of an initial ARV regimen because several currently approved ARV drugs or regimens have been associated with poorer responses in patients with high baseline viral load (see What to Start). Commercially available HIV-1 RNA assays do not detect HIV-2 viral load. For further discussion on HIV-2 RNA monitoring in patients with HIV-1/HIV-2 co-infection or HIV-2 mono-infection, see HIV-2 Infection.

Several systematic reviews of data from clinical trials involving thousands of participants have established that decreases in viral load following initiation of ART are associated with reduced risk of progression to AIDS or death.[1-3] Thus, viral load testing is an established surrogate marker for treatment response.[4] The minimal change in viral load considered to be statistically significant (2 standard deviations) is a three-fold change (equivalent to a 0.5 $\log_{10}$ copies/mL change). Optimal viral suppression is defined generally as a viral load persistently below the level of detection (HIV RNA <20 to 75 copies/mL, depending on the assay used). However, isolated blips (viral loads transiently detectable at low levels, typically HIV RNA <400 copies/mL) are not uncommon in successfully treated patients and are not predictive of virologic failure.[5] Furthermore, the data on the association between persistently low level but quantifiable viremia (HIV RNA <200 copies/mL) and virologic failure is conflicting. One recent study showed an increased risk of subsequent failure at this level of viremia; however, the association was not observed in other studies.[6-9] These guidelines and the AIDS Clinical Trials Group (ACTG) now define virologic failure as a confirmed viral load >200 copies/mL—a threshold that eliminates most cases of apparent viremia caused by viral load blips or assay variability[10] (see Virologic Failure and Suboptimal Immunologic Response).

Individuals who are adherent to their ARV regimens and do not harbor resistance mutations to the component drugs can generally achieve viral suppression 8 to 24 weeks after ART initiation; rarely, in some patients it

may take longer. Recommendations on the frequency of viral load monitoring are summarized below:

- **After initiation of ART or modification of therapy because of virologic failure.** Plasma viral load should be measured before initiation of ART and within 2 to 4 weeks but no later than 8 weeks after treatment initiation or modification **(AIII)**. The purpose of the measurements is to confirm an adequate initial virologic response to ART, indicating appropriate regimen selection and patient adherence to therapy. Repeat viral load measurement should be performed at 4- to 8-week intervals until the level falls below the assay's limit of detection **(BIII)**.
- **In virologically suppressed patients in whom ART was modified because of drug toxicity or for regimen simplification.** Viral load measurement should be performed within 4 to 8 weeks after changing therapy **(AIII)**. The purpose of viral load monitoring at this point is to confirm the effectiveness of the new regimen.
- **In patients on a stable, suppressive ARV regimen.** Viral load should be repeated every 3 to 4 months **(AIII)** or as clinically indicated to confirm continuous viral suppression. Clinicians may extend the interval to 6 months for adherent patients whose viral load has been suppressed for more than 2 years and whose clinical and immunologic status is stable **(AIII)**.
- **In patients with suboptimal response.** The frequency of viral load monitoring will depend on clinical circumstances, such as adherence and availability of further treatment options. In addition to viral load monitoring, a number of additional factors, such as patient adherence to prescribed medications, suboptimal drug exposure, or drug interactions, should be assessed. Patients who fail to achieve viral suppression should undergo resistance testing to aid in the selection of an alternative regimen (see Drug-Resistance Testing and Virologic Failure and Suboptimal Immunologic Response sections).

CD4 Count Monitoring

The CD4 count is the most important laboratory indicator of immune function in HIV-infected patients. It is also the strongest predictor of subsequent disease progression and survival according to findings from clinical trials and cohort studies.[11,12] CD4 counts are highly variable; a significant change (2 standard deviations) between 2 tests is approximately a 30% change in the absolute count, or an increase or decrease in CD4 percentage by 3 percentage points. Monitoring of lymphocyte subsets other than CD4 (e.g., CD8, CD19) has not proven clinically useful, is more expensive, and is **not routinely recommended (BIII)**.

Use of CD4 Count for Initial Assessment

CD4 count should be measured in all patients at entry into care **(AI)**. It is the key factor in determining the need to initiate OI prophylaxis (see the Adult Opportunistic Infection Guidelines)[13] and the urgency to initiate ART **(AI)** (see the Initiating Antiretroviral Therapy in Antiretroviral-Naive Patients section of these guidelines). Although most OIs occur in patients with CD4 counts <200 cells/mm^3, some OIs can occur in patients with higher CD4 counts.[14]

Use of CD4 Count for Monitoring Therapeutic Response

The CD4 count is used to assess a patient's immunologic response to ART. It is also used to determine whether prophylaxis for OIs can be discontinued (see the Adult Opportunistic Infection Guidelines)[13]. For most patients on therapy, an adequate response is defined as an increase in CD4 count in the range of 50 to 150 cells/mm^3 during the first year of ART, generally with an accelerated response in the first 3 months of treatment. Subsequent increases average approximately 50 to 100 cells/mm^3 per year until a steady state level is reached.[15] Patients who initiate therapy with a low CD4 count[16] or at an older age[17] may have a blunted increase in their counts despite virologic suppression.

Frequency of CD4 Count Monitoring

ART is now recommended for all HIV-infected patients. In patients who remain untreated for whatever reason, CD4 counts should be monitored every 3 to 6 months to assess the urgency of ART initiation and the need for OI prophylaxis **(AIII)**.

A repeat CD4 count 3 months after ART initiation will provide information regarding the magnitude of immune reconstitution **(AIII)**. This repeat measurement is most important in patients who initiate ART with more advanced disease and require OI prophylaxis or treatment. In these patients, the magnitude and duration of CD4 count increase can be used to determine whether to discontinue OI prophylaxis and/or treatment as recommended in the guidelines for treatment and prophylaxis of opportunistic infections.[13] In this setting, and in the first 2 years following ART initiation, CD4 count can be monitored at 3- to 6-month intervals **(BII)**.

The CD4 count response to ART varies widely, but a poor CD4 response in a patient with viral suppression is rarely an indication for modifying an ARV regimen. In patients with consistently suppressed viral loads who have already experienced ART-related immune reconstitution, the CD4 count provides limited information. Frequent testing is unnecessary because the results rarely lead to a change in clinical management. One retrospective study found that declines in CD4 count to <200 cells/mm^3 are rare in patients with viral suppression and CD4 counts >300 cells/mm^3.[18] Similarly, the ARTEMIS trial found that CD4 monitoring had no clinical benefit in patients who had suppressed viral loads and CD4 counts >200 cells/mm^3 after 48 weeks of therapy.[19] Furthermore, the risk of *Pneumocystis jirovecii* pneumonia is extremely low in patients on suppressive ART who have CD4 counts between 100 and 200 cells/mm^3.[20] Although uncommon, CD4 count declines can occur in a small percentage of virologically suppressed patients and may be associated with adverse clinical outcomes such as cardiovascular disease, malignancy, and death.[21] An analysis of costs associated with CD4 monitoring in the United States estimated that reducing CD4 monitoring in treated patients from every 6 months to every 12 months could result in annual savings of approximately $10 million.[22]

For the patient on a suppressive regimen whose CD4 count has consistently ranged between 300 and 500 cells/mm^3 for at least 2 years, the Panel recommends CD4 monitoring on an annual basis **(BII)**. Continued CD4 monitoring for virologically suppressed patients whose CD4 counts have been consistently >500 cells/mm^3 for at least 2 years may be considered optional **(CIII)**. The CD4 count should be monitored more frequently, as clinically indicated, when there are changes in a patient's clinical status that may decrease CD4 count and thus prompt OI prophylaxis. Examples of such changes include the appearance of new HIV-associated clinical symptoms or initiation of treatment known to reduce CD4 cell count (e.g., interferon, chronic corticosteroids, or anti-neoplastic agents) **(AIII)**. In patients who fail to maintain viral suppression while on ART, the Panel recommends CD4 count monitoring every 3 to 6 months **(AIII)** (see Virologic Failure and Suboptimal Immunologic Response section).

Factors that Affect Absolute CD4 Count

The absolute CD4 count is a calculated value based on the total white blood cell (WBC) count and the percentages of total and CD4+ T lymphocytes. This absolute number may fluctuate in individuals or may be influenced by factors that may affect the total WBC count and lymphocyte percentages, such as use of bone marrow-suppressive medications or the presence of acute infections. Splenectomy[23,24] or co-infection with human T-lymphotropic virus type I (HTLV-1)[25] may cause misleadingly elevated CD4 counts. Alpha-interferon may reduce the absolute CD4 count without changing the CD4 percentage.[26] In all these settings, CD4 percentage remains stable and may be a more appropriate parameter to assess a patient's immune function.

Table 4. Recommendations on the Indications and Frequency of Viral Load and CD4 Count Monitoring[a]

Clinical Scenario	Viral Load Monitoring	CD4 Count Monitoring
Before initiating ART	At entry into care **(AIII)** If ART initiation is deferred, repeat before initiating ART **(AIII)**. In patients not initiating ART, repeat testing is optional **(CIII)**.	At entry into care **(AI)** If ART is deferred, every 3 to 6 months **(AIII)**.[b]
After initiating ART	Preferably within 2 to 4 weeks (and no later than 8 weeks) after initiation of ART **(AIII)**; thereafter, every 4 to 8 weeks until viral load suppressed **(BIII)**.	3 months after initiation of ART **(AIII)**
After modifying ART because of drug toxicities or for regimen simplification in a patient with viral suppression	4 to 8 weeks after modification of ART to confirm effectiveness of new regimen **(AIII)**.	Monitor according to prior CD4 count and duration on ART, as outlined below.
After modifying ART because of virologic failure	Preferably within 2 to 4 weeks (and no later than 8 weeks) after modification **(AIII)**; thereafter, every 4 to 8 weeks until viral load suppressed **(BIII)**. If viral suppression is not possible, repeat viral load every 3 months or more frequently if indicated **(AIII)**.	Every 3 to 6 months **(AI)**
During the first 2 years of ART	Every 3 to 4 months **(AIII)**	Every 3 to 6 months[a] **(BII)**
After 2 years of ART (VL consistently suppressed, CD4 consistently 300-500 cells/mm^3)	Can extend to every 6 months for patients with consistent viral suppression for ≥2 years **(AIII)**.	Every 12 months **(BII)**
After 2 years of ART (VL consistently suppressed, CD4 consistently >500 cells/mm^3)		Optional **(CIII)**
While on ART with detectable viremia (VL repeatedly >200 copies/mL)	Every 3 months **(AIII)** or more frequently if clinically indicated. (See Virologic Failure and Suboptimal Immunologic Response section)	Every 3 to 6 months **(AIII)**
Change in clinical status (e.g., new HIV clinical symptom or initiation of interferon, chronic systemic corticosteroids, or antineoplastic therapy)	Every 3 months **(AIII)**	Perform CD4 count and repeat as clinically indicated[c] **(AIII)**

[a] Monitoring of lymphocyte subsets other than CD4 (e.g., CD8, CD19) has not proven clinically useful, adds to costs, and is not routinely recommended **(BIII)**.

[b] Some experts may repeat CD4 count every 3 months in patients with low baseline CD4 count (<200–300 cells/mm^3) before ART but every 6 months in those who initiated ART at higher CD4 cell count (e.g., >300 cells/mm^3).

[c] The following are examples of clinically indicated scenarios: changes in a patient's clinical status that may decrease CD4 count and thus prompt initiation of prophylaxis for opportunistic infections (OI), such as new HIV-associated symptoms, or initiation of treatment with medications which are known to reduce CD4 cell count.

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Drug-Resistance Testing (Last updated May 1, 2014; last reviewed May 1, 2014)

Panel's Recommendations

- HIV drug-resistance testing is recommended in persons with HIV infection at entry into care regardless of whether antiretroviral therapy (ART) will be initiated immediately or deferred **(AII)**. If therapy is deferred, repeat testing should be considered at the time of ART initiation **(CIII)**.
- Genotypic testing is recommended as the preferred resistance testing to guide therapy in antiretroviral (ARV)-naive patients **(AIII)**.
- Standard genotypic drug-resistance testing in ARV-naive persons involves testing for mutations in the reverse transcriptase (RT) and protease (PR) genes. If transmitted integrase strand transfer inhibitor (INSTI) resistance is a concern, providers may wish to supplement standard genotypic resistance testing with an INSTI genotype test **(CIII)**.
- HIV drug-resistance testing should be performed to assist in the selection of active drugs when changing ARV regimens in persons with virologic failure and HIV RNA levels >1,000 copies/mL **(AI)**. In persons with HIV RNA levels >500 but <1,000 copies/mL, testing may be unsuccessful but should still be considered **(BII)**.
- Drug-resistance testing should also be performed when managing suboptimal viral load reduction **(AII)**.
- In persons failing INSTI-based regimens, genotypic testing for INSTI resistance should be performed to determine whether to include a drug from this class in subsequent regimens **(AII)**.
- Drug-resistance testing in the setting of virologic failure should be performed while the person is taking prescribed ARV drugs or, if not possible, within 4 weeks after discontinuing therapy **(AII)**. If greater than 4 weeks has lapsed since the ARVs were discontinued, resistance testing may still provide useful information to guide therapy, recognizing that previously selected resistance mutations can be missed **(CIII)**.
- Genotypic testing is recommended as the preferred resistance testing to guide therapy in patients with suboptimal virologic responses or virologic failure while on first or second regimens **(AII)**.
- The addition of phenotypic to genotypic testing is generally preferred for persons with known or suspected complex drug-resistance mutation patterns, particularly to protease inhibitors (PIs) **(BIII)**.
- Genotypic resistance testing is recommended for all pregnant women before initiation of ART **(AIII)** and for those entering pregnancy with detectable HIV RNA levels while on therapy **(AI)** (see the Perinatal Treatment Guidelines for more detailed discussion).

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Genotypic and Phenotypic Resistance Assays

Genotypic and phenotypic resistance assays are used to assess viral strains and inform selection of treatment strategies. Standard assays provide information on resistance to nucleoside reverse transcriptase inhibitors (NRTIs), non-nucleoside reverse transcriptase inhibitors (NNRTIs), and protease inhibitors (PIs). Testing for integrase and fusion inhibitor resistance can also be ordered separately from several commercial laboratories. Co-receptor tropism assays should be performed whenever the use of a CCR5 antagonist is being considered. Phenotypic co-receptor tropism assays have been used in clinical practice. A genotypic assay to predict co-receptor use is now commercially available (see Co-receptor Tropism Assays).

Genotypic Assays

Genotypic assays detect drug-resistance mutations present in relevant viral genes. Most genotypic assays involve sequencing of the RT and PR genes to detect mutations that are known to confer drug resistance. Genotypic assays that assess mutations in the integrase and gp41 (envelope) genes are also commercially available. Genotypic assays can be performed rapidly and results are available within 1 to 2 weeks of sample collection. Interpretation of test results requires knowledge of the mutations selected by different antiretroviral (ARV) drugs and of the potential for cross resistance to other drugs conferred by certain mutations. The International AIDS Society-USA (IAS-USA) maintains an updated list of significant resistance-associated mutations in the RT, PR, integrase, and envelope genes (see

http://www.iasusa.org/resistance_mutations).[1] The Stanford University HIV Drug Resistance Database (http://hivdb.stanford.edu) also provides helpful guidance for interpreting genotypic resistance test results. Various tools to assist the provider in interpreting genotypic test results are now available.[2-5] Clinical trials have demonstrated that consultation with specialists in HIV drug resistance improves virologic outcomes.[6] Clinicians are thus encouraged to consult a specialist to facilitate interpretation of genotypic test results and design of an optimal new regimen.

Phenotypic Assays

Phenotypic assays measure the ability of a virus to grow in different concentrations of ARV drugs. RT and PR gene sequences and, more recently, integrase and envelope sequences derived from patient plasma HIV RNA are inserted into the backbone of a laboratory clone of HIV or used to generate pseudotyped viruses that express the patient-derived HIV genes of interest. Replication of these viruses at different drug concentrations is monitored by expression of a reporter gene and is compared with replication of a reference HIV strain. The drug concentration that inhibits viral replication by 50% (i.e., the median inhibitory concentration [IC_{50}]) is calculated, and the ratio of the IC_{50} of test and reference viruses is reported as the fold increase in IC_{50} (i.e., fold resistance).

Automated phenotypic assays that can produce results in 2 to 3 weeks are commercially available, but they cost more to perform than genotypic assays. In addition, interpretation of phenotypic assay results is complicated by incomplete information regarding the specific resistance level (i.e., fold increase in IC_{50}) that is associated with drug failure, although clinically significant fold increase cutoffs are now available for some drugs.[7-11] Again, consultation with a specialist to interpret test results can be helpful.

Further limitations of both genotypic and phenotypic assays include lack of uniform quality assurance testing for all available assays, relatively high cost, and insensitivity to minor viral species. Despite being present, drug-resistant viruses that constitute less than 10% to 20% of the circulating virus population will probably not be detected by commercially available assays. This limitation is important because after drugs exerting selective pressure on drug-resistant populations are discontinued, a wild-type virus often re-emerges as the predominant population in the plasma. As a consequence, the proportion of virus with resistance mutations decreases to below the 10% to 20% threshold.[12-14] In the case of some drugs, this reversion to predominantly wild-type virus can occur in the first 4 to 6 weeks after the drugs are discontinued. Prospective clinical studies have shown that despite this plasma reversion, re-initiation of the same ARV agents (or those sharing similar resistance pathways) is usually associated with early drug failure, and that the virus present at failure is derived from previously archived resistant virus.[15] Therefore, resistance testing is of greatest value when performed before or within 4 weeks after drugs are discontinued **(AII)**. Because resistant virus may persist in the plasma of some patients for longer periods of time, resistance testing done 4 to 6 weeks after discontinuation of drugs may still detect mutations. However, the absence of detectable resistance in such patients must be interpreted with caution when designing subsequent ARV regimens.

Use of Resistance Assays in Clinical Practice (See Table 5)

Use of Resistance Assays in Determining Initial Treatment

Transmission of drug-resistant HIV strains is well documented and associated with suboptimal virologic response to initial antiretroviral therapy (ART).[16-19] The likelihood that a patient will acquire drug-resistant virus is related to the prevalence of drug resistance in HIV-infected persons engaging in high-risk behaviors in the community. In the United States and Europe, recent studies suggest that the risk that transmitted virus will be resistant to at least one ARV drug is in the range of 6% to 16%.[20-25] Up to 8%, but generally less than 5% of transmitted viruses will exhibit resistance to drugs from more than one class.[24, 26-28]

If the decision is made to initiate therapy in a person with early HIV infection, resistance testing at baseline

can guide regimen selection to optimize virologic response. Therefore, resistance testing in this situation is recommended **(AII)**. A genotypic assay is preferred for this purpose **(AIII)**. In this setting, treatment initiation should not be delayed pending resistance testing results. Once results are obtained, the treatment regimen can be modified if warranted (see Acute and Recent HIV Infection). In the absence of therapy, resistant viruses may decline over time to less than the detection limit of standard resistance tests, but when therapy is eventually initiated, resistant viruses even at a low level may still increase the risk of treatment failure.[29-31] Therefore, if therapy is deferred, resistance testing should still be done during acute HIV infection **(AIII)**. In this situation, the genotypic resistance test result may be kept on record until the patient is to be started on ART. Repeat resistance testing at the time treatment is started should be considered because it is possible for a patient to acquire drug-resistant virus (i.e., superinfection) between entry into care and initiation of ART **(CIII)**.

Performing drug-resistance testing before ART initiation in patients with chronic HIV infection is less straightforward. The rate at which transmitted resistance-associated mutations revert to wild-type virus has not been completely delineated, but mutations present at the time of HIV transmission are more stable than those selected under drug pressure. It is often possible to detect resistance-associated mutations in viruses that were transmitted several years earlier.[32-34] No prospective trial has addressed whether drug-resistance testing before initiation of therapy confers benefit in this population. However, data from several, but not all, studies suggest that virologic responses in persons with baseline resistance mutations are suboptimal.[16-19, 35-37] In addition, a cost-effectiveness analysis of early genotypic resistance testing suggests that baseline testing in this population should be performed.[38] Therefore, resistance testing in chronically infected persons is recommended at the time of entry into HIV care **(AII)**. Although no definitive prospective data exist to support the choice of one type of resistance testing over another, genotypic testing is generally preferred in this situation because of lower cost, more rapid turnaround time, the assay's ability to detect mixtures of wild-type and resistant virus, and the relative ease of interpreting test results **(AIII)**. If therapy is deferred, repeat testing soon before initiation of ART should be considered because the patient may have acquired drug-resistant virus (i.e., superinfection) **(CIII)**.

Standard genotypic drug-resistance testing in ARV-naive persons involves testing for mutations in the RT and PR genes. Although transmission of integrase strand transfer inhibitor (INSTI)-resistant virus has rarely been reported, as use of INSTIs increases, the potential for transmission of INSTI-resistant virus may also increase. Therefore, when INSTI resistance is suspected, providers may wish to supplement standard baseline genotypic resistance testing with genotypic testing for resistance to this class of drugs **(CIII)**.

Use of Resistance Assays in the Event of Virologic Failure

Resistance assays are useful in guiding treatment decisions for patients who experience virologic failure while on ART. Several prospective studies assessed the utility of resistance testing to guide ARV drug selection in patients with virologic failure. These studies involved genotypic assays, phenotypic assays, or both.[6, 39-45] In general, these studies found that changes in therapy that were informed by resistance testing results produced better early virologic response to salvage regimens than regimen changes guided only by clinical judgment.

In addition, one observational cohort study found that performance of genotypic drug-resistance testing in ART-experienced patients with detectable plasma HIV RNA was independently associated with improved survival.[46] Thus, resistance testing is recommended as a tool in selecting active drugs when changing ARV regimens because of virologic failure in persons with HIV RNA >1,000 copies/mL **(AI)** (see Virologic Failure and Suboptimal Immunologic Response). In persons with HIV RNA >500 copies/mL but <1,000 copies/mL, testing may be unsuccessful but should still be considered **(BII)**. Drug-resistance testing in persons with a plasma viral load <500 copies/mL is not usually recommended because resistance assays cannot be consistently performed given low HIV RNA levels **(AIII)**.

Resistance testing also can help guide treatment decisions for patients with suboptimal viral load reduction **(AII)**. Virologic failure in the setting of combination ART is, for certain patients, associated with resistance to only one component of the regimen.[47-49] In this situation, substituting individual drugs in a failing regimen may be a possible option, but this concept will require clinical validation (see Virologic Failure and Suboptimal Immunologic Response).

In patients who are on a failing first or second ARV drug regimen and experiencing virologic failure or suboptimal viral load reduction, genotypic testing is generally preferred for resistance testing **(AII)**. This is based on the fact that, when compared with phenotypic testing, genotypic testing costs less to perform, has a faster turnaround time, and greater sensitivity for detecting mixtures of wild-type and resistant virus. In addition, observations show that the assays are comparable predictors of virologic response to subsequent ART regimens.[50]

Addition of phenotypic to genotypic testing is generally preferred for persons with known or suspected complex drug-resistance mutation patterns, particularly to PIs **(BIII)**.

In patients failing INSTI-based regimens, testing for INSTI resistance should be performed to determine whether to include drugs from this class in subsequent regimens **(AII)**; genotypic testing is preferred for this purpose.

When the use of a CCR5 antagonist is being considered, a co-receptor tropism assay should be performed **(AI)**. Phenotypic co-receptor tropism assays have been used in clinical practice. A genotypic assay to predict co-receptor use is now commercially available and is less expensive than phenotypic assays. Evaluation of genotypic assays is ongoing, but current data suggest that such testing should be considered as an alternative assay. The same principles regarding testing for co-receptor use also apply to testing when patients exhibit virologic failure on a CCR5 antagonist.[51] Resistance to CCR5 antagonists in the absence of detectable CXCR4-using virus has been reported, but such resistance is uncommon (see Co-receptor Tropism Assays).

Use of Resistance Assays in Pregnant Women

In pregnant women, the goal of ART is to maximally reduce plasma HIV RNA to provide optimal maternal therapy and to prevent perinatal transmission of HIV. Genotypic resistance testing is recommended for all pregnant women before initiation of therapy **(AIII)** and for those entering pregnancy with detectable HIV RNA levels while on therapy **(AI)**. Phenotypic testing in those found to have complex drug-resistance mutation patterns, particularly to PIs, may provide additional information **(BIII)**. Optimal prevention of perinatal transmission may require initiation of ART pending resistance testing results. Once the results are available, the ARV regimen can be changed as needed.

Table 5. Recommendations for Using Drug-Resistance Assays (page 1 of 2)

Clinical Setting/Recommendation	Rationale
Drug-resistance assay recommended	
In acute HIV infection: Drug-resistance testing is recommended regardless of whether antiretroviral therapy (ART) is initiated immediately or deferred **(AII)**. A genotypic assay is generally preferred **(AIII)**.	If ART is initiated immediately, drug-resistance testing can determine whether drug-resistant virus was transmitted. Test results will help in the design of initial regimens or to modify or change regimens if results are obtained after treatment initiation. Genotypic testing is preferred to phenotypic testing because of lower cost, faster turnaround time, and greater sensitivity for detecting mixtures of wild-type and resistant virus.
If ART is deferred, repeat resistance testing should be considered at the time therapy is initiated **(CIII)**. A genotypic assay generally is preferred **(AIII)**.	If ART is deferred, testing should still be performed because of the greater likelihood that transmitted resistance-associated mutations will be detected earlier in the course of HIV infection. Results of resistance testing may be important when treatment is initiated. Repeat testing at the time ART is initiated should be considered because the patient may have acquired a drug-resistant virus (i.e., superinfection).
In ART-naive patients with chronic HIV infection: Drug-resistance testing is recommended at entry into HIV care, regardless of whether therapy is initiated immediately or deferred **(AII)**. A genotypic assay is generally preferred **(AIII)**.	Transmitted HIV with baseline resistance to at least 1 drug is seen in 6% to 16% of patients, and suboptimal virologic responses may be seen in patients with baseline resistant mutations. Some drug-resistance mutations can remain detectable for years in untreated, chronically infected patients.
If therapy is deferred, repeat resistance testing should be considered before initiation of ART **(CIII)**. A genotypic assay is generally preferred **(AIII)**.	Repeat testing before initiation of ART should be considered because the patient may have acquired a drug-resistant virus (i.e., a superinfection). Genotypic testing is preferred to phenotypic testing because of lower cost, faster turnaround time, and greater sensitivity for detecting mixtures of wild-type and resistant virus.
If an INSTI is considered for an ART-naive patient and transmitted INSTI resistance is a concern, providers may supplement standard resistance testing with a specific INSTI genotypic resistance assay **(CIII)**.	Standard genotypic drug-resistance assays test only for mutations in the RT and PR genes.
If use of a CCR5 antagonist is being considered, a co-receptor tropism assay should be performed **(AI)** (see Co-receptor Tropism Assays)	(see Co-receptor Tropism Assays)
In patients with virologic failure: Drug-resistance testing is recommended in patients on combination ART with HIV RNA levels >1,000 copies/mL **(AI)**. In patients with HIV RNA levels >500 copies/mL but <1,000 copies/mL, testing may not be successful but should still be considered **(BII)**.	Testing can help determine the role of resistance in drug failure and maximize the clinician's ability to select active drugs for the new regimen. Drug-resistance testing should be performed while the patient is taking prescribed ARV drugs or, if not possible, within 4 weeks after discontinuing therapy.
A standard genotypic resistance assay is generally preferred for patients experiencing virologic failure on their first or second regimens **(AII)**.	Genotypic testing is preferred to phenotypic testing because of lower cost, faster turnaround time, and greater sensitivity for detecting mixtures of wild-type and resistant HIV.
In patients failing INSTI-based regimens, genotypic testing for INSTI resistance should be performed to determine whether to include drugs from this class in subsequent regimens **(AII)**.	Standard genotypic drug-resistance assays test only for mutations in the RT and PR genes.
If use of a CCR5 antagonist is being considered, a co-receptor tropism assay should be performed **(AI)** (see Co-receptor Tropism Assays).	
Addition of phenotypic assay to genotypic assay is generally preferred in patients with known or suspected complex drug-resistance patterns, particularly to protease inhibitors (PIs) **(BIII)**.	Phenotypic testing can provide additional useful information in patients with complex drug-resistance mutation patterns, particularly to PIs.

Table 5. Recommendations for Using Drug-Resistance Assays (page 2 of 2)

Clinical Setting/Recommendation	Rationale
Drug-resistance assay recommended	
In patients with suboptimal suppression of viral load: Drug-resistance testing is recommended in patients with suboptimal suppression of viral load after initiation of ART **(AII)**.	Testing can help determine the role of resistance and thus assist the clinician in identifying the number of active drugs available for a new regimen.
In HIV-infected pregnant women: Genotypic resistance testing is recommended for all pregnant women before initiation of ART **(AIII)** and for those entering pregnancy with detectable HIV RNA levels while on therapy **(AI)**.	The goal of ART in HIV-infected pregnant women is to achieve maximal viral suppression for treatment of maternal HIV infection and for prevention of perinatal transmission of HIV. Genotypic resistance testing will assist the clinician in selecting the optimal regimen for the patient.
Drug-resistance assay not usually recommended	
After therapy is discontinued: Drug-resistance testing is not usually recommended more than 4 weeks after discontinuation of ARV drugs **(BIII)**.	Drug-resistance mutations may become minor species in the absence of selective drug pressure, and available assays may not detect minor drug-resistant species. If testing is performed in this setting, the detection of drug resistance may be of value; however, the absence of resistance does not rule out the presence of minor drug-resistant species.
In patients with low HIV RNA levels: Drug-resistance testing is not usually recommended in patients with a plasma viral load <500 copies/mL **(AIII)**.	Resistance assays cannot be consistently performed given low HIV RNA levels.

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Co-Receptor Tropism Assays (Last updated February 12, 2013; last reviewed February 12, 2013)

Panel's Recommendations
• A co-receptor tropism assay should be performed whenever the use of a CCR5 co-receptor antagonist is being considered **(AI)**. • Co-receptor tropism testing is also recommended for patients who exhibit virologic failure on a CCR5 antagonist **(BIII)**. • A phenotypic tropism assay is preferred to determine HIV-1 co-receptor usage **(AI)**. • A genotypic tropism assay should be considered as an alternative test to predict HIV-1 co-receptor usage **(BII)**.
Rating of Recommendations: *A = Strong; B = Moderate; C = Optional* ***Rating of Evidence:*** *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

HIV enters cells by a complex process that involves sequential attachment to the CD4 receptor followed by binding to either the CCR5 or CXCR4 molecules and fusion of the viral and cellular membranes.[1] CCR5 co-receptor antagonists prevent HIV entry into target cells by binding to the CCR5 receptors.[2] Phenotypic and, to a lesser degree, genotypic assays have been developed that can determine or predict the co-receptor tropism (i.e., CCR5, CXCR4, or both) of the patient's dominant virus population. An older generation assay (*Trofile*, Monogram Biosciences, Inc., South San Francisco, CA) was used to screen patients who were participating in clinical trials that led to the approval of maraviroc (MVC), the only CCR5 antagonist currently available. The assay has been improved and is now available with enhanced sensitivity. In addition, a genotypic assay to predict co-receptor usage is now commercially available.

During acute/recent infection, the vast majority of patients harbor a CCR5-utilizing virus (R5 virus), which suggests that the R5 variant is preferentially transmitted. Viruses in many untreated patients eventually exhibit a shift in co-receptor tropism from CCR5 usage to either CXCR4 or both CCR5 and CXCR4 tropism (i.e., dual- or mixed-tropic; D/M-tropic). This shift is temporally associated with a more rapid decline in CD4 T-cell counts,[3, 4] but whether this tropism shift is a cause or a consequence of progressive immunodeficiency remains undetermined.[1] Antiretroviral (ARV)-treated patients with extensive drug resistance are more likely to harbor X4- or D/M-tropic variants than untreated patients with comparable CD4 counts.[5] The prevalence of X4- or D/M-tropic variants increases to more than 50% in treated patients who have CD4 counts <100 cells/mm^3.[5, 6]

Phenotypic Assays

Phenotypic assays characterize the co-receptor usage of plasma-derived virus. These assays involve the generation of laboratory viruses that express patient-derived envelope proteins (i.e., gp120 and gp41). These pseudoviruses, which are replication-defective, are used to infect target cell lines that express either CCR5 or CXCR4.[7, 8] Using the *Trofile* assay, the co-receptor tropism of the patient-derived virus is confirmed by testing the susceptibility of the virus to specific CCR5 or CXCR4 inhibitors *in vitro*. This assay takes about 2 weeks to perform and requires a plasma HIV RNA level ≥1,000 copies/mL.

The performance characteristics of these assays have evolved. Most, if not all, patients enrolled in pre-marketing clinical trials of MVC and other CCR5 antagonists were screened with an earlier, less sensitive version of the *Trofile* assay.[8] This earlier assay failed to routinely detect low levels of CXCR4-utilizing variants. As a consequence, some patients enrolled in these clinical trials harbored low levels of CXCR4-utilizing virus at baseline that were below the assay limit of detection and exhibited rapid virologic failure after initiation of a CCR5 antagonist.[9] The assay has been revised and is now able to detect lower levels of CXCR4-utlizing viruses. *In vitro*, the assay can detect CXCR4-utilizing clones with 100% sensitivity when those clones represent 0.3% or more of the virus population.[10] Although this more sensitive assay has had limited use in prospective clinical trials, it is now the only one that is commercially available. For unclear

reasons, a minority of samples cannot be successfully phenotyped with either generation of the *Trofile* assay.

In patients with plasma HIV-1 RNA below the limit of detection, co-receptor usage can be determined from proviral DNA obtained from peripheral blood mononuclear cells; however, the clinical utility of this assay remains to be determined.[11]

Genotypic Assays

Genotypic determination of HIV-1 co-receptor usage is based on sequencing of the V3-coding region of HIV-1 *env*, the principal determinant of co-receptor usage. A variety of algorithms and bioinformatics programs can be used to predict co-receptor usage from the V3 sequence. When compared to the phenotypic assay, genotypic methods show high specificity (~90%) but only modest sensitivity (~50%–70%) for the presence of a CXCR4-utilizing virus. Given these performance characteristics, these assays may not be sufficiently robust to completely rule out the presence of an X4 or D/M variant.[12]

Studies in which V3 genotyping was performed on samples from patients screened for clinical trials of MVC suggest that genotyping performed as well as phenotyping in predicting the response to MVC.[13-15] On the basis of these data, accessibility, and cost, European guidelines currently favor genotypic testing to determine co-receptor usage.[16] An important caveat to these results is that the majority of patients who received MVC were first shown to have R5 virus by a phenotypic assay (*Trofile*). Consequently, the opportunity to assess treatment response to MVC in patients whose virus was considered R5 by genotype but D/M or X4 by phenotype was limited to a relatively small number of patients.

Use of Assays to Determine Co-Receptor Usage in Clinical Practice

An assay for HIV-1 co-receptor usage should be performed whenever the use of a CCR5 antagonist is being considered **(AI)**. In addition, because virologic failure may occur due to a shift from CCR5-using to CXCR4-using virus, testing for co-receptor usage is recommended in patients who exhibit virologic failure on a CCR5 antagonist **(BIII)**. Virologic failure also may be caused by resistance of a CCR5-using virus to a CCR5 antagonist, but such resistance is uncommon. Compared to genotypic testing, phenotypic testing has more evidence supporting its usefulness. Therefore, a phenotypic test for co-receptor usage is generally preferred **(AI)**. However, because phenotypic testing is more expensive and requires more time to perform, a genotypic test to predict HIV-1 co-receptor usage should be considered as an alternative test **(BII)**.

A tropism assay may potentially be used in clinical practice for prognostic purposes or to assess tropism before starting ART if future use of a CCR5 antagonist is anticipated (e.g., a regimen change for toxicity). Currently, sufficient data do not exist to support these uses.

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HLA-B*5701 Screening (Last updated December 1, 2007; last reviewed January 10, 2011)

Panel's Recommendations
• The Panel recommends screening for HLA-B*5701 before starting patients on an abacavir (ABC)-containing regimen to reduce the risk of hypersensitivity reaction (HSR) **(AI)**. • HLA-B*5701-positive patients should not be prescribed ABC **(AI)**. • The positive status should be recorded as an ABC allergy in the patient's medical record **(AII)**. • When HLA-B*5701 screening is not readily available, it remains reasonable to initiate ABC with appropriate clinical counseling and monitoring for any signs of HSR **(CIII)**.
Rating of Recommendations: *A = Strong; B = Moderate; C = Optional*
Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

The ABC HSR is a multiorgan clinical syndrome typically seen within the initial 6 weeks of ABC treatment. This reaction has been reported in 5%–8% of patients participating in clinical trials when using clinical criteria for the diagnosis, and it is the major reason for early discontinuation of ABC. Discontinuing ABC usually promptly reverses HSR, whereas subsequent rechallenge can cause a rapid, severe, and even life-threatening recurrence.[1]

Studies that evaluated demographic risk factors for ABC HSR have shown racial background as a risk factor, with white patients generally having a higher risk (5%–8%) than black patients (2%–3%). Several groups reported a highly significant association between ABC HSR and the presence of the major histocompatibility complex (MHC) class I allele HLA-B*5701.[2-3] Because the clinical criteria used for ABC HSR are overly sensitive and may lead to false-positive ABC HSR diagnoses, an ABC skin patch test (SPT) was developed as a research tool to immunologically confirm ABC HSR.[4] A positive ABC SPT is an ABC-specific delayed HSR that results in redness and swelling at the skin site of application. All ABC SPT–positive patients studied were also positive for the HLA-B*5701 allele.[5] The ABC SPT could be falsely negative for some patients with ABC HSR and, at this point, is not recommended for use as a clinical tool. The PREDICT-1 study randomized patients before starting ABC either to be prospectively screened for HLA-B*5701 (with HLA-B*5701–positive patients not offered ABC) or to standard of care at the time of the study (i.e., no HLA screening, with all patients receiving ABC).[6] The overall HLA-B*5701 prevalence in this predominately white population was 5.6%. In this cohort, screening for HLA-B*5701 eliminated immunologic ABC HSR (defined as ABC SPT positive) compared with standard of care (0% vs. 2.7%), yielding a 100% negative predictive value with respect to SPT and significantly decreasing the rate of clinically suspected ABC HSR (3.4% vs. 7.8%). The SHAPE study corroborated the low rate of immunologically validated ABC HSR in black patients and confirmed the utility of HLA-B*5701 screening for the risk of ABC HSR (100% sensitivity in black and white populations).[7]

On the basis of the results of these studies, the Panel recommends screening for HLA-B*5701 before starting patients on an ABC-containing regimen **(AI)**. HLA-B*5701–positive patients should not be prescribed ABC **(AI)**, and the positive status should be recorded as an ABC allergy in the patient's medical record **(AII)**. HLA-B*5701 testing is needed only once in a patient's lifetime; thus, efforts to carefully record and maintain the test result and to educate the patient about its implications are important. The specificity of the HLA-B*5701 test in predicting ABC HSR is lower than the sensitivity (i.e., 33%–50% of HLA-B*5701–positive patients would likely not develop confirmed ABC HSR if exposed to ABC). HLA-B*5701 should not be used as a substitute for clinical judgment or pharmacovigilance, because a negative HLA-B*5701 result does not absolutely rule out the possibility of some form of ABC HSR. When HLA-B*5701 screening is not

readily available, it remains reasonable to initiate ABC with appropriate clinical counseling and monitoring for any signs of ABC HSR **(CIII)**.

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Treatment Goals (Last updated March 27, 2012; last reviewed March 27, 2012)

Eradication of HIV infection cannot be achieved with available antiretroviral (ARV) regimens even when new, potent drugs are added to a regimen that is already suppressing plasma viral load below the limits of detection of commercially available assays.[1] This is chiefly because the pool of latently infected CD4 T cells is established during the earliest stages of acute HIV infection[2] and persists with a long half-life, despite prolonged suppression of plasma viremia.[3-7] Therefore the primary goals for initiating antiretroviral therapy (ART) are to:

- reduce HIV-associated morbidity and prolong the duration and quality of survival,
- restore and preserve immunologic function,
- maximally and durably suppress plasma HIV viral load (see Plasma HIV RNA Testing), and
- prevent HIV transmission.

ART has reduced HIV-related morbidity and mortality[8-11] and has reduced perinatal[12] and behavior-associated transmission of HIV.[13-17] HIV suppression with ART may also decrease inflammation and immune activation thought to contribute to higher rates of cardiovascular and other end-organ damage reported in HIV-infected cohorts. (See Initiating Antiretroviral Therapy.) Maximal and durable suppression of plasma viremia delays or prevents the selection of drug-resistance mutations, preserves CD4 T-cell numbers, and confers substantial clinical benefits, all of which are important treatment goals.[18-19]

Achieving viral suppression requires the use of ARV regimens with at least two, and preferably three, active drugs from two or more drug classes. Baseline resistance testing and patient characteristics should guide design of the specific regimen. (See What to Start: Initial Combination Regimens for the Antiretroviral-Naive Patient.) When initial suppression is not achieved or is lost, rapidly changing to a new regimen with at least two active drugs is required. (See Virologic Failure and Suboptimal Immunologic Response.) The increasing number of drugs and drug classes makes viral suppression below detection limits an appropriate goal in all patients.

Viral load reduction to below limits of assay detection in an ART-naive patient usually occurs within the first 12–24 weeks of therapy. Predictors of virologic success include:

- high potency of ARV regimen,
- excellent adherence to treatment regimen,[20]
- low baseline viremia,[21]
- higher baseline CD4 count (>200 cells/mm^3),[22] and
- rapid reduction of viremia in response to treatment.[21,23]

Successful outcomes are usually observed, although adherence difficulties may lower the success rate in clinical practice to below the 90% rate commonly seen in clinical trials.[24]

Strategies to Achieve Treatment Goals

Achieving treatment goals requires a balance of sometimes competing considerations, outlined below. Providers and patients must work together to define individualized strategies to achieve treatment goals.

Selection of Initial Combination Regimen

Several preferred and alternative ARV regimens are recommended for use. (See What to Start.) Many of these regimens have comparable efficacy but vary to some degree in dosing frequency and symmetry, pill

burden, drug interactions, and potential side effects. Regimens should be tailored for the individual patient to enhance adherence and thus improve long-term treatment success. Individual regimen choice is based on such considerations as expected side effects, convenience, comorbidities, interactions with concomitant medications, and results of pretreatment genotypic drug-resistance testing.

Pretreatment Drug-Resistance Testing

Current studies suggest a 6%–16% prevalence of HIV drug resistance in ART-naive patients,[25-29] and some studies suggest that the presence of transmitted drug-resistant viruses may lead to suboptimal virologic responses.[30] Therefore, pretreatment genotypic resistance testing should be used to guide selection of the most optimal initial ARV regimen. (See Drug-Resistance Testing.)

Improving Adherence

Suboptimal adherence may result in reduced treatment response. Incomplete adherence can result from complex medication regimens; patient factors, such as active substance abuse and depression; and health system issues, including interruptions in patient access to medication and inadequate treatment education and support. Conditions that promote adherence should be maximized before and after initiation of ART. (See Adherence to Antiretroviral Therapy.)

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Initiating Antiretroviral Therapy in Treatment-Naive Patients (Last updated May 1, 2014; last reviewed May 1, 2014)

Panel's Recommendations

- Antiretroviral therapy (ART) is recommended for all HIV-infected individuals to reduce the risk of disease progression.
  - The strength of and evidence for this recommendation vary by pretreatment CD4 T lymphocyte (CD4) cell count: CD4 count <350 cells/mm^3 **(AI)**; CD4 count 350 to 500 cells/mm^3 **(AII)**; CD4 count >500 cells/mm^3 **(BIII)**.
- ART is also recommended for HIV-infected individuals to prevent of transmission of HIV.
  - The strength of and evidence for this recommendation vary by transmission risks: perinatal transmission **(AI)**; heterosexual transmission **(AI)**; other transmission risk groups **(AIII)**.
- Patients starting ART should be willing and able to commit to treatment and understand the benefits and risks of therapy and the importance of adherence **(AIII)**. Patients may choose to postpone therapy, and providers, on a case-by-case basis, may elect to defer therapy on the basis of clinical and/or psychosocial factors.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Introduction

Without treatment, most HIV-infected individuals will eventually develop progressive immunosuppression, as evident by CD4 T lymphocyte (CD4) cell depletion, leading to AIDS-defining illnesses and premature death. The primary goal of ART is to prevent HIV-associated morbidity and mortality. This goal is best accomplished by using effective ART to maximally inhibit HIV replication so that plasma HIV RNA (viral load) remains below levels detectable by commercially available assays. Durable viral suppression improves immune function and overall quality of life, lowers the risk of both AIDS-defining and non-AIDS-defining complications, and prolongs life.

Furthermore, high plasma HIV RNA is a major risk factor for HIV transmission, and effective antiretroviral therapy (ART) can reduce viremia and transmission of HIV to sexual partners by more than 96%.[1,2] Modelling studies suggest that expanded use of ART may result in lower incidence and, eventually, prevalence of HIV on a community or population level.[3] Thus, a secondary goal of ART is to reduce the risk of HIV transmission.

Historically, HIV-infected individuals have had low CD4 counts at presentation to care.[4] However, there have been concerted efforts to increase testing of at-risk patients and to link these patients to medical care before they have advanced HIV disease. Deferring ART until CD4 count declines put an individual at risk of AIDS-defining conditions has been associated with higher risk of morbidity and mortality (as discussed below). Furthermore, the magnitude of CD4 recovery is directly correlated with CD4 count at ART initiation. Consequently, many individuals who start treatment with CD4 counts <350 cells/mm^3 never achieve counts >500 cells/mm^3 after up to 6 years on ART.[5]

The recommendation to initiate ART in individuals with high CD4 cell counts—whose short-term risk for death and development of AIDS-defining illness is low[6,7]—is based on growing evidence that untreated HIV infection or uncontrolled viremia is associated with development of non-AIDS-defining diseases, including cardiovascular disease (CVD), kidney disease, liver disease, neurologic complications, and malignancies. Furthermore, newer ART regimens are more effective, more convenient, and better tolerated than regimens used in the past.

Regardless of CD4 count, the decision to initiate ART should always include consideration of a patient's comorbid conditions, his or her willingness and readiness to initiate therapy, and available resources. In settings where there are insufficient resources to initiate ART in all patients, treatment should be prioritized for patients with the following clinical conditions: pregnancy; CD4 count <200 cells/mm^3 or history of an AIDS-defining illness including HIV-associated dementia, HIV-associated nephropathy (HIVAN), or hepatitis B virus (HBV); and acute HIV infection.

Tempering the enthusiasm to treat all patients regardless of CD4 count is the absence of randomized trial data that demonstrate a definitive clinical benefit of ART in patients with higher CD4 counts (e.g., >350 cells/ mm^3) and mixed results from observational cohort studies as to the definitive benefits of early ART (i.e., when CD4 count >500 cells/mm^3). For some asymptomatic patients, the potential risks of short- or long-term drug-related complications and non-adherence to long-term therapy may offset possible benefits of earlier initiation of therapy. An ongoing randomized controlled trial evaluating the role of immediate versus delayed ART in patients with CD4 counts >500 cells/mm^3 (see Strategic Timing of Antiretroviral Treatment (START); ClinicalTrials.gov identifier NCT00867048) should help to further define the role of ART in this patient population.

The known and potential benefits and limitations of ART in general, and in different patient populations are discussed below.

Benefits of Antiretroviral Therapy

Reduction in Mortality and/or AIDS-Related Morbidity According to Pretreatment CD4 Cell Count

Patients with a History of an AIDS-Defining Illness or CD4 Count <350 cells/mm^3

HIV-infected patients with CD4 counts <200 cells/mm^3 are at higher risk of opportunistic diseases, non-AIDS morbidity, and death than HIV-infected patients with higher CD4 counts. Randomized controlled trials in patients with CD4 counts <200 cells/mm^3 and/or a history of an AIDS-defining condition provide strong evidence that ART improves survival and delays disease progression in these patients.[8-10] Long-term data from multiple observational cohort studies comparing earlier ART (i.e., initiated at CD4 count >200 cells/mm^3) with later treatment (i.e., initiated at CD4 count <200 cells/mm^3) have also provided strong support for these findings.[11-16]

Few large, randomized controlled trials address when to start therapy in patients with CD4 counts >200 cells/mm^3. CIPRA HT-001, a randomized clinical trial conducted in Haiti, enrolled 816 participants without AIDS. Participants were randomized to start ART with CD4 counts in the 200 to 350 cells/mm^3 range or to defer treatment until their CD4 counts dropped to <200 cells/mm^3 or they developed an AIDS-defining condition. The study was terminated when an interim analysis showed a survival benefit in the early treatment arm. When compared with participants who began ART with CD4 counts in the 200 to 350 cells/mm^3 range, patients who deferred therapy had a higher mortality rate (23 versus 6 deaths; hazard ratio [HR] = 4.0; 95% confidence interval [CI], 1.6–9.8) and a higher rate of incident tuberculosis (TB) (HR = 2.0; 95% CI, 1.2–3.6).[17]

Collectively, these studies support the Panel's recommendation that ART should be initiated in patients with a history of an AIDS-defining illness or with a CD4 count <350 cells/mm^3 **(AI)**.

Patients with CD4 Counts Between 350 and 500 cells/mm^3

Data supporting initiation of ART in patients with CD4 counts ranging from 350 cells/mm^3 to 500 cells/mm^3 are from large observational studies conducted in North America, Europe, and Australia and from secondary analysis of randomized controlled trials. Findings from the observational studies were analyzed using

advanced statistical methods that minimize the bias and confounding that arise when observational data are used to address the question of when to start ART. However, unmeasured confounders for which adjustment was not possible may have influenced the analysis.

Among the cohort studies analyzed, the ART Cohort Collaboration (ART-CC) included 45,691 patients from 18 cohort studies conducted primarily in North America and Europe. Data from ART-CC showed that the rate of progression to AIDS and/or death was higher in participants who delayed ART initiation until their CD4 counts fell to 251 to 350 cells/mm^3 than in those who initiated ART at CD4 count level of 351 to 450 cells/mm^3 (risk ratio: 1.28; 95% CI, 1.04–1.57).[13] When analysis of the data was restricted to mortality alone, the difference between the 2 strategies was weaker and not statistically significant (risk ratio: 1.13; 95% CI, 0.80–1.60).

The NA-ACCORD cohort evaluated patients regardless whether they had started therapy. The 6,278 patients who deferred therapy until their CD4 counts fell to <350 cells/mm^3 had a greater risk of death than the 2,084 patients who initiated therapy with CD4 counts between 351 cells/mm^3 and 500 cells/mm^3 (risk ratio: 1.69; 95% CI, 1.26–2.26) after adjustment for other factors that differed between these 2 groups.[18]

The HIV-CAUSAL cohort evaluated 8,392 ART-naive patients with initial CD4 counts >500 cells/mm^3 that declined to <500 cells/mm^3.[16] The study estimated that delaying initiation of ART until CD4 count fell to <350 cells/mm^3 was associated with a greater risk of AIDS-defining illness or death than initiating ART with CD4 count between 350 cells/mm^3 and 500 cells/mm^3 (HR: 1.38; 95% CI, 1.23–1.56). However, there was no difference in mortality between the 2 groups (HR: 1.01; 95% CI, 0.84–1.22).

The CASCADE cohort included 5,527 ART-naive patients with CD4 counts in the 350 to 499 cells/mm^3 range. Compared with patients who deferred therapy until their CD4 counts fell to <350 cells/mm^3, patients who started ART immediately had a marginally lower risk of AIDS-defining illness or death (HR: 0.75; 95% CI, 0.49–1.14) and a lower risk of death (HR: 0.51; 95% CI,98 0.33–0.80).[19]

Randomized data showing clinical evidence that supports ART for patients with higher CD4 cell counts came from two studies. In the SMART trial, HIV-infected participants with CD4 counts >350 cells/mm^3 were randomized to continuous ART or to treatment interruption until their CD4 counts fell to <250 cells/mm^3. In the subgroup of 249 participants who were ART naive at enrollment (median CD4 count: 437 cells/mm^3), those who deferred ART until their CD4 counts dropped to <250 cells/mm^3 had a greater risk of serious AIDS- and non-AIDS-related events than those who initiated therapy immediately (7 vs. 2 events; HR: 4.6; 95% CI, 1.0–22.2).[20] HPTN 052 was a large multi-continent randomized trial that examined whether treatment of HIV-infected individuals reduces transmission to their uninfected sexual partners.[2] A secondary objective of the study was to determine whether ART reduces clinical events in the HIV-infected participants. This trial enrolled 1,763 HIV infected participants with CD4 counts between 350 and 550 cells/mm^3 and their HIV uninfected partners. The infected participants were randomized to initiate ART immediately or to delay initiation until they had 2 consecutive CD4 counts <250 cells/mm^3. At a median follow-up of 2.1 years, there were 57 primary events in the early therapy arm versus 77 events in the delayed therapy arm (HR: 0.73; 95% CI, 0.52–1.03). The most frequent event was tuberculosis (17 cases in the early therapy arm and 34 cases in the delayed therapy arm); deaths were relatively rare (11 cases in the early therapy arm and 15 cases in the delayed therapy arm).[21,22]

Collectively, these studies suggest that initiating ART in patients with CD4 counts between 350 and 500 cells/mm^3 reduces HIV-related disease progression; whether there is a corresponding reduction in mortality is unclear. This benefit supports the Panel's recommendation that ART should be initiated in patients with CD4 counts 350 to 500 cells/mm^3 **(AII)**. Recent evidence demonstrating the public health benefit of earlier initiation of ART in reducing HIV transmission further supports the strength of this recommendation (see Prevention of Sexual Transmission).

Patients with CD4 Counts >500 cells/mm^3

An analysis of the risks of HIV-associated disease progression in ART-naive patients with CD4 cell counts >500 cells/mm^3 is difficult because only a small proportion of individuals present for clinical care with CD4 cell counts at this level.[4,23] However, studies have demonstrated a gradient of increased risk of AIDS and death when ART is initiated at lower CD4 cell count levels and have provided no evidence of a safe CD4 count level.[6,24,25]

To date, questions regarding the risks and benefits of starting ART in patients with CD4 cell counts >500 cells/mm^3 as compared to deferring initiation until CD4 cell counts are lower have not yet been answered in a definitive randomized clinical trial. Evidence supporting early initiation comes from an observational study. The NA-ACCORD study observed patients who started ART with CD4 counts >500 cells/mm^3 or after their CD4 counts dropped below this threshold. The adjusted mortality rates were significantly higher in the 6,935 patients who deferred therapy until their CD4 counts fell to <500 cells/mm^3 than in the 2,200 patients who started therapy with CD4 counts >500 cells/mm^3 (risk ratio: 1.94; 95% CI, 1.37–2.79).[18]

In contrast, in an analysis of the ART-CC cohort,[13] the rate of progression to AIDS/death associated with deferral of therapy until CD4 counts fell to the 351 to 450 cells/mm^3 range was similar to the rate with initiation of therapy with CD4 counts in the 451 to 550 cells/mm^3 range (HR: 0.99; 95% CI, 0.76–1.29). The analysis showed no significant difference in rate of death in the immediate and deferred therapy groups (HR: 0.93; 95% CI, 0.60–1.44). In the CASCADE Collaboration,[19] among the 5,162 patients with CD4 counts in the 500 to 799 cells/mm^3 range, compared with patients who deferred therapy, those who started ART immediately did not experience a significant reduction in the composite outcome of progression to AIDS/death (HR: 1.10; 95% CI, 0.67–1.79) or death (HR: 1.02; 95% CI, 0.49–2.12).

Although not a clinical endpoint study, a recent clinical trial (Setpoint Study) randomized patients within 6 months of HIV seroconversion to receive either immediate ART for 36 weeks or deferred treatment. More than 57% of the study participants had CD4 counts >500 cells/mm^3. The deferred treatment group had a statistically higher risk of meeting study defined ART initiation criteria than the immediate treatment group. The study was halted early, showing that the time from diagnosis of early infection and the need for initiation of ART was shorter than anticipated in the deferral therapy group. Fully half of the participants in the deferral group met the criteria for treatment initiation by week 72.[26]

Another recent study provides evidence that early treatment enhances recovery of CD4 counts to levels >900 cells/mm^3.[27] Among individuals who were identified during primary infection, those who initiated ART within 4 months after the estimated date of infection were more likely to have CD4 cell recovery and had a faster rate of recovery than those initiating ART at 4 to 12 months or >12 months after the estimated date of infection. However, even among participants who started ART earlier, those who initiated ART with lower CD4 counts were less likely to have CD4 cell recovery and had a lower rate of recovery than those who initiated ART with higher CD4 counts.

With a better understanding of the pathogenesis of HIV infection, the growing awareness that untreated HIV infection increases the risk of many non-AIDS-defining diseases (as discussed below), and the benefit of ART in reducing transmission of HIV, the Panel recommends initiation of ART in patients with CD4 counts >500 cells/mm^3 **(BIII)**.

When discussing initiation of ART at high CD4 cell counts (>500 cells/mm^3), clinicians should inform patients that data on the clinical benefit of starting treatment at such levels are not conclusive, especially for patients with very high CD4 counts. Clinicians should also inform patients that viral suppression from effective ART can reduce the risk of sexual transmission. Lastly, patients should be informed that untreated HIV infection will eventually lead to immunological deterioration and increased risk of clinical disease and death. Therefore, if therapy is not initiated, continued monitoring and close follow-up are necessary.

Further ongoing research (both randomized clinical trials and cohort studies) to assess the short- and long-term clinical and public health benefits and cost effectiveness of starting therapy at higher CD4 counts is needed. Findings from such research will provide further evidence to help the Panel make future recommendations.

Effects of Viral Replication on HIV-Related Morbidity

Since the mid-1990s, it has been known that measures of viral replication predict HIV disease progression. Among untreated HIV-infected individuals, time to clinical progression and mortality is fastest in those with higher viral loads.[28] This finding is confirmed across the spectrum of HIV-infected patient populations, such as injection drug users (IDUs),[29] women,[30] and individuals with hemophilia.[31] Several studies have shown the prognostic value of pre-treatment viral load for predicting post-therapy response.[32,33] Once therapy has been initiated, failure to achieve viral suppression[34-36] and viral load at the time of treatment failure[37] are predictive of clinical disease progression.

More recent studies have examined the impact of ongoing viral replication for both longer durations and at higher CD4 cell counts. Using viremia copy-years, a novel metric for quantifying viral load over time, the Centers for AIDS Research Network of Integrated Clinical Systems (CNICS) cohort found that cumulative exposure to replicating virus is independently associated with mortality. Using viremia copy-years, the HR for mortality was 1.81 per $\log_{10}$ copy-year/mL (95% CI, 1.51–2.18), which was the only viral load-related variable that retained statistical significance in the multivariable model (HR 1.44 per $\log_{10}$ copy-year/mL; 95% CI, 1.07–1.94). These findings support the concept that unchecked viral replication, which occurs in the absence of effective ART, is a factor in disease progression and death independent of CD4 count.[38]

The EuroSIDA collaboration evaluated HIV-infected individuals with CD4 counts >350 cells/mm^3 segregated by three viral load strata (<500 copies/mL, 500–9,999 copies/mL, and ≥10,000 copies/mL) to determine the impact of viral load on rates of fatal and nonfatal AIDS-related and non-AIDS-related events. The lower viral load stratum included more participants on ART (92%) than the middle (62%) and high (31%) viral load strata. After adjustment for age, region, and ART, the rates of non-AIDS events were 61% ($P = 0.001$) and 66% ($P = 0.004$) higher in participants with viral loads 500 to 9,999 copies/mL and >10,000 copies/mL, respectively, than in individuals with viral loads <500 copies/mL. These data further confirm that unchecked viral replication is associated with adverse clinical outcomes in individuals with CD4 counts >350 cells/mm^3.[39]

Collectively, these data show that the harm of ongoing viral replication affects both untreated patients and those who are on ART but remain viremic. The harm of ongoing viral replication in patients on ART is compounded by the risk of emergence of drug-resistant virus. Therefore, all patients on ART should be carefully monitored and counseled on the importance of adherence to therapy.

Effects of Antiretroviral Therapy on HIV-Related Morbidity

HIV-associated immune deficiency, the direct effects of HIV on end organs, and the indirect effects of HIV-associated inflammation on these organs all likely contribute to HIV-related morbidity and mortality. In general, the available data demonstrate the following:

- Untreated HIV infection (ongoing viral replication) may have negative effects at all stages of infection.
- Earlier treatment may prevent the damage associated with HIV replication during early stages of infection.
- ART is beneficial even when initiated later in infection; however, later therapy may not repair damage associated with viral replication during early stages of infection.
- Sustaining viral suppression and maintaining higher CD4 count levels, mostly as a result of effective

combination ART, may delay, prevent, or reverse some non-AIDS-defining complications, such as HIV-associated kidney disease, liver disease, CVD, neurologic complications, and malignancies, as discussed below.

HIV-Associated Nephropathy

HIVAN is the most common cause of chronic kidney disease in HIV-infected individuals that may lead to end-stage kidney disease.[40] HIVAN is almost exclusively seen in black patients and can occur at any CD4 count. Ongoing viral replication appears to be directly involved in renal injury;[41] HIVAN is extremely uncommon in virologically suppressed patients.[42] ART in patients with HIVAN has been associated with both preserved renal function and prolonged survival.[43-45] Therefore, regardless of CD4 count, ART should be started in all patients with HIVAN at the earliest sign of renal dysfunction **(AII)**.

Coinfection with Hepatitis B Virus and/or Hepatitis C Virus

HIV infection is associated with more rapid progression of viral hepatitis-related liver disease, including cirrhosis, end-stage liver disease, hepatocellular carcinoma, and fatal hepatic failure.[46 48] The pathogenesis of accelerated liver disease in HIV-infected patients has not been fully elucidated, but HIV-related immunodeficiency and a direct interaction between HIV and hepatic stellate and Kupffer cells have been implicated.[49-52] In individuals co-infected with HBV and/or hepatitis C virus (HCV), ART may attenuate liver disease progression by preserving or restoring immune function and reducing HIV-related immune activation and inflammation.[53-55] Antiretroviral (ARV) drugs active against both HIV and HBV (such as tenofovir disoproxil fumarate [TDF], lamivudine [3TC], and emtricitabine [FTC]) also may prevent development of significant liver disease by directly suppressing HBV replication.[56,57] Although ARV drugs do not inhibit HCV replication directly, HCV treatment outcomes typically improve when HIV replication is controlled or CD4 counts increase.[58] In one prospective cohort, after controlling for liver and HIV disease stage, HCV co-infected patients receiving ART were approximately 66% less likely to experience end-stage liver disease, hepatocellular carcinoma, and fatal hepatic failure than patients not receiving ART.[59] While some studies have shown that chronic viral hepatitis increases the risk of ART-induced liver injury, the majority of coinfected persons do not develop clinically significant liver injury[60-62] and the rate of hepatotoxicity may be greater in persons with more advanced HIV disease. Collectively, these data suggest that earlier treatment of HIV infection in persons coinfected with HBV (and likely HCV) may reduce the risk of liver disease progression. ART is recommended for patients coinfected with HBV, and the ART regimen should include drugs with activity against both HIV and HBV **(AII)** (also see Hepatitis B Virus/HIV Coinfection). ART is also recommended for most patients coinfected with HCV **(BII)**, including those with high CD4 counts and those with cirrhosis. This recommendation is based on findings from retrospective and prospective cohort studies that indicated that the receipt of ART is associated with slower progression of hepatic fibrosis and reduced risk of liver disease outcomes.[59,63-65] Combined treatment of HIV and HCV can be complicated by large pill burden, drug interactions, and overlapping toxicities; however, the complexity of treatment depends on the HCV regimen selected. ART should be considered for HIV/HCV-coinfected patients regardless of CD4 cell count. However, for patients with CD4 counts >500 cells/mm^3 and also infected with HCV genotype 1, if treatment is to include an HCV protease inhibitor, some clinicians may choose to defer ART until HCV treatment is completed (also see HIV/Hepatitis C Virus Co-Infection).

Cardiovascular Disease

In HIV-infected patients, CVD is a major cause of morbidity and mortality, accounting for one-third of serious non-AIDS conditions and at least 10% of deaths.[66-68] A number of studies have found that, over time, HIV-infected persons are at greater risk for CVD events than age-matched uninfected individuals.

Persons living with HIV infection have higher rates of established CVD risk factors, particularly smoking and dyslipidemia, than HIV-uninfected individuals. In the Data Collection on Adverse Events of Anti-HIV

Drugs (D:A:D) cohort study such factors, including age, male gender, obesity, smoking, family history of CVD, diabetes, and dyslipidemia, were each independently associated with risk of myocardial infarction (MI).[69] This study also found that the risk of CVD was greater with exposure to some ARV drugs, including certain PIs (ritonavir-boosted lopinavir and ritonavir-boosted fosamprenavir) and abacavir, than with exposure to other ARV drugs.[69,70]

In terms of preventing the progression to CVD events, it has not been determined whether delaying ART initiation is preferable to immediate treatment. In the meta-analysis mentioned above, the risk of CVD in HIV-infected individuals was 1.5 times higher in those treated with ART than in those not treated with ART.[63] These analyses were limited by concern that the treated individuals may have been infected for longer periods of time and had prior episodes of untreated HIV disease, as well as the fact that the untreated people were at higher risk for competing events, including death. Furthermore, there is evidence that untreated HIV infection may also be associated with an increased risk of CVD. In the SMART study, the risk of cardiovascular events was greater in participants randomized to CD4-guided treatment interruption than in participants who received continuous ART.[71] In other studies, ART resulted in marked improvement in parameters associated with CVD, including markers of inflammation (such as interleukin 6 [IL-6]), immune dysfunction (e.g., T cell activation, T cell senescence), monocyte activation (e.g., IL-6, soluble CD14 and CD163), hyper-coagulation (e.g., D-dimers) and, most importantly, endothelial dysfunction.[72,73] Low nadir and/or proximal on-therapy CD4 cell count has been linked to CVD (MI and/or stroke),[74-76] suggesting that low CD4 count might result in increased risk of CVD.

Collectively, the increased risk of cardiovascular events with treatment interruption, the effects of ART on markers of inflammation and endothelial dysfunction, and the association between CVD and CD4 cell depletion suggest that early control of HIV replication with ART can be used as a strategy to reduce risk of CVD, particularly if drugs with potential cardiovascular toxicity are avoided. However, no study has demonstrated that initiation of ART prevents CVD. Therefore, a role for early ART in preventing CVD remains to be established. For HIV-infected individuals with a significant risk of CVD, as assessed by medical history and estimated risk calculations, risk of CVD should be considered when selecting a specific ART regimen.

Malignancies

HIV-infected individuals are at increased risk for developing several cancers and human papilloma virus (HPV)-related pre-malignant intraepithelial neoplasia.[77,78] Increased rates of Kaposi sarcoma and non-Hodgkin lymphoma in patients with advanced HIV infection have been noted since early in the AIDS epidemic, and, together with cervical cancer, both diseases have been defined as AIDS-defining malignancies (ADMs) for public health surveillance purposes. HIV infection and associated immunosuppression increase the risk of several cancers identified as non-AIDS-defining malignancies (NADMs). Importantly, the incidence of lung, anal, oropharyngeal, liver and skin cancers, Hodgkin lymphoma, and melanoma, is higher in HIV-infected individuals than in matched HIV-uninfected controls,[79-81] and the burden of these NADMs continued to increase in the United States between 1996 and 2007.[82] Incidental cancers that occur in HIV-infected individuals are becoming more common, which is due to the aging of the HIV population rather than to HIV-associated risks of malignancies. These cancers are also sometimes considered NADMs. Most cancers with increased incidence are either virally related (i.e., Hodgkin lymphoma, anal cancer, liver cancer) or smoking related (lung cancer), although HIV remains an independent risk factor for the later.[83]

Large cohort studies enrolling mainly patients receiving ART have reported a consistent link between low CD4 counts (<350 to 500 cells/mm^3) and the risk of ADMs and/or NADMs.[14,76,84-87] The ANRS C04 Study demonstrated that, in contrast to patients with CD4 counts >500 cells/mm^3, patients with CD4 counts <500 cells/mm^3 had a statistically significant relative risk of all cancers evaluated (except for anal carcinoma). The

study also showed an increased risk of anal cancer based on extent of time with CD4 counts <200 cells/mm^3, and that, regardless of CD4 count, ART has a protective effect for HIV-associated malignancies.[84] This potential effect of HIV-associated immunodeficiency is striking particularly with regard to cancers and pre-malignant diseases associated with chronic viral infections such as HBV, HCV, HPV, Epstein-Barr virus, and human herpes virus-8.[88,89] For some cancers, risk is related to HIV viremia. Cumulative HIV viremia, independent of other factors, is associated with increased risk of non-Hodgkin lymphoma and other ADM.[87,90] In the SMART study,[91] patients randomized to the drug conservation arm (ART interruption with re-initiation if CD4 count fell to <250 cells/mm^3) had a higher incidence of ADM but not NADM, although increased NADM was noted in non-smokers in the drug-conservation arm.

From the early 1990s through 2000, incidence rates for many cancers occurring with advanced immunosuppression, including Kaposi sarcoma, diffuse large B-cell lymphoma, and primary central nervous system (CNS) lymphoma, declined markedly in HIV-infected individuals in the United States, with more gradual declines noted after 2000.[92] However, for other ADMs and NADMs, such as Burkitt lymphoma, Hodgkin lymphoma, cervical cancer, and anal cancer, similar reductions in incidence have not been observed.[92,93] Declines in competing causes of mortality (e.g., opportunistic infections [OIs]) and concurrent cancer risk factors such as smoking or aging of HIV-infected cohorts, may confound a full assessment of the relative impact of ART on cancer prevention for NADMs.[82,94]

Additionally, data from the era of potent combination ART suggest that overall survival in HIV-infected patients who develop ADMs or NADMs also depends on immune status as measured by CD4 count.[85,95,96] For non-Hodgkin lymphoma, data from the Center for AIDS Research Network of Integrated Clinical Systems Cohort shows that across CD4 strata, the level of HIV viremia 6 months after the diagnosis of lymphoma (including Hodgkin lymphoma) is associated with an increased risk of death.[95]

Together this evidence suggests that initiating ART to suppress HIV replication, maximize immune reconstitution, and maintain CD4 counts at levels >350 to 500 cells/mm^3 reduces the overall incidence of ADMs and may reduce the risk of some NADMs as well. The effect of ART on cancer incidence and mortality in patients with cancer[95,97] is likely to be heterogeneous across various cancer types.

Neurological Complications

In the untreated HIV-infected patient, CNS involvement is a nearly universal facet of systemic HIV infection as evident by detection of HIV RNA in cerebrospinal fluid (CSF).[98-101] The CNS is an important target of ART, not only to treat neurologically symptomatic infection but also to prevent later development of virus-related brain injury, which can range from severe and debilitating encephalopathy to milder and more insidious cognitive and motor dysfunction.[102-104]

Like systemic infection, CNS virus populations and the character of CNS infection can evolve within individual patients. Characteristically during the earliest phases of systemic infection, CSF viral isolates are similar to those found in blood and likely reflect transfer of blood populations across CNS barriers in T lymphocytes.[105] Over time CSF isolates may exhibit increasing compartmentalization that reflect divergence from the predominant blood populations, a transformation most notable in patients with frank HIV encephalitis presenting with HIV-associated dementia (HAD).[106] Combination ART usually reduces CSF HIV RNA to below the level of detection,[99,107] largely preventing this development, and consequently, reducing the incidence of severe HIV-related brain disease in virologically suppressed patients.[108-110] Hence, prevention of HAD is among the arguments for early ART, although the CD4 threshold for treatment to prevent this disorder is not established. Additionally, treatment of patients presenting with HAD—usually seen in the context of late HIV presentation—can arrest and variably reverse neurological abnormalities;[111] therefore, the diagnosis of HAD is an indication for rapid initiation of ART **(AI)**.

With the successful control of HAD with ART, attention has shifted to milder forms of neurocognitive

impairment in HIV infection, largely recognized by reduced neuropsychological test performance.[104,112] These milder forms of impairment are categorized in two groups: asymptomatic neurocognitive impairment and mild neurocognitive disorder. Although patients with either form exhibit the same degree of impairment on neuropsychological tests (<1 SD below normative performance in two neurocognitive domains), they differ as to the absence or presence of symptoms or mild functional impairment in everyday activities.[103] Even after exclusion of confounding conditions, the prevalence of these milder forms of neurocognitive impairment appears to be substantial, including in treated patients with plasma viral suppression.[104,112] Less certain is the extent to which these impairments are the consequence of earlier mild or subclinical brain injury sustained before ART initiation, or alternatively, reflect ongoing injury despite ART and plasma viral suppression. Association of these milder deficits with nadir CD4 count may favor the role of earlier injury,[100,113-115] providing further argument for early treatment.

Peripheral neuropathies are a second category of important HIV-associated neurological disease.[116] In the early decades of the discovery of HIV infection and the use of some nucleoside analogs, painful distal sensory neuropathy was particularly common and a difficult problem that did not respond to ART.[117] Although some reports suggest that the incidence of this HIV-associated neuropathy remains high, clinical experience suggests that the condition mainly affects patients with longer duration of HIV infection who initiated ART late in the course of the disease.[118] There appears to be a reduced incidence of neuropathies as more patients begin treatment at earlier stages of HIV infection.

Overall, effective ART may be beneficial in preventing and treating symptomatic and subclinical CNS HIV infection and the CNS and peripheral nervous system consequences of infection.

Age and Treatment-Related Immune Reconstitution

Also see HIV and the Older Patient.

The CD4 cell response to ART is an important predictor of short- and long-term morbidity and mortality. In most, but not all studies, treatment initiation at an older age has been associated with a less robust CD4 count response; starting therapy at a younger age may result in better immunologic and perhaps clinical outcomes.[4,119-122]

Persistent Inflammation and Immunodeficiency During Antiretroviral Therapy

Untreated HIV infection is associated with chronic inflammation, as defined by the frequency of activated T cells and monocyte/macrophages and levels of a number of pro-inflammatory cytokines (e.g., IL-6, CRP, soluble CD14). Effective ART decreases levels of most of these inflammatory markers, but the effect is often incomplete, with levels in many of those on ART remaining higher than those observed in age-matched uninfected adults.[123,124] Chronic inflammation during both untreated and treated disease is strongly associated with risk of non-AIDS defining morbidity and all-cause mortality.[125-128] Because HIV replication contributes to this inflammatory state through both direct and indirect mechanisms, earlier use of ART to blunt this process may be beneficial. However, there are no data showing that ART-mediated changes in any inflammatory biomarker are associated with reduced morbidity and mortality.

Immune function as defined by the peripheral CD4 cell count is also an important determinant of health. Although effective ART results in a sustained and beneficial increase in CD4 cell counts, this effect is often incomplete. Patients who delay therapy to the point of advanced immunodeficiency may require several years of ART to normalize their peripheral CD4 cell counts,[129] and some patients may never achieve a normal level.[130] A lower CD4 count on therapy is associated with higher risk of developing cancer, liver disease, cardiovascular disease and death.[14] In some studies a history of low CD4 counts is associated with risk of morbidity and mortality during subsequent effective therapy.[131,132]

Collectively, these observations support earlier use of ART. Treatment decreases the level of inflammation,

which may be associated with reduced short-term risk of AIDS- and non-AIDS-related morbidity and mortality.[125,133,134] ART also prevents progressive loss of CD4 cells, thus reducing risk of immunodeficiency and its related complications. Some studies have shown that a patient's pre-therapy CD4 cell count nadir is predictive of the degree of residual inflammation and/or T-cell dysfunction during ART.[123,135,136] Thus, earlier ART may result in less residual immunological perturbations during treatment, which theoretically may result in reduced risk of disease during the decades that a patient requires ART **(CIII)**.

Antiretroviral Therapy for Prevention of HIV Transmission

Prevention of Perinatal Transmission

Effective ART reduces transmission of HIV. The most dramatic and well-established example of this effect is the use of ART in pregnant women to prevent perinatal transmission of HIV. Effective suppression of HIV replication, as reflected in plasma HIV RNA, is a key determinant in reducing perinatal transmission. In the setting of ART initiation before 28 weeks' gestation and an HIV RNA level <50 copies/mL near delivery, use of combination ART during pregnancy has reduced the rate of perinatal transmission of HIV from approximately 20% to 30% to 0.1% to 0.5%.[137,138] Thus, use of combination ART drug regimens is recommended for all HIV-infected pregnant women **(AI)**. Following delivery, in the absence of breastfeeding, considerations regarding continuation of the ARV regimen for maternal therapeutic indications are the same as those regarding ART for other non-pregnant individuals. For detailed recommendations, see the Perinatal Guidelines.[139]

Prevention of Sexual Transmission

A number of investigations, including biological, ecological and epidemiological studies and one randomized clinical trial, provide strong support for the premise that treatment of the HIV-infected individual can significantly reduce sexual transmission of HIV. Lower plasma HIV RNA levels are associated with decreases in the concentration of the virus in genital secretions.[140,141] Studies of HIV-serodiscordant heterosexual couples have demonstrated a relationship between level of plasma viremia and risk of transmission of HIV—when plasma HIV RNA levels are lower, transmission events are less common.[1,142-145] A study conducted in KwaZulu-Natal, South Africa, used geospatial techniques to assess the relationship between ART use and HIV incidence in an observational cohort of more than 16,000 study participants living in many different communities.[146] After adjustment for sexual behavior and prevalent HIV cases, each percentage point increase in ART coverage of HIV-infected persons lowered the HIV infection risk in a community by 1.7%.

Most significantly, the multi-continental HPTN 052 trial enrolled 1,763 HIV-serodiscordant couples in which the HIV-infected partner was ART naive with a CD4 count of 350 to 550 cells/mm^3 at enrollment to compare the effect of immediate ART versus delayed therapy (not started until CD4 count <250 cells/mm^3) on HIV transmission to the HIV-infected partner.[2] At study entry, 97% of the participants were in heterosexual monogamous relationships. All study participants were counseled on behavioral modification and condom use. Twenty-eight linked HIV transmission events were identified during the study period, but only 1 event occurred in the early therapy arm. This 96% reduction in transmission associated with early ART was statistically significant (HR 0.04; 95% CI, 0.01–0.27; P <0.001). These results show that early ART is more effective at preventing transmission of HIV than all other behavioral and biomedical prevention interventions studied. This study, as well as other observational studies and modeling analyses showing a decreased rate of HIV transmission among serodiscordant heterosexual couples following the introduction of ART, demonstrate that suppression of viremia in ART-adherent patients with no concomitant sexually transmitted diseases (STDs) substantially reduces the risk of transmission of HIV.[3,144,145,147-149] HPTN 052 was conducted in heterosexual couples and not in populations at risk of transmission via homosexual exposure or needle sharing. In addition, in this clinical trial, adherence to ART was well supported and near complete. However,

the prevention benefits of effective ART observed in HPTN 052 can reasonably be presumed to apply broadly. Therefore, the Panel recommends that ART be offered to patients who are at risk of transmitting HIV to sexual partners (the strength of this recommendation varies according to mode of sexual transmission: **AI** for heterosexual transmission and **AIII** for male-to-male and other modes of sexual transmission). Clinicians should discuss with patients the potential individual and public health benefits of therapy and the need for adherence to the prescribed regimen and counsel patients that ART is not a substitute for condom use and behavioral modification and that ART does not protect against other STDs (see Preventing Secondary Transmission of HIV).

Concerns Regarding Earlier Initiation of Therapy

Despite increasing evidence showing the benefits of earlier initiation of ART, four areas of concern remain as reasons for deferral of HIV therapy.

ARV Drug Toxicities Have an Adverse Effect on Quality of Life and Adherence

Earlier initiation of ART extends exposure to ARV agents by several years. The D:A:D study found an increased incidence of CVD associated with cumulative exposure to some drugs in the nucleoside reverse transcriptase inhibitor and protease inhibitor (PI) drug classes.[69,150] Renal and bone health are also of concern. Aging coupled with long term use of tenofovir may increase risk of significant renal dysfunction.[151-153] In the SMART study, compared with interruption or deferral of therapy, continuous exposure to ART was associated with significantly greater loss of bone density.[71] There may be unknown complications related to cumulative use of ARV drugs for many decades. A list of known ARV-associated toxicities can be found in Adverse Effects of Antiretroviral Agents.

ART frequently improves quality of life for symptomatic patients. However, some side effects of ART may impair quality of life for some patients, especially those who are asymptomatic at initiation of therapy and at low risk of AIDS events. For example, efavirenz can cause neurocognitive or psychiatric side effects and PIs have been associated with gastrointestinal side effects. As noted above, some therapies may increase the risk of CVD. Patients who find that the inconvenience of taking medication every day outweighs the overall benefit of early ART may choose to delay therapy.

ARV Non-Adherence May Have an Impact on Virologic Response.

At any CD4 count, adherence to therapy is essential to achieve viral suppression and prevent emergence of drug-resistance mutations. Several clinical, behavioral, and social factors associated with poor adherence, such as untreated major psychiatric disorders, active substance abuse, unfavorable social circumstances, patient concerns about side effects, and poor adherence to clinic visits, have been identified. Clinicians should identify areas where additional intervention is needed to improve adherence both before and after initiation of therapy. Some strategies to improve adherence are discussed in Adherence to Antiretroviral Therapy.

Earlier Development of Resistance may Reduce Future Therapeutic Options.

Non-adherence and subsequent virologic failure may promote emergence of drug resistance mutations and limit subsequent treatment options. Despite concerns about the development of resistance to ARV drugs, the evidence thus far indicates that resistance occurs more frequently in individuals who initiate therapy later in the course of infection than in those who initiate ART earlier.[154] Furthermore, recent data have indicated a slight increase in the prevalence of 2-drug class resistance from 2000 to 2005.[155]

Cost may be a Barrier to Early Initiation of Therapy.

In resource-rich countries, the cost of ART exceeds $10,000 per year (see Cost Considerations and Antiretroviral Therapy). Several modeling studies support the cost effectiveness of HIV therapy initiated soon after diagnosis.[156-158] One study reported that the annual cost of care is 2.5 times higher for patients with

CD4 counts <50 cells/mm^3 than for patients with CD4 counts >350 cells/mm^3.[159] Much of the health care expenditure in patients with advanced infection is from non-ARV drugs and hospitalization. However, there are no comparisons of the cost of earlier ART initiation (i.e., CD4 count 350–500 cells/mm^3) versus later initiation (i.e., CD4 count >500 cells/ mm^3). As generic formulations for more ARV drugs become available in the next several years, the cost of ART may decline. However, despite any significant cost savings, decisions regarding which ARVs to select for system-wide HIV programs must be based on rigorous cost-effectiveness assessments (see Cost section).[160]

Conditions Favoring More Urgent Initiation of Therapy

Several conditions increase the urgency for therapy, including:

- Pregnancy **(AI)**. Clinicians should refer to the Perinatal Guidelines for more detailed recommendations on the management of HIV-infected pregnant women.[139]
- AIDS-defining conditions, including HAD **(AI)**
- Acute OIs (see discussion below)
- Lower CD4 counts (e.g., <200 cells/mm^3) **(AI)**
- HIVAN **(AII)**
- Acute/Early Infection **(BII)**. See more discussion in the Acute/Early Infection section.
- HIV/HBV coinfection **(AII)**
- HIV/HCV coinfection **(BII)**
- Rapidly declining CD4 counts (e.g., >100 cells/mm^3 decrease per year) **(AIII)**
- Higher viral loads (e.g., >100,000 copies/mL) **(BII)**

Acute Opportunistic Infections

In patients who have opportunistic diseases for which no effective therapy exists (e.g., cryptosporidiosis, microsporidiosis, progressive multifocal leukoencephalopathy), but in whom ART may improve outcomes by improving immune responses, treatment should be started as soon as possible **(AIII)**. For patients with mild to moderate cutaneous Kaposi's sarcoma (KS), prompt initiation of ART alone without chemotherapy has been associated with improvement of the KS lesions, even though initial transient progression of KS lesion as a manifestation of immune reconstitution inflammatory syndrome (IRIS) can also occur.[161]

In the setting of some OIs, such as cryptococcal meningitis, for which immediate therapy may increase the risk of serious immune reconstitution inflammatory syndrome (IRIS), a short delay before initiating ART may be warranted.[162-164] In the setting of other OIs, such as *Pneumocystis jirovecii* pneumonia, early initiation of ART is associated with increased survival;[10] therefore, therapy should not be delayed **(AI)**.

In patients who have active TB, initiating ART during treatment for TB confers a significant survival advantage;[165-169] therefore, ART should be initiated as recommended in *Mycobacterium Tuberculosis* Disease with HIV Coinfection.

Clinicians should refer to the Guidelines for Prevention and Treatment of Opportunistic Infections in HIV-Infected Adults and Adolescents[161] for more detailed discussion on when to initiate ART in the setting of a specific OI.

Conditions Where Deferral of Therapy May be Considered

Some patients and their clinicians may decide to defer therapy on the basis of clinical or personal circumstances. Deferring therapy for the reasons discussed below may be reasonable in patients with high CD4 counts (e.g., >500 cells/mm^3), but deferring therapy in patients with much lower CD4 counts (e.g.,

<200 cells/mm^3) should be considered only in rare situations and should be undertaken with close clinical follow-up. Briefly delaying therapy to allow a patient more time to prepare for lifelong treatment may be considered.

When There are Significant Barriers to Adherence

Also see Adherence to Antiretroviral Therapy.

In patients with higher CD4 counts who are at risk of poor adherence, it may be prudent to defer treatment while addressing the barriers to adherence. However, in patients with conditions that require urgent initiation of ART (see above), therapy should be started while simultaneously addressing the barriers to adherence.

Several methods are available to assess adherence. When the most feasible measure of adherence is self-report, this assessment should be completed at each clinic visit using one of the available reliable and valid instruments.[170,171] If other objective measures (e.g., pharmacy refill data, pill count) are available, these methods should be used to assess adherence at each follow-up visit.[172–174] Continual assessment and counseling allow the clinician to intervene early to address barriers to adherence occurring at any point during treatment (see Adherence to Antiretroviral Therapy).

Presence of Comorbidities that Complicate or Prohibit Antiretroviral Therapy

Deferral of ART may be considered when either the treatment or manifestations of other medical conditions may complicate the treatment of HIV infection or vice versa. Examples include:

- Surgery that may result in an extended interruption of ART
- Treatment with medications that have clinically significant drug interactions with ART and for which alternative medications are not available

In each of these circumstances, the assumption is that the situation is temporary and that ART will be initiated after the conflicting condition has resolved.

There are some less common situations that preclude ART at any time while CD4 counts remain high. In particular, such situations include that of patients who have a poor prognosis because of a concomitant medical condition and are not expected to gain survival or quality-of-life benefits from ART. Examples include patients with incurable non-HIV-related malignancies or end-stage liver disease who are not being considered for liver transplantation. In this setting, deciding to forgo ART may be easier in patients with higher CD4 counts who are likely asymptomatic for HIV and in whom ART is unlikely to prolong survival. However, it should be noted that ART may improve outcomes, including survival, in patients with some HIV-associated malignancies (e.g., lymphoma, Kaposi sarcoma) and in patients with liver disease due to chronic HBV or HCV.

Long-term Non-Progressors and Elite HIV Controllers

A small subset of HIV-infected individuals (~3% to 5%) can maintain normal CD4 counts for many years without treatment (long-term non-progressors), and an even smaller subset (~1%) can maintain low to undetectable HIV RNA levels for years (elite controllers).[175,176] Although there is significant overlap in these clinical phenotypes, many long-term non-progressors have detectable viremia and some controllers progress immunologically and clinically despite having no detectable viremia.

There are limited data on how to manage these individuals. Given potential harm associated with uncontrolled HIV replication, many of the preceding arguments for early therapy likely apply to non-progressors who have consistently detectable viremia (i.e., HIV RNA >200 to 1000 copies/mL). Given that ongoing HIV replication occurs even in controllers, ART is also recommended for those rare controllers with evidence of disease progression, as defined by declining CD4 counts or development of HIV-related complications **(AII)**. The Panel has no recommendations on managing controllers with high CD4 counts,

although the fact that ART reduces the level of inflammation in this setting suggests that treatment may be beneficial.[177]

The Need for Early Diagnosis of HIV

Fundamental to the earlier initiation of ART recommended in these guidelines is the assumption that patients will be diagnosed early in the course of HIV infection, making earlier initiation of therapy an option. Unfortunately, most HIV-infections are diagnosed at later stages of disease,[178-181] although in recent years, HIV is increasingly being detected earlier.[4] Despite the recommendations for routine, opt-out HIV screening in the health care setting regardless of perceptions about a patient's risk of infection,[182] the median CD4 count of newly diagnosed patients remains below 350 cells/mm^3, although this number is increasing.[4] Diagnosis of HIV infection is delayed more often in nonwhites, IDUs, and older patients than in other populations, and many individuals in these groups develop AIDS-defining illnesses within 1 year of diagnosis.[178-181] Therefore, to ensure that the current treatment guidelines have maximum impact, routine HIV screening per current CDC recommendations is essential. It is also critical that all newly diagnosed patients are educated about HIV disease and linked to care for full evaluation, follow-up, and management. Once patients are in care, focused effort is required to retain them in the health care system so that both the infected individuals and their sexual partners can fully benefit from early diagnosis and treatment.

Conclusion

The current recommendations are based on growing evidence supporting earlier initiation of ART and the lack of demonstrable harm in starting therapy earlier. The strength of each recommendation varies according to the quality and availability of existing evidence supporting the recommendation. In addition to the benefit of earlier initiation of therapy for the health of the HIV-infected individual, the reduction in sexual transmission to HIV-uninfected individuals provides further reason for earlier initiation of ART. The Panel will continue to monitor and assess the results of ongoing and planned randomized clinical trials and observational studies, which will provide information to guide future Panel recommendations.

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What to Start: Initial Combination Regimens for the Antiretroviral-Naive Patient (Last updated April 8, 2015; last reviewed April 8, 2015)

Panel's Recommendations

- An antiretroviral regimen for a treatment-naive patient generally consists of two nucleoside reverse transcriptase inhibitors in combination with a third active antiretroviral drug from one of three drug classes: an integrase strand transfer inhibitor, a non-nucleoside reverse transcriptase inhibitor, or a protease inhibitor with a pharmacokinetic enhancer (cobicistat or ritonavir).
- The Panel classifies the following regimens as Recommended regimens for antiretroviral-naive patients:

  Integrase Strand Transfer Inhibitor-Based Regimens:
  - Dolutegravir/abacavir/lamivudine[a]—**only** for patients who are HLA-B*5701 negative **(AI)**
  - Dolutegravir plus tenofovir disoproxil fumarate (tenofovir)/emtricitabine[a] **(AI)**
  - Elvitegravir/cobicistat/tenofovir/emtricitabine—**only** for patients with pre-antiretroviral therapy CrCl >70 mL/min **(AI)**
  - Raltegravir plus tenofovir/emtricitabine[a] **(AI)**

  Protease Inhibitor-Based Regimen:
  - Darunavir/ritonavir plus tenofovir/emtricitabine[a] **(AI)**
- On the basis of individual patient characteristics and needs, an Alternative regimen or; less frequently, an Other regimen; may in some instances be the optimal regimen for a patient. A list of Alternative and Other regimens can be found in Table 6.
- Given the large number of excellent options for initial therapy, selection of a regimen for a particular patient should be guided by factors such as virologic efficacy, toxicity, pill burden, dosing frequency, drug-drug interaction potential, resistance testing results, comorbid conditions, and cost. Table 7 provides guidance on choosing an antiretroviral regimen based on selected clinical case scenarios. Table 8 highlights the advantages and disadvantages of different components in a regimen.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert Opinion*

[a] Lamivudine may substitute for emtricitabine or vice versa.

Introduction

More than 25 antiretroviral (ARV) drugs in 6 mechanistic classes are Food and Drug Administration (FDA) approved for treatment of HIV infection. These six classes include the nucleoside/nucleotide reverse transcriptase inhibitors (NRTIs), non-nucleoside reverse transcriptase inhibitors (NNRTIs), protease inhibitors (PIs), a fusion inhibitor (FI), a CCR5 antagonist, and integrase strand transfer inhibitors (INSTIs). In addition, two drugs (pharmacokinetic [PK] enhancers or boosters) are used solely to improve the pharmacokinetic profiles of some ARV drugs (e.g., PIs and the INSTI elvitegravir [EVG]).

The initial ARV regimen for a treatment-naive patient generally consists of two NRTIs, usually abacavir plus lamivudine (ABC/3TC) or tenofovir disoproxil fumarate plus emtricitabine (TDF/FTC), plus a drug from one of three drug classes: an INSTI, an NNRTI, or a PK-enhanced PI. As shown in clinical trials and by retrospective evaluation of cohorts of patients in clinical care, this strategy for initial treatment has resulted in HIV RNA decreases and CD4 T lymphocyte (CD4) cell increases in most patients.[1-3]

Data Used for Making Recommendations

The Panel on Antiretroviral Guidelines for Adults and Adolescents (the Panel)'s recommendations are primarily based on clinical trial data published in peer-reviewed journals and data prepared by manufacturers for FDA review. In select cases, the Panel considers data presented in abstract format at major scientific meetings. The Panel's first criterion for selection of evidence on which to base recommendations is published information from a randomized, prospective clinical trial with an adequate sample size that demonstrates that an ARV regimen has shown high rates of viral suppression, increased CD4 cell count, and has a favorable

safety profile. Comparative clinical trials of initial treatments generally show no significant differences in HIV-related clinical endpoints or survival. Thus, assessment of regimen efficacy and safety are primarily based on surrogate marker endpoints (especially rates of HIV RNA suppression) and the incidence and severity of adverse events. When developing recommendations, the Panel also considers post-marketing safety data, observational cohort data published in peer-reviewed publications, and the experience of clinicians and community members who are actively engaged in patient care.

The Panel reviewed the available data to arrive at Recommended, Alternative, or Other regimens, as specified in Table 6. Each of the regimens listed in Table 6 has shown potent virologic efficacy as measured by the proportion of participants in comparative clinical trials able to achieve and maintain viral suppression. Recommended regimens are those studied in randomized controlled trials and shown to have optimal and durable virologic efficacy, favorable tolerability and toxicity profiles, and ease of use. Alternative regimens are those that are effective but have potential disadvantages, limitations for use in certain patient population, or less supporting data than Recommended regimens. In certain situations, depending on individual patient characteristics and needs, an Alternative regimen may actually be the optimal regimen for a specific patient. Some regimens are classified as Other regimens because, compared with Recommended or Alternative regimens, they have reduced virologic activity, limited supporting data from large comparative clinical trials, or other factors such as greater toxicities, higher pill burden, drug interaction potential, or limitations for use in certain patient populations.

In addition to Table 6, a number of tables presented below and at the end of the guidelines provide clinicians with guidance on selecting and prescribing an optimal regimen for an individual patient. Table 7 lists specific case scenarios to guide regimen selection for patients with common clinical conditions. Table 8 lists the potential advantages and disadvantages of the components used in Recommended and Alternative regimens. Table 9 lists agents or regimens not recommended for initial treatment. Appendix B, Tables 1–6 lists characteristics of individual ARV agents, such as formulations, dosing recommendations, PKs, and common adverse effects. Appendix B, Table 7 provides ARV dosing recommendations for patients who have renal or hepatic insufficiency.

Changes Since the Last Revision of the Guidelines

Since the last revision of these guidelines, new data from clinical trials and cohort studies, as well as experience in clinical practice, have prompted significant changes to the list of Recommended, Alternative, and Other regimens for treatment-naive patients (Table 6). Among these changes, the following deserve emphasis:

- There are now five Recommended regimens for antiretroviral therapy (ART)-naive patients: four INSTI-based regimens and one ritonavir-boosted PI (PI/r)-based regimen.
- Results from a large comparative clinical trial comparing atazanavir/ritonavir (ATV/r) plus TDF/FTC to darunavir/ritonavir (DRV/r) or raltegravir (RAL) plus TDF/FTC showed a greater rate of toxicities-related discontinuation in the ATV/r arm.[4] Therefore, ATV/r plus TDF/FTC has been moved from the Recommended to the Alternative category.
- The Panel has also moved EFV/TDF/FTC from the Recommended to the Alternative category because of concerns about the tolerability of efavirenz (EFV) in clinical trials and practice, especially the high rate of central nervous system (CNS) related toxicities, and a possible association with suicidality observed in one analysis of four clinical trials.[5]
- Regimens that were previously listed as Recommended for patients with baseline HIV RNA <100,000 copies/mL or CD4 count >200 cells/mm^3 are now in the Alternative or Other category, with the same caveat to limit their use to patients with the cited HIV RNA and CD4 levels.
- Two regimens that use fewer than two NRTIs (DRV/r plus RAL and lopinavir/ritonavir [LPV/r] plus 3TC) are listed among the Other regimens, with the caveat that their use be limited to patients who cannot take either TDF or ABC.

- Coformulations of ATV and DRV with the PK enhancer cobicistat (COBI) have been added to the Alternative regimen options.

Table 6. Recommended, Alternative, and Other Antiretroviral Regimen Options for Treatment-Naive Patients (page 1 of 2)

An ARV regimen generally consists of two NRTIs (one of which is FTC or 3TC) plus an INSTI, NNRTI, or PK-enhanced PI. Selection of a regimen should be individualized on the basis of virologic efficacy, potential adverse effects, pill burden, dosing frequency, drug-drug interaction potential, a patient's resistance test results and comorbid conditions, and cost. Table 7 lists specific case scenarios to guide regimen selection for patients with common clinical conditions. For more detailed recommendations on ARV choices and dosing in HIV-infected pregnant women, refer to the latest perinatal guidelines available at http://aidsinfo.nih.gov/guidelines.

Recommended Regimen Options (Drug classes and regimens within each class are arranged in alphabetical order.)
INSTI-Based Regimens: • DTG/ABC/3TC[a]—**only** for patients who are HLA-B*5701 negative **(AI)** • DTG plus TDF/FTC[a] **(AI)** • EVG/c/TDF/FTC—only for patients with pre-treatment estimated CrCl ≥70 mL/min **(AI)** • RAL plus TDF/FTC[a] **(AI)** PI-Based Regimens: • DRV/r plus TDF/FTC[a] **(AI)**
Alternative Regimen Options (Drug classes and regimens within each class are arranged in alphabetical order.) Regimens that are effective and tolerable, but that have potential disadvantages when compared with the recommended regimens listed above, have limitations for use in certain patient population, or have less supporting data from randomized clinical trials. **An alternative regimen may be the preferred regimen for some patients.**
NNRTI-Based Regimens: • EFV/TDF/FTC[a] **(BI)** • RPV/TDF/FTC[a]—**only** for patients with pre-treatment HIV RNA <100,000 copies/mL and CD4 cell count >200 cells/mm^3 **(BI)** PI-Based Regimens: • ATV/c plus TDF/FTC[a] —**only** for patients with pre-treatment estimated CrCl ≥70 mL/min **(BI)** • ATV/r plus TDF/FTC[a] **(BI)** • (DRV/c or DRV/r) plus ABC/3TC[a] —**only** for patients who are HLA-B*5701 negative (**BIII** for DRV/c and **BII** for DRV/r) • DRV/c plus TDF/FTC[a] —**only** for patients with pre-treatment estimated CrCl ≥70 mL/min **(BII)**

Table 6. Recommended, Alternative, and Other Antiretroviral Regimen Options for Treatment-Naive Patients (page 2 of 2)

Other Regimen Options
(Drugs classes and regimens within each class are arranged in alphabetical order.)
Regimens that, in comparison with Recommended and Alternative regimens, may have reduced virologic activity, limited supporting data from large comparative clinical trials, or other factors such as greater toxicities, higher pill burden, drug interaction potential, or limitations for use in certain patient populations.
INSTI-Based Regimen: • RAL plus ABC/3TC[a]—**only** for patients who are HLA-B*5701 negative **(CII)** NNRTI-Based Regimen: • EFV plus ABC/3TC[a]—**only** for patients who are HLA-B*5701 negative and with pre-treatment HIV RNA <100,000 copies/mL **(CI)** PI-Based Regimens: • (ATV/c or ATV/r) plus ABC/3TC[a]—**only** for patients who are HLA-B*5701 negative and with pre-treatment HIV RNA <100,000 copies/mL (**CIII** for ATV/c and **CI** for ATV/r) • LPV/r (once[b] or twice daily) plus ABC/3TC[a]—**only** for patients who are HLA-B*5701 negative **(CI)** • LPV/r (once[b] or twice daily) plus TDF/FTC[a] **(CI)** Other Regimens When TDF or ABC Cannot be Used: • DRV/r plus RAL—**only** for patients with pre-treatment HIV RNA <100,000 copies/mL and CD4 cell count >200 cells/mm^3 **(CI)** • LPV/r (twice daily) plus 3TC (twice daily) **(CI)**
Rating of Recommendations: *A = Strong; B = Moderate; C = Optional* ***Rating of Evidence:*** *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

[a] 3TC may be substituted for FTC or vice versa.

[b] Once daily LPV/r is not recommended for pregnant patients.

Note: The following are available as co-formulated fixed-dose combination products: ABC/3TC, ATV/c, DRV/c, DTG/ABC/3TC, EFV/TDF/FTC, EVG/c/TDF/FTC, LPV/r, RPV/TDF/FTC, and TDF/FTC.

Key to Acronyms: 3TC = lamivudine; ABC = abacavir; ARV = antiretroviral; ATV/c = cobicistat-boosted atazanavir; ATV/r = ritonavir-boosted atazanavir; CrCl = creatinine clearance; DRV/c = cobicistat-boosted darunavir; DRV/r = ritonavir-boosted darunavir; DTG = dolutegravir; EFV = efavirenz; EVG/c/TDF/FTC = elvitegravir/cobicistat/tenofovir DF/emtricitabine; FTC = emtricitabine; INSTI = integrase strand transfer inhibitor; LPV/r = ritonavir-boosted lopinavir; NNRTI = non-nucleoside reverse transcriptase inhibitor; NRTI = nucleoside reverse transcriptase inhibitor; PI = protease inhibitor; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; TDF = tenofovir disoproxil fumarate

Considerations When Selecting A Regimen for Antiretroviral Therapy-Naive Patients

As noted in Table 6, the Recommended Regimens include four INSTI-based regimens and one DRV/r-based regimen for initial therapy. The INSTI-based regimens were selected because of their high virologic efficacy, excellent safety and tolerability profiles, and (with RAL and dolutegravir [DTG]) low number of drug-drug interactions (see the INSTI section for discussion regarding the special characteristics and clinical trial results for each of the 3 Recommended INSTIs). For patients who are at high risk for intermittent therapy because of poor adherence or have transmitted NRTI drug resistance, a PI/r-based treatment is preferred given the PIs high genetic barrier to resistance (see PI section for discussion of the different PK-boosted PIs recommended by the Panel). In some situations, an NNRTI-based regimen may be a better choice for a particular patient. Table 7 provides guidance on regimen selection based on various patient- and regimen-specific characteristics.

Factors to Consider When Selecting an Initial Regimen

When selecting a regimen for an individual patient, a number of patient and regimen specific characteristics should be considered, with the goal of providing a potent, safe, tolerable, and easy to adhere to regimen for the patient in order to achieve sustained virologic control. Some of the factors can be grouped into the following categories:

Initial Characteristics of the Patient:

- Pre-treatment HIV RNA level (viral load)
- Pre-treatment CD4 cell count
- HIV genotypic drug resistance testing results
- HLA-B*5701 status
- Patient preferences
- Patient's anticipated adherence

Specific Comorbidities or Other Conditions:

- Cardiovascular disease, hyperlipidemia, renal disease, osteoporosis, psychiatric illness, neurologic disease, drug abuse or dependency requiring narcotic replacement therapy
- Pregnancy or pregnancy potential. Clinicians should refer to the latest Perinatal Guidelines for more detailed recommendations on the safety and effectiveness of ARV drugs during pregnancy.
- Coinfections: hepatitis C (HCV), hepatitis B (HBV), tuberculosis (TB)

Regimen-Specific Considerations:

- Regimen's genetic barrier to resistance
- Potential adverse drug effects
- Known or potential drug interactions with other medications
- Convenience (e.g., pill burden, dosing frequency, availability of fixed-dose combination products, food requirements)
- Cost (see Cost Consideration and Antiretroviral Therapy section)

Table 7. Antiretroviral Regimen Considerations as Initial Therapy based on Specific Clinical Scenarios (page 1 of 3)

This table is designed to guide clinicians in choosing an initial ARV regimen according to various patient and regimen characteristics and specific clinical scenarios. When more than one scenario applies to a patient, clinicians should review considerations for each relevant scenario and use their clinical judgment to select the most appropriate regimen. This table is intended to guide the initial choice of regimen. However, if a patient is doing well on a particular regimen, it is not necessary to switch to another regimen based on the scenarios outlined in this table.

Please see Table 8 for additional information regarding the advantages and disadvantages of particular ARV medications.

Patient or Regimen Characteristics	Clinical Scenario	Consideration(s)	Rationale/Comments
Pre-ART Characteristics	CD4 count <200 cells/mm^3	**Do Not Use the Following Regimens:** • RPV-based regimens • DRV/r plus RAL	Higher rate of virologic failure observed in those with low pre-treatment CD4 cell count
	HIV RNA >100,000 copies/mL	**Do Not Use the Following Regimens:** • RPV-based regimens • ABC/3TC with EFV or ATV/r • DRV/r plus RAL	Higher rates of virologic failure observed in those with high pre-treatment HIV RNA
	HLA-B*5701 positive	**Do not use ABC-containing regimen.**	Abacavir hypersensitivity, a potentially fatal reaction, is highly associated with positivity for the HLA-B*5701 allele.
	Must treat before HIV drug resistance results available	**Avoid NNRTI-based regimen.**	Transmitted mutations conferring NNRTI resistance are more likely than mutations associated with PI or INSTI resistance. Some experts avoid using INSTI-containing regimens in this setting because of concern regarding their ability to fully suppress viral replication if transmitted NRTI mutations are present.
ART Specific Characteristics	One pill once daily regimen desired	ART Options Include: • DTG/ABC/3TC • EFV/TDF/FTC • EVG/c/TDF/FTC • RPV/TDF/FTC (if HIV RNA <100,000 copies/mL and CD4 count >200/mm^3)	Available as fixed-dose combination tablets
	Food effects	Regimens that Should be Taken with Food: • ATV/r or ATV/c-based regimens • DRV/r or DRV/c-based regimens • EVG/c/TDF/FTC • RPV/TDF/FTC Regimens that Should be Taken on an Empty Stomach: • EFV-based regimens	Food improves absorption of the listed regimens. Taking EFV-based regimens with food increases EFV absorption and may increase CNS side effects.

Table 7. Antiretroviral Regimen Considerations as Initial Therapy based on Specific Clinical Scenarios (page 2 of 3)

Patient or Regimen Characteristics	Clinical Scenario	Consideration(s)	Rationale/Comments
Presence of Other Conditions	Chronic kidney disease (defined as eGFR<60 mL/min)	**Consider avoiding TDF.** If eGFR is <70 mL/min, Do Not Use: • EVG/c/TDF/FTC, or • ATV/c with TDF, or • DRV/c with TDF Options for CKD Patients *Use ABC/3TC if HLA-B*5701 Negative:* • If HIV RNA >100,000 copies/mL, do not use ABC/3TC with EFV or ATV/r. • If CrCl <50 mL/min, do not use coformulated ABC/3TC because 3TC requires dose adjustment. Other Options (See Text for Discussion): • DRV/r plus RAL (if HIV <100,000/mL and CD4 count >200/mm^3), or • LPV/r plus 3TC, or • Modify TDF dose	TDF has been associated with renal tubulopathy. See Appendix B, Table 7 for recommendations on ARV dose modification.
	Osteoporosis	**Consider avoiding TDF.** Use ABC/3TC if HLA-B*5701 negative If HIV RNA >100,000 copies/mL, do not use ABC/3TC plus (EFV or ATV/r)	TDF is associated with greater decrease in bone mineral density along with renal tubulopathy, urine phosphate wasting, and osteomalacia.
	Psychiatric illnesses	**Consider avoiding EFV-based regimens.**	EFV can exacerbate psychiatric symptoms and may be associated with suicidality.
	HIV-associated dementia (HAD)	**Avoid EFV-based regimens if possible.** Favor DRV-based or DTG-based regimen.	EFV neuropsychiatric effects may confound assessment of the effect of ART on improvement of symptoms associated with HAD. Theoretical CNS penetration advantage
	Narcotic replacement therapy required	**If patient receiving methadone, consider avoiding EFV-based regimen.** If EFV is used, an increase in methadone dose may be necessary.	EFV reduces methadone concentrations and may lead to withdrawal symptoms.
	High cardiac risk	**Consider avoiding ABC- and LPV/r -based regimens.**	Increased cardiovascular risk in some studies (see ABC discussion in this section)
	Hyperlipidemia	The Following ARV Drug Classes or Drugs have been Associated with Deleterious Effects on Lipids: • PI/r • ABC • EFV • EVG/c	TDF has been associated with beneficial lipid effects, thus it may be preferable to ABC
	Pregnancy	Refer to the Perinatal Antiretroviral Treatment Guidelines.	

Table 7. Antiretroviral Regimen Considerations as Initial Therapy based on Specific Clinical Scenarios (page 3 of 3)

Patient or Regimen Characteristics	Clinical Scenario	Consideration(s)	Rationale/Comments
Presence of Co-Infections	HBV infection	Use TDF/FTC (or TDF plus 3TC) whenever possible. If TDF is Contraindicated: • For treatment of HBV, use FTC or 3TC with entecavir or another drug active against HBV.	TDF, FTC, and 3TC are active against both HIV and HBV. 3TC- or FTC-associated HBV mutations can emerge rapidly when these drugs are used without another HBV-active agent.
	HCV treatment required	Refer to recommendations in the HIV/HCV co-infection section.	
	TB infection	If Rifampin is Used: • EFV-based regimens have the least drug-drug interactions. • If RAL is used, increase RAL dose to 800 mg BID. • Use DTG at 50 mg BID dose only in patients without selected INSTI mutations (refer to product label). If using a PI-based regimen, rifabutin should be used in place of rifampin in the TB regimen.	• Rifampin is a strong inducer of CYP3A4 and UGT1A1 enzymes, causing significant decrease in concentrations of PI, INSTI, and RPV. • Rifampin has a less significant effect on EFV concentration than on other NNRTIs, PIs, and INSTIs • Rifabutin is a less potent inducer and is a good option for patients receiving non-EFV-based regimens Refer to Tables 19a, b, d and e for dosing recommendations for rifamycins used with different ARV agents.

Key to Acronyms: 3TC = lamivudine; ABC = abacavir; ATV/r = ritonavir-boosted atazanavir; ARV = antiretroviral; c = cobicistat; CKD = chronic kidney disease; CrCl = creatinine clearance; DRV/r = ritonavir- boosted darunavir; DTG = dolutegravir; eGFR = estimated glomerular filtration rate; EFV = efavirenz; EVG/c/TDF/FTC = elvitegravir/cobicistat/tenofovir/emtricitabine; FDA = Food and Drug Administration; FTC = emtricitabine; HBV = hepatitis B virus; HCV = hepatitis C virus; INSTI = integrase strand transfer inhibitor; LPV/r = ritonavir-boosted lopinavir; NNRTI = non-nucleoside reverse transcriptase inhibitor; NRTI = nucleoside reverse transcriptase inhibitor; PI = protease inhibitor; PI/r = ritonavir-boosted protease inhibitor; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; TDF = tenofovir disoproxil fumarate

Selecting an Initial Antiretroviral Regimen

Initial therapy generally consists of two NRTIs combined with an INSTI, an NNRTI, or a pharmacologically boosted PI. All Recommended and Alternative regimens include the NRTI combination of TDF/FTC or ABC/3TC, each combination is available as fixed-dose combination tablets. The choice of NRTI combination is usually guided by differences between TDF and ABC because FTC and 3TC have few adverse events and have comparable efficacy. Considerations that are germane to deciding between TDF and ABC are summarized in Table 8 and in the section on Dual NRTI options (below).

Choosing Between an Integrase Strand Transfer Inhibitor-, A Non-Nucleoside Reverse Transcriptase Inhibitor-, or A Protease Inhibitor-Based Regimen

The choice between an INSTI, NNRTI, or PI as the third drug in an initial ARV regimen should be guided by the regimen's efficacy, genetic barrier to resistance, adverse effects profile, and convenience; the patient's co-morbidities; and concomitant medications and the potential for drug-drug interactions (See Tables 7 and 8 for guidance). The Panel's Recommended regimens as listed in Table 6 include an INSTI or DRV/r in combination

with 2 NRTIs. For most patients, an INSTI-containing regimen will be highly effective, have few adverse effects, and (with RAL and DTG) have no significant CYP 3A4-associated drug interactions. In addition, in the two head-to-head comparisons between DRV/r- and INSTI-containing regimens, the INSTI was better tolerated, with fewer treatment discontinuations.[4,6] For these reasons, all three currently available INSTIs are included among the Recommended regimens and, in general, should be selected for most patients. An exception is in those individuals with uncertain adherence or in whom treatment needs to begin before resistance testing results are available. In this context, DRV/r may have an important role given its high genetic barrier to resistance and low rate of treatment-emergent resistance during many years of clinical experience.

Alternative Regimens include either an NNRTI-based (EFV or rilpivirine [RPV]) or a PK-enhanced, PI-based (ATV/r, atazanavir/cobicistat [ATV/c], or darunavir/cobicistat [DRV/c]) regimen. Although the NNRTIs EFV or RPV are optimal choices for some patients, these drugs have low genetic barriers to resistance, especially in patients with suboptimal adherence. EFV has a long track record of widespread use in the United States and globally. Most EFV-based regimens have strong virologic efficacy, including in patients with high HIV RNA (except when EFV is used with ABC/3TC); however, the relatively high rate of CNS-related side effects makes the EFV-based regimen less tolerable than other regimens. RPV has fewer adverse effects than EFV, is available in the smallest coformulated single tablet, and has a favorable lipid profile. However, RPV has lower virologic efficacy in patients with high baseline HIV RNA (>100,000 copies/mL) and low CD4 count (< 200 cells/mm^3). ATV/r has demonstrated excellent virologic efficacy in clinical trials, and has relatively few metabolic adverse effects in comparison to other boosted PI regimens; however, recent clinical trial data showed that ATV/r had a higher rate of adverse effect-associated drug discontinuation with than the comparators (DRV/r and RAL). Thus, despite these favorable attributes, based on the above considerations, EFV-, RPV-, and ATV/r- containing regimens are no longer Recommended Regimens as initial therapy in all patients, and are listed as Alternatives. However, based on individual patient characteristics, some Alternative regimens may actually be the optimal regimen for some patients. Furthermore, patients who are doing well on EFV-, RPV-, and ATV/r- containing regimens should not necessarily be switched to other agents.

Choosing Among Different Drugs from an Antiretroviral Drug Class

The sections below provides clinicians with comparisons of different currently recommended ARV drugs within a drug class, including information related to the safety and virologic efficacy of different drugs based on clinical trial results and/or post-marketing data, special considerations to take into account, and the rationales for the Panel's recommendations.

Dual-Nucleoside Reverse Transcriptase Inhibitor Options A Part of Initial Combination Therapy

Summary

TDF/FTC and ABC/3TC are NRTI combinations commonly used for initial therapy. Table 6 provides recommendations and ratings for the individual regimens. These recommendations are based on the virologic potency and durability, short- and long-term toxicity, and dosing convenience of these drugs.

Clinical Trials Comparing Abacavir/Lamivudine to Tenofovir/Emtricitabine

Several randomized controlled trials in ART-naive participants compared ABC/3TC to TDF/FTC, each with the same[7-9] or a different third ARV drug (also see discussion in the DTG section).[10]

- The ACTG 5202 study, a randomized controlled trial in more than 1,800 participants, evaluated the efficacy and safety of ABC/3TC and TDF/FTC when each used in combination with either EFV or ATV/r.
- Treatment randomization was stratified on the basis of a screening HIV RNA level <100,000 copies/mL or ≥100,000 copies/mL. HLA B*5701 testing was not required before study entry.

- A Data Safety Monitoring Board recommended early termination of the ≥100,000 copies/mL stratification group because of a significantly shorter time to study-defined virologic failure in the ABC/3TC arm than in the TDF/FTC arm.[7] This difference in time to virologic failure between the arms was observed regardless of whether the third active drug was EFV or ATV/r.
- There was no difference between ABC/3TC and TDF/FTC in time to virologic failure for participants who had plasma HIV RNA <100,000 copies/mL at screening.[11]
- The ASSERT study compared open label ABC/3TC with TDF/FTC in 385 HLA B*5701-negative, ART-naive patients; all participants also received EFV. The primary study endpoint was renal safety of the regimens. At week 48, the proportion of participants with HIV RNA <50 copies/mL was lower among ABC/3TC-treated participants than among TDF/FTC-treated participants.[8]
- In the HEAT study, 688 participants received ABC/3TC or TDF/FTC in combination with once-daily LPV/r. Virologic efficacy was similar in the two study arms. In a subgroup analysis of patients with baseline HIV RNA ≥100,000 copies/mL, the proportion of participants who achieved HIV RNA <50 copies/mL at 96 weeks did not differ between the two regimens.[9]

Dual-Nucleoside Reverse Transcriptase Inhibitor Choices

Note: In alphabetical order.

Abacavir/Lamivudine

ABC plus 3TC has been studied in combination with EFV, several PIs, and DTG in ART-naive patients.[10,12-14]

Adverse Effects:

Hypersensitivity Reactions:

- Clinically suspected hypersensitivity reactions (HSRs) were observed in 5% to 8% of individuals who started ABC in clinical trials conducted before the use of HLA-B*5701 testing. The risk of HSRs is highly associated with the presence of the HLA-B*5701 allele.[15,16] HLA-B*5701 testing should precede use of ABC. ABC should not be given to patients who test positive for HLA-B*5701 and based on a positive test result, ABC hypersensitivity should be noted on a patient's allergy list. Patients who are HLA-B*5701 negative are far less likely to experience an HSR, but they should be counseled about the symptoms of the reaction. Patients who discontinue ABC because of a suspected HSR should never be re-challenged, regardless of their HLA-B*5701 status.

Cardiovascular Risk:

- An association between ABC use and myocardial infarction (MI) was first reported in the D:A:D study. This large, multinational observational study group found that recent (within 6 months) or current use of ABC was associated with an increased risk of MI, particularly in participants with pre-existing cardiac risk factors.[17,18]
- Since the D:A:D report, several studies have evaluated the relationship between ABC therapy and cardiovascular events. Some studies have found an association;[19-22] others, including an FDA meta-analysis of 26 randomized clinical trials that evaluated ABC, have not.[23-27]
- No consensus has been reached on the association between ABC use and MI risk or the mechanism for such an association.

Other Factors and Considerations:

- ABC/3TC is available as a co-formulated tablet and as a coformulated single-tablet regimen with DTG.
- ABC and 3TC are available separately in generic tablet formulations.

- ABC does not cause renal dysfunction and is an option for TDF in patients with underlying renal dysfunction or who are at risk for renal effects. No dosage adjustment is required in patients with renal dysfunction.

Panel's Recommendations:

- ABC should only be prescribed for patients who are HLA B*5701 negative.
- On the basis of clinical trial safety and efficacy data, experience in clinical practice, and the availability of ABC/3TC as a component of co-formulated products, the Panel classifies ABC/3TC plus DTG as a Recommended regimen **(AI)** (see discussion regarding DTG in this section regarding the clinical efficacy data for ABC/3TC plus DTG) .
- ABC/3TC use with EFV, ATV/r, or ATV/c is only recommended for patients with pre-treatment HIV RNA <100,000 copies/mL.
- ABC/3TC is a part of several Alternative or Other regimens when combined with another ARV drug. See Table 6 for more detailed recommendations on use of ABC/3TC with other drugs.
- ABC should be used with caution or avoided in patients with known high cardiovascular risk.

Tenofovir/Emtricitabine

TDF, with either 3TC or FTC, has been studied in combination with EFV, RPV, several boosted PIs, EVG/c, RAL, and DTG in randomized clinical trials.[28-37]

Adverse Effects:

- New onset or worsening renal impairment has been associated with TDF use.[38,39] Risk factors may include advanced HIV disease; longer treatment history; low body weight, especially in females;[40] and pre-existing renal impairment.[41]
  - Concomitant use of a PK-enhanced regimen (with a PI or EVG) can increase TDF concentrations; studies have suggested a greater risk of renal dysfunction when TDF is used in these regimens.[39,42-46]
- While initiation of all NRTI-containing regimens has been associated with a decrease in bone mineral density (BMD), the loss of BMD is greater with TDF-containing regimens. For example, in two randomized studies comparing TDF/FTC with ABC/3TC, participants receiving TDF/FTC experienced a significantly greater decline in bone mineral density than ABC/3TC-treated participants.[47,48] Following an early decline after ART initiation, BMD generally stabilizes.
- Cases of osteomalacia associated with proximal renal tubulopathy have been reported with the use of TDF.[49]

Other Factors and Considerations:

- TDF/FTC is available in fixed-dose drug combinations with EFV, EVG/c, and RPV, allowing the regimens to be administered as a single pill, given once daily.
- Renal function, urine glucose, and urine protein should be assessed before initiating treatment with TDF and periodically during treatment (see Laboratory Monitoring section). In patients who have pre-existing renal insufficiency (CrCl <60 mL/min),[50] TDF should generally be avoided. If TDF is used, dosage adjustment is required if the patient's CrCl falls below 50 mL/min (see Appendix B, Table 7 for dosage recommendations).
- Both TDF and FTC are active against HBV. In patients with HIV/HBV coinfection, TDF/FTC should be used as the NRTI pair of the ART regimen because the drugs have activity against both viruses (also see HIV/HBV Coinfection section).

Panel's Recommendations:

- On the basis of clinical trial safety and efficacy data, long-term experience in clinical practice, and the combination's availability as a component of co-formulated products, the Panel considers TDF/FTC as a Recommended NRTI combination for initial ART in treatment-naive patients when combined with DTG, EVG/c, RAL, or DRV/r. See Table 6 for recommendations regarding use of TDF/FTC with other drugs.
- TDF should be used with caution or avoided in patients with renal disease and osteoporosis.

Integrase Strand Transfer Inhibitor-Based Regimens

Summary

Three INSTIs—DTG, EVG, and RAL—are currently approved for HIV-infected, ARV-naive patients. DTG and EVG are currently available as components of one-tablet once daily complete regimens: DTG is coformulated with ABC/3TC; EVG is coformulated with a PK enhancer (COBI) and TDF/FTC. EVG is also available as a single agent designed to be used in combination with PI/r in ART-experienced patients, and is not recommended for use in treatment-naive patients.

Recommended Integrase Strand Transfer Inhibitor-Based Regimens

Note: In alphabetical order.

Dolutegravir

Efficacy in Clinical Trials:

The efficacy of DTG in treatment-naive patients has been evaluated in three fully powered clinical trials, including two randomized double-blinded clinical trials and one randomized open-label clinical trial. In these three trials, DTG-based regimens were non-inferior or superior to a comparator INSTI, NNRTI, or PI-based regimen. The primary efficacy endpoint in these clinical trials was the proportion of participants with plasma HIV RNA <50 copies/mL.

- The SPRING-2 trial compared DTG 50 mg once daily to RAL 400 mg twice daily, each in combination with investigator-selected NRTI ABC/3TC or TDF/FTC, in 822 participants. At week 96, DTG was non-inferior to RAL.[37]
- The SINGLE trial compared DTG 50 mg once daily plus ABC/3TC to EFV/TDF/FTC in 833 participants. At week 48, DTG was superior to EFV, primarily because the study treatment discontinuation rate was higher in the EFV arm than in the DTG arm.[10] At week 144, DTG plus ABC/3TC remained superior to EFV/TDF/FTC.[51]
- The FLAMINGO study, a randomized open-label clinical trial, compared DTG 50 mg once daily to DRV/r 800 mg/100 mg once daily, each in combination with investigator-selected ABC/3TC or TDF/FTC. At week 48, DTG was superior to DRV/r because of the higher rate of discontinuation in the DRV/r arm.[6,52] The difference in response rates favoring DTG was greater in patients with pre-treatment HIV RNA levels >100,000 copies/mL. At week 96, DTG remained superior to DRV/r.[53]

Adverse Effects:

- DTG is generally well tolerated. The most common adverse reactions of moderate to severe intensity with an incidence ≥2% in the clinical trials were insomnia and headache. Cases of hypersensitivity reactions were reported in <1% of trial participants.

Other Factors and Considerations:

- In treatment-naive patients, DTG is given once daily, with or without food.

- DTG decreases tubular secretion of creatinine without affecting glomerular function, with increases in serum creatinine observed within the first 4 weeks of treatment (mean increase in serum creatinine was 0.11 mg/dL after 48 weeks).
- DTG has few drug interactions. DTG increases metformin levels approximately two-fold; close monitoring for metformin adverse effects is advisable. Rifampin decreases DTG levels, therefore, an increase in dosing of DTG to 50 mg twice daily is required.
- DTG absorption may be reduced when the ARV is coadministered with polyvalent cations (see Drug Interaction section). DTG should be taken at least 2 hours before or 6 hours after cation-containing antacids or laxatives. Alternatively, DTG and supplements containing calcium or iron can be taken simultaneously with food.
- Treatment-emergent mutations that confer DTG resistance have not been reported in patients receiving DTG for initial therapy, which suggests that DTG has a higher genetic barrier to resistance than other INSTIs.

Panel's Recommendation:

- On the basis of clinical trial data, the Panel categorizes DTG in combination with either ABC/3TC or TDF/FTC as a Recommended regimen in ART-naive patients **(AI)**.

Elvitegravir

EVG is available as a component of a four-drug, fixed-dose combination product containing EVG, COBI, TDF, and FTC (EVG/c/TDF/FTC). COBI is a specific, potent CYP3A inhibitor that has no activity against HIV. It acts as a PK enhancer of EVG, which allows for once daily dosing of the combination.

Efficacy in Clinical Trials:

The efficacy of EVG/c/TDF/FTC in ARV-naive participants has been evaluated in two randomized, double-blind active-controlled trials.

- At 144 weeks, EVG/c/TDF/FTC was non-inferior to fixed-dose EFV/TDF/FTC.[54]
- EVG/c/TDF/FTC was also found to be non-inferior to a combination containing ATV/r plus TDF/FTC.[55]

Adverse Effects:

- The most common adverse events reported with EVG/c/TDF/FTC were diarrhea, nausea, upper respiratory infection, and headache.[54,55]

Other Factors and Considerations:

- EVG is metabolized primarily by CYP3A enzymes; as a result, CYP3A inducers or inhibitors may alter EVG concentrations.
- Because COBI inhibits CYP3A, it interacts with a number of medications that are metabolized by this enzyme (see Drug-Drug Interactions section).[56]
- EVG plasma concentrations are lower when the ARV is administered simultaneously with polyvalent cation-containing antacids or supplements (see Drug Interaction section). Separate EVG/cobi/TDF/FTC and polyvalent antacid administration by at least 2 hours; administer polyvalent cation-containing supplements at least 2 hours before or 6 hours after EVG dosing.
- COBI inhibits active tubular secretion of creatinine, resulting in increases in serum creatinine and a reduction in estimated CrCl without reducing glomerular function.[57] Patients with a confirmed increase in serum creatinine greater than 0.4 mg/dL from baseline while taking EVG/c/TDF/FTC should be closely monitored and evaluated for evidence of TDF-related proximal renal tubulopathy.[46]

- EVG/c/TDF/FTC is **not recommended** for patients with pre-treatment estimated CrCl <70 mL/min.[46]
- At the time of virologic failure, INSTI-associated mutations were detected in some EVG/c/TDF/FTC-treated patients whose therapy failed.[54,55] These mutations conferred cross-resistance to RAL, with most retaining susceptibility to DTG.

Panel's Recommendation:

- On the basis of the above factors, the Panel classifies EVG/c/FTC/TDF as a Recommended regimen in ART-naive patients **(AI)**.

Raltegravir

RAL was the first INSTI approved for use in both ARV-naive and ARV-experienced patients.

Efficacy in Clinical Trials:

The efficacy of RAL (with either TDF/FTC or ABC/3TC) as initial therapy has been evaluated in two randomized, double-blinded, controlled clinical trials, and a third open-label randomized trial.

- STARTMRK compared RAL 400 mg twice daily to EFV 600 mg once daily, each in combination with TDF/FTC. RAL was non-inferior to EFV at 48 weeks.[33] RAL was superior to EFV at 4 and 5 years,[36,58] in part because of more frequent discontinuations due to adverse events in the EFV group than in the RAL group.
- The SPRING-2 trial compared DTG 50 mg once daily to RAL 400 mg twice daily, each in combination with investigator-selected ABC/3TC or TDF/FTC. At week 96, DTG was non-inferior to RAL.
- The SPRING-2 trial also provided non-randomized data on the efficacy of RAL plus ABC/3TC. In this trial, 164 participants (39 and 125 with baseline viral loads ≥100,000 copies/mL and <100,000 copies/mL, respectively) received RAL in combination with ABC/3TC. After 96 weeks, there was no difference in virologic response between the ABC/3TC and TDF/FTC groups when RAL was given as the third drug.[37]
- ACTG A5257, a large randomized open-label trial, compared 3 NNRTI-sparing regimens containing RAL, ATV/r, or DRV/r, each given with TDF/FTC. At week 96, all 3 regimens had similar virologic efficacy, but RAL was superior to both ATV/r and DRV/r for the combined endpoints of virologic efficacy and tolerability. Lipids increased more in participants in the PI/r arms than in the RAL arm, and bone mineral density decreased to a greater extent in participants in the PI/r arms than in participants in the RAL arm.[4]

Adverse Effects:

- RAL use has been associated with creatine kinase elevations. Myositis and rhabdomyolysis have been reported.
- Rare cases of severe skin reactions and systemic hypersensitivity reactions in patients who received RAL have been reported during post-marketing surveillance.[59]

Other Factors and Considerations:

- RAL must be administered twice daily—a potential disadvantage when comparing RAL-based treatment with other Recommended regimens.
- Coadministration of RAL with aluminum and/or magnesium-containing antacids can reduce absorption of RAL and is not recommended. Raltegravir may be coadministered with calcium carbonate-containing antacids. Polyvalent cation-containing supplements may also reduce absorption of RAL; thus, RAL should be given at least 2 hours before or 6 hours after cation-containing supplements.

- RAL has a lower genetic barrier to resistance than RTV-boosted PIs and DTG.

Panel's Recommendations:

- On the basis of these data and long-term clinical experience with RAL, the Panel considers RAL plus TDF/FTC as a Recommended regimen in ARV-naive patients **(AI)**.
- Because few patients have received RAL plus ABC/3TC in clinical trials or practice and there has not been a randomized trial comparing ABC/3TC plus RAL to TDF/FTC plus RAL, the Panel categorizes RAL plus ABC/3TC as an Other therapy **(BII)**.

Non-Nucleoside Reverse Transcriptase Inhibitor-Based Regimens

Summary

Five NNRTIs (delavirdine [DLV], EFV, etravirine [ETR], nevirapine [NVP], and RPV) are currently FDA approved.

NNRTI-based regimens have demonstrated virologic potency and durability. The major disadvantages of currently available NNRTIs are the prevalence of NNRTI-resistant viral strains in ART-naive patients60 and the drugs' low genetic barrier for the development of resistance. Resistance testing should be performed to guide therapy selection for ART-naive patients (see Drug-Resistance Testing). High-level resistance to all NNRTIs (except ETR) may occur with a single mutation; within-class cross-resistance is common. In RPV-treated patients, the presence of RPV resistance mutations at virologic failure may confer cross resistance to other NNRTIs, including ETR.[61,62]

Efavirenz

EFV is an NNRTI approved for use in combination with 2-NRTIs for ART-naive patients.

Efficacy in Clinical Trials:

Large randomized, controlled trials and cohort studies in ART-naive patients have demonstrated potent and durable viral suppression in patients treated with EFV plus two NRTIs. In clinical trials, EFV-based regimens in ART-naive patients have demonstrated superiority or non-inferiority to several comparator regimens.

- In ACTG 5142, EFV was superior to LPV/r, although drug resistance was more common after EFV failure than after LPV/r failure.[63]
- In the 2NN study, compared to EFV, NVP did not meet non-inferiority criteria.[64]
- In ACTG 5202, EFV was comparable to ATV/r when each was given with either TDF/FTC or ABC/3TC.[65]
- In the ECHO and THRIVE studies, EFV was non-inferior to RPV, with less virologic failure but more discontinuations due to adverse events. The virologic advantage of EFV was most notable in participants with pre-ART viral loads >100,000 copies/mL, and NRTI and NNRTI resistance was more frequent with RPV failure.[66]
- In the GS 102 study, EFV/TDF/FTC was non-inferior to EVG/c/TDF/FTC.[54]

More recently, some regimens have demonstrated superiority to EFV, based primarily on fewer discontinuations because of adverse events:

- In the SINGLE trial, a DTG-based regimen was superior to EFV at the primary endpoint of viral suppression at Week 48.[10]
- In the STARTMRK trial, RAL was non-inferior to EFV at 48 weeks.[33] RAL was superior to EFV at 4 and

5 years,[36,58] in part because of more frequent discontinuations due to adverse events in the EFV group than in the RAL group.

- In the open-label STaR trial, participants with baseline viral loads ≤100,000 copies/mL had higher rates of treatment success on RPV than on EFV.[67]

A recent multinational randomized placebo-controlled trial compared two once daily doses of EFV (combined with TDF/FTC): EFV 600 mg (standard dose) versus EFV 400 mg (reduced dose). At 48 weeks, EFV 400 mg was non-inferior to EFV 600 mg for rate of viral suppression.[68] Study drug-related adverse events were less frequent in the EFV 400 mg group than in the 600 mg group. Although there were fewer self-reported CNS events in the 400 mg group, the two groups had similar rates of psychiatric events. Unlike the 600 mg dose of EFV, the 400 mg dose is not approved for initial treatment and is not co-formulated as a component of a single pill regimen.

Adverse Effects:

- EFV can cause CNS side effects, such as abnormal dreams, dizziness, headache, and depression, which resolve over a period of days to weeks in most patients. However, more subtle, long-term neuropsychiatric effects can occur. A recent analysis of 4 AIDS Clinical Trial Group (ACTG) comparative trials showed a higher rate of suicidality (i.e., reported suicidal ideation or attempted or completed suicide) among EFV-treated patients than among patients taking comparator regimens.[5] This association, however, was not found in analyses of two large observational cohorts.[69,70]
- EFV may cause elevation in LDL cholesterol and triglycerides.

Other Factors and Considerations:

- EFV is formulated both as a single-drug tablet and in a fixed-dose combination tablet of EFV/TDF/FTC that allows for once daily dosing.
- EFV is a substrate of CYP3A4 and an inducer of CYP3A4 and 2D6 and therefore may potentially interact with other drugs using the same pathways.
- EFV has been associated with CNS birth defects in non-human primates, and cases of neural tube defects have been reported after first trimester exposure in humans.[71] Alternative regimens should be considered in women who are planning to become pregnant or who are sexually active and not using effective contraception. Because the risk of neural tube defects is restricted to the first 5 to 6 weeks of pregnancy, before pregnancy is usually recognized, a suppressive EFV-based regimen can be continued in pregnant women who present for antenatal care in the first trimester, or may be initiated after the first trimester (see Perinatal Guidelines).

Panel's Recommendations:

- Given the availability of regimens with fewer treatment-limiting adverse events with non-inferior or superior efficacy, the Panel classifies EFV/TDF/FTC as an Alternative regimen for ART-naive patients **(BI)**.
- Given virologic and pharmacogenetic parameters that limit its use in some patients, the Panel recommends EFV with ABC/3TC as an Other regimen, and **only** for patients with a pre-ART viral load <100,000 copies/mL and negative HLA B*5701 status (see discussion in ABC/3TC section) **(CI)**.
- EFV at a reduced dose has not been studied in the U.S. population. The Panel cannot recommend use of reduced dose EFV until further data to support its use in the U.S. population are available.

Rilpivirine

RPV is an NNRTI approved for use in combination with NRTIs for ART-naive patients with pre-treatment

viral loads <100,000 copies/mL.

Efficacy in Clinical Trials:

Two Phase 3 randomized, double-blinded clinical trials, ECHO and THRIVE, compared RPV and EFV, each combined with 2 NRTIs.[66] At 96 weeks, the following findings were reported:

- RPV was non-inferior to EFV overall.
- Among participants with a pre-ART viral load >100,000 copies/mL, more RPV-treated than EFV-treated participants experienced virologic failure. Moreover, in this subgroup of participants with virologic failure, NNRTI and NRTI resistance was more frequently identified in those treated with RPV.
- Among the RPV-treated participants, the rate of virologic failure was greater in those with pre-treatment CD4 counts <200 cells/mm^3 than in those with CD4 counts ≥200 cells/mm^3.

STaR, a Phase 3b, open-label study, compared the fixed-dose combinations of RPV/TDF/FTC and EFV/TDF/FTC in 786 treatment-naive patients. At 96 weeks, the following key findings were reported:[67]

- RPV was non-inferior to EFV overall.
- RPV was superior to EFV in patients with pre-ART viral loads ≤100,000 copies/mL and non-inferior in those with pre-ART viral loads >100,000 copies/mL. In patients with pre-ART viral loads >500,000 copies/mL., virologic failure was more common in RPV-treated patients than in EFV-treated patients.
- At 48 weeks, NRTI and NNRTI resistance occurred in 2% and 1% of RPV- and EFV-treated patients, respectively, with viral loads ≤100,000; in 5% and 0% of RPV- and EFV-treated patients, respectively, with viral loads 100,000 to 500,000; and in 19% and 4% of RPV- and EFV-treated patients, respectively, with viral loads >500,000 copies/mL.

Adverse Effects:

- RPV is generally well tolerated. In the ECHO, THRIVE, and STaR trials, fewer CNS adverse events (e.g., abnormal dreams, dizziness, psychiatric side effects), skin rash, and dyslipidemia were reported in the RPV arms than the EFV arms, and fewer patients in the RPV arms discontinued therapy due to adverse events.

Other Factors and Considerations:

- RPV is formulated both as a single-drug tablet and in a fixed-dose combination tablet with TDF/FTC. Among available single pill regimens, it is the smallest tablet.
- RPV/TDF/FTC is given as a once daily regimen, and must be administered with a meal (at least 400 kcal).
- The oral drug absorption of RPV can be significantly reduced in the presence of acid-lowering agents. RPV is contraindicated in patients who are receiving proton pump inhibitors, and should be used with caution in those receiving H2 antagonists or antacids (see Drug Interaction section for dosing recommendations).
- RPV is primarily metabolized in the liver by CYP3A enzyme; its plasma concentration may be affected in the presence of CYP3A inhibitors or inducers (see Drug Interaction section).
- At higher than the approved dose of 25 mg, RPV may cause QTc interval prolongation. RPV should be used with caution when coadministered with a drug known to increase the risk of Torsades de Pointes.

Panel's Recommendations:

- Given the availability of other effective regimens that do not have virologic and immunologic

prerequisites to initiate treatment, the Panel recommends RPV/TDF/FTC as an Alternative regimen.

- Use of RPV with TDF/FTC should be limited to ART-naive patients with pre-treatment viral load <100,000 copies/mL and CD4 count >200 cells/mm^3 **(BI)**.
- Data on RPV with ABC/3TC are insufficient to consider recommending this regimen as a Recommended, Alternative, or Other regimen.

Protease Inhibitor-Based Regimens

Summary

FDA-approved PIs include ATV, ATV/c, DRV, DRV/c, fosamprenavir (FPV), indinavir (IDV), LPV/r, nelfinavir (NFV), ritonavir (RTV), saquinavir (SQV), and tipranavir (TPV). PI-based regimens (particularly with PK enhancement) have demonstrated virologic potency and (for those with RTV boosting) durability in treatment-naive patients and a high genetic barrier to resistance. Few or no PI mutations are detected when a patient's first PI-based regimen fails, which is not the case with NNRTI- and some INSTI-based regimens.[72,73] All PIs (PK enhanced by either RTV or COBI) inhibit the cytochrome (CYP) 450 3A isoenzyme, which may lead to significant drug-drug interactions (see Drug Interactions section). Each PI has specific characteristics related to its virologic potency, adverse effects profile, and PK properties. The characteristics of Recommended and Alternative PIs are listed in Table 8 and Appendix B, Table 3.

A number of metabolic abnormalities, including dyslipidemia and insulin resistance, have been associated with PI use. The currently available PIs differ in their propensity to cause these metabolic complications, which also depends on the dose of RTV used as a pharmacokinetic enhancing agent. Two large observational cohort studies suggest that LPV/r, IDV, FPV, or FPV/r may be associated with increased rates of MI or stroke.[18,24] This association was not seen with ATV.[74] Because of the limited number of patients receiving DRV/r, this boosted-PI was not included in the analysis of the two studies.

Recommended PIs for use in ART-naive patients should have proven virologic efficacy, once daily dosing, a low pill count, and good tolerability. On the basis of these criteria, the Panel considers once-daily DRV/r plus TDF/FTC as a Recommended PI. In a large, randomized controlled trial comparing DRV/r, ATV/r, and RAL, all in combination with TDF/FTC, all three regimens achieved similar virologic suppression rates; however, the proportion of patients who discontinued their assigned treatment because of adverse effects was greater in the in the ATV/r arm than in the other two arms.[4] Because of its higher rate of adverse effects, the Panel now classifies ATV/r plus TDF/FTC as an Alternative regimen **(BI)**. ATV/c- and DRV/c-based regimens are considered Alternative PI regimens for the reasons detailed below.

LPV/r has twice the daily dose of RTV as other PI/r and is associated with more metabolic complications and gastrointestinal side effects than PK-enhanced ATV or DRV. LPV/r remains as an Other PI/r because it is currently the only PI co-formulated with RTV and it has extensive experience in clinical trials and practice. Compared to other PIs, FPV/r, unboosted ATV, and SQV/r have disadvantages such as greater pill burden, lower efficacy, or increased toxicity, and thus are no longer included as an option for initial therapy. Nonetheless, patients who are doing well on regimens containing these PIs should not necessarily be switched to other agents.

Recommended Protease Inhibitor-Based Regimen

Darunavir/Ritonavir

Efficacy in Clinical Trials:

- The ARTEMIS study compared DRV/r (800/100 mg once daily) with LPV/r (800/200 mg once daily or 400/100 mg twice daily), both in combination with TDF/FTC, in a randomized, open-label, non-

inferiority trial. DRV/r was non-inferior to LPV/r at week 48,[31] and superior at week 192.[75] Among participants with baseline HIV RNA levels >100,000 copies/mL, virologic response rates were lower in the LPV/r arm than in the DRV/r arm.

- The FLAMINGO study compared DRV/r with DTG, each in combination with two NRTIs, in 488 ART-naive participants. The rate of virologic suppression at week 48 was significantly greater among those who received DTG than in those who received DRV/r, largely because of more drug discontinuations in the DRV/r group.[6]
- A small retrospective study that followed participants for 48 weeks suggested that DRV/r plus ABC/3TC may be effective in treatment-naive patients.[76]
- The ACTG A5257 study showed similar virologic efficacy for DRV/r, ATV/r, and RAL, but more participants in the ATV/r group discontinued randomized treatment because of adverse events.[4]

Adverse Effects:

- In the ARTEMIS Study, grades 2 to 4 adverse events, primarily diarrhea, were seen less frequently in DRV/r recipients than in LPV/r recipients.
- Patients starting DRV/r may develop a skin rash, which is usually mild-to-moderately severe and self-limited. Treatment discontinuation is necessary on rare occasions when severe rash with fever or elevated transaminases occur.

Other Factors and Considerations:

- DRV/r is administered once daily with food in treatment-naive patients.
- DRV has a sulfonamide moiety, and should be used with caution in patients with severe sulfonamide allergies. In clinical trials, the incidence and severity of rash were similar in participants who did or did not have a history of sulfonamide allergy. Most patients with sulfonamide allergy are able to tolerate DRV.
- DRV/r is a potent CYP3A4 inhibitor, and may lead to significant interactions with other medications metabolized through this same pathway (see Drug Interactions section).

Panel's Recommendation:

- On the basis of efficacy and safety data from clinical trials and clinical experience, the Panel classifies DRV/r with TDF/FTC as a Recommended regimen **(AI)**. DRV/r with ABC/3TC is considered an Alternative regimen because there are fewer studies to support its use **(BII)**.

Alternative Protease Inhibitor-Based Regimens

Atazanavir/Ritonavir or Atazanavir/Cobicistat

Efficacy in Clinical Trials:

- The CASTLE study compared once-daily ATV/r (300/100 mg) with twice-daily LPV/r (400/100 mg), each in combination with TDF/FTC. In this open-label, non-inferiority study, the 2 regimens showed similar virologic and CD4 responses at 48 weeks[30] and at 96 weeks.[77]
- The ACTG A5202 study compared open-label ATV/r and EFV, each given in combination with placebo-controlled TDF/FTC or ABC/3TC. Efficacy was similar in the ATV/r and EFV groups.[65] In a separate analysis, women assigned to ATV/r were found to have a higher risk of virologic failure than women assigned to EFV or men assigned to ATV/r.[78]
- In a study comparing ATV/r plus TDF/FTC to EVG/c/TDF/FTC, virologic suppression rates through 144 weeks were similar in the two groups.[55]

- ACTG A5257, a large randomized open-label trial, compared ATV/r with DRV/r or RAL, each given with TDF/FTC. At week 96, all 3 regimens had similar virologic efficacy. However, a significantly higher proportion of patients in the ATV/r arm discontinued randomized treatment because of adverse events, mostly for elevated indirect bilirubin/jaundice or gastrointestinal toxicities. Lipid changes in participants in the ATV/r and DRV/r arms were similar. Bone mineral density decreased to a greater extent in participants in the ATV/r and DRV/r arms than in participants in the RAL arm.[4]
- The Gilead Study 114 enrolled 692 treatment-naive patients. All patients received TDF/FTC and ATV, and were randomized to receive either RTV or COBI as PK enhancers. Both RTV and COBI were given as a separate pill with matching placebos. At 48 weeks, similar percentages of patients achieved virologic suppression, had adverse events, and changes in serum creatinine and indirect bilirubin levels.[79]

Adverse Effects:

- The main adverse effect associated with ATV/c or ATV/r is reversible indirect hyperbilirubinemia, with or without jaundice or scleral icterus, but without concomitant hepatic transaminase elevations.
- Nephrolithiasis,[80-82] nephrotoxicity,[83] and cholelithiasis[84] have also been reported in patients who received ATV, with or without RTV.
- Both ATV/c and ATV/r can cause gastrointestinal side effects including diarrhea.

Other Factors and Considerations:

- ATV/c and ATV/r are dosed once daily and with food.
- ATV requires acidic gastric pH for dissolution. As a result, concomitant use of drugs that raise gastric pH (e.g., antacids, H2 antagonists, and particularly PPIs) may impair absorption of ATV. Table 19a provides recommendations for use of ATV/c or ATV/r with these agents.
- ATV/c and ATV/r are potent CYP3A4 inhibitors and may have significant interactions with other medications metabolized through this same pathway (see Drug Interaction section).
- ATV/c coadministered with TDF/FTC **is not recommended** for patients with CrCl <70 mL/min.

Panel's Recommendations:

- On the basis of clinical trial safety and efficacy data, the Panel classifies ATV/r and ATV/c plus TDF/FTC as Alternative regimens for ART-naive patients regardless of pre-treatment HIV RNA **(BI)**.
- Because of an inferior virologic response seen in patients with a high baseline viral load, the Panel recommends ATV/r or ATV/c plus ABC/3TC as Other regimens. Use of the regimens should be limited to patients with pre-ART HIV RNA <100,000 copies/mL **(CI)**.
- As noted earlier, ATV/c plus TDF/FTC **is not recommended** for patients with CrCl <70 mL/min.

Darunavir/Cobicistat

A combination of (DRV 800 mg with COBI 150 mg) is bioequivalent to (DRV 800 mg with RTV 100 mg) in healthy volunteers.[85]

Efficacy in Clinical Trial:

- In a single arm trial of treatment-naive (94%) and treatment-experienced (6%) patients, the co-formulated DRV/c 800 mg/150 mg tablet was evaluated in combination with investigator-selected NRTI/NtRTI (99% of participants were given TDF/FTC). At week 48, 81% of participants achieved HIV RNA <50 copies/ml; 5% of participants discontinued treatment because of adverse events.[86]

Adverse Effects:

- In the single arm trial, the most common treatment emergent adverse events were diarrhea, nausea, and headache.

Other Factors:

- (DRV 800 mg and COBI 150 mg) is available as a co-formulated tablet.
- Coadministration with TDF is not recommended in patients with CrCl <70 mL/min.

Panel's Recommendation:

- On the basis of the bioequivalence study and the single arm trial, the Panel recommends DRV/c plus TDF/FTC **(BII)** and DRV/c plus ABC/3TC **(BIII)** as Alternative Regimens for ART-naive patients.
- As noted earlier, DRV/c plus TDF/FTC **is not recommended** for patients with CrCl <70 mL/min.

Other Protease Inhibitor-Based Regimens

Lopinavir/Ritonavir

Efficacy in Clinical Trials:

- A 7-year follow-up study of LPV/r and 2 NRTIs showed sustained virologic suppression in patients who were maintained on the originally assigned regimen.[87]
- Results of clinical trials that compared LPV/r with ATV/r and DRV/r are discussed above, demonstrating more favorable safety and tolerability of ATV/r and DRV/r.
- In the ACTG 5142 study, at 96 weeks, a smaller proportion of patients who received LPV/r plus 2 NRTIs achieved viral suppression (HIV RNA <50 copies/mL) than those who received EFV plus 2 NRTIs. However, the CD4 cell response was greater with LPV/r, and there was less drug resistance associated with virologic failure.[63]
- In the GARDEL study, patients were randomized to 3TC or a 2 NRTI combination, with all study participants receiving LPV/r. The results demonstrated non-inferiority of the two strategies.[88]

Adverse Effects:

- In addition to diarrhea, major adverse effects of LPV/r include insulin resistance and hyperlipidemia, especially hypertriglyceridemia; these require pharmacologic management in some patients.
- In the D:A:D and French observational cohorts, cumulative use of LPV/r was associated with a slightly increased risk of MI.[18,24]
- In another D:A:D study, LPV/r use was also reported as an independent predictor of chronic renal impairment.[83]

Other Factors and Considerations:

- LPV/r must be boosted with 200 mg/day of RTV and is associated with higher rates of GI side effects and hyperlipidemia than ATV/r and DRV/r, both of which are boosted with 100 mg/day of RTV.
- LPV/r can be given once or twice daily.
- Once-daily dosing should not be used in pregnant women, especially during the third trimester, when LPV levels are expected to decline (see Perinatal Guidelines).
- LPV/r is currently the only available PI co-formulated with RTV.

Panel's Recommendation:

- On the basis of greater potential for adverse events and higher RTV dose and pill burden than ATV/r and DRV/r, the Panel recommends LPV/r plus TDF/FTC or LPV/r plus ABC/3TC as Other regimens **(CI)**.

Other Antiretroviral Regimens for Initial Therapy When Abacavir or Tenofovir Cannot Be Used

All currently Recommended and Alternative regimens consist of two NRTIs plus a third active drug. This strategy, however, may not be possible or optimal in all patients. In some situations it may be necessary to avoid both TDF and ABC, such as in the case of a patient with pre-existing renal disease who is HLA B*5701 positive or at high risk of cardiovascular disease.

Based on these concerns, several clinical studies have evaluated strategies using initial regimens that avoid 2 NRTIs or the NRTI drug class altogether. Many of these studies were not fully powered to permit comparisons, and regimens from these studies will not be discussed further. However, there are now sufficient data on two regimens (DRV/r plus RAL and LPV/r plus 3TC) to warrant including them as options when ABC or TDF cannot be used.

Darunavir/Ritonavir plus Raltegravir

In the NEAT/ANRS 143 study, 805 treatment-naive participants were randomized to receive either twice-daily RAL or once-daily TDF/FTC, both with DRV/r (800 mg/100 mg once daily). At week 96, DRV/r plus RAL was non-inferior to DRV/r plus TDF/FTC based on the primary endpoint of proportion of patients with virologic or clinical failure. Among those with baseline CD4 cell count <200/mm^3, however, there were more failures in the two-drug arm; a trend towards more failure was also observed for those with pre-treatment HIV RNA ≥100,000 copies/mL.[89] High rates of virologic failure in patients with HIV RNA >100,000 copies/mL were also seen in two smaller studies of DRV/r plus RAL.[90,91]

On the basis of these study results, the Panel recommends that DRV/r plus RAL be considered for use only in patients with HIV RNA <100,000 copies/uL and CD4 cell counts >200/mm^3, and only in those patients who cannot take either TDF or ABC **(CI)**.

Lopinavir/Ritonavir plus Lamivudine

In the GARDEL study, 426 ART-naive patients were randomized to receive twice-daily LPV/r plus either open-label 3TC (twice daily) or two NRTIs selected by the study investigators. At 48 weeks, a similar number of patients in each arm had HIV RNA <50 copies/mL, meeting the study's non-inferiority criteria. The LPV/r plus 3TC regimen was better tolerated than the LPV/r plus 2 NRTI regimen.[88]

An important limitation of the GARDEL study is the use of LPV/r, twice daily dosing, and relatively high pill burden (total of 6 tablets per day). LPV/r is not considered a Recommended or Alternative initial PI because of its unfavorable adverse event and pill burden characteristics as compared to pharmacokinetically enhanced ATV and DRV. Given the above limitations, the Panel recommends that LPV/r plus 3TC be considered for use only in patients who cannot take either TDF or ABC **(CI)**.

In summary, the aggregate results from these two fully powered studies with NRTI-limiting regimens demonstrate that these initial strategies have significant deficiencies as compared to standard-of-care treatment approaches, in particular, disadvantages related to pill burden or dosing frequency. In addition, there are concerns about the virologic efficacy of DRV/r plus RAL in patients with high viral loads or low CD4 cell counts. The Panel only recommend LPV/r plus 3TC or DRV/r plus RAL for initial therapy when both TDF and ABC are contraindicated. Other less well-tested NRTI-limiting combinations are not recommended.

Table 8. Advantages and Disadvantages of Antiretroviral Components Recommended as Initial Antiretroviral Therapy (page 1 of 3)

Note: All drugs within an ARV class are listed in alphabetical order.

ARV Class	ARV Agent(s)	Advantages	Disadvantages
Dual-NRTI	ABC/3TC	• Co-formulated with DTG as an STR	• Inferior virologic responses in patients with baseline HIV RNA ≥100,000 copies/mL when given with EFV or ATV/r as compared with TDF/FTC in ACTG 5202 study. This difference was not seen when ABC/3TC was used in combination with DTG. • May cause life-threatening hypersensitivity reaction in patients positive for the HLA B*5701 allele. As a result, HLA-B*5701 testing required before use • ABC use has been associated with cardiac events in some but not all observational studies.
	TDF/FTC	• Co-formulated with EFV, EVG/c, and RPV as a STR • Active against HBV; recommended dual-NRTI for HIV/HBV co-infected patients • Better virologic responses than with ABC/3TC in patients with baseline viral load ≥100,000 copies/mL when combined with ATV/r or EFV	• Renal toxicity, including proximal tubulopathy and acute or chronic renal insufficiency • Decreases BMD more than other NRTI combinations
INSTI	DTG	• Once-daily dosing • May have higher barrier to resistance than EVG or RAL • Co-formulated with ABC and 3TC as an STR • No food requirement • No CYP3A4 interactions	• Oral absorption can be reduced by simultaneous administration with products containing polyvalent cations (e.g., Al, Ca, or Mg-containing antacids or supplements, or multivitamin tablets with minerals). See dosing recommendations in Table 19d. • Inhibits renal tubular secretion of Cr and can increase serum Cr, without affecting glomerular function • UGT substrate; potential for drug interactions (see Table 19d)
	EVG/c	• Co-formulated as a STR with TDF/FTC • Once daily dosing • Compared with ATV/r, causes smaller increases in total and LDL cholesterol	• EVG/c/TDF/FTC is only recommended for patients with baseline CrCl ≥70 mL/min; therapy should be discontinued if CrCl decreases to <50 mL/min. • COBI is a potent CYP3A4 inhibitor, which can result in significant interactions with CYP3A substrates. • Oral absorption of EVG can be reduced by simultaneous administration with antacids containing polyvalent cations, such as Al, Ca, or Mg (see dosing recommendations in Table 19d). • COBI inhibits active tubular secretion of Cr and can increase serum Cr, without affecting renal glomerular function. • May have lower genetic barrier to resistance than boosted PI- or DTG-based regimens • Food requirement
	RAL	• Compared to other INSTIs, has longest post marketing experience • No food requirement • No CYP3A4 interactions	• Twice-daily dosing • May have lower genetic barrier to resistance than boosted PI- or DTG-based regimens • Increases in creatine kinase, myopathy, and rhabdomyolysis have been reported. • Rare cases of severe hypersensitivity reactions (including SJS and TEN) have been reported. • Oral absorption of RAL can be significantly impaired by antacids containing Al or Mg; coadministration is not recommended (see dosing recommendations in Table 19d). • UGT substrate; potential for drug interactions (see Table 19d)

Table 8. Advantages and Disadvantages of Antiretroviral Components Recommended as Initial Antiretroviral Therapy (page 2 of 3)

ARV Class	ARV Agent(s)	Advantages	Disadvantages
NNRTIs	EFV	• Once-daily dosing • Co-formulated with TDF/FTC • Long term clinical experience • EFV-based regimens (except for EFV plus ABC/3TC) have well documented efficacy in patients with high HIV RNA	• Transmitted resistance more common than with PIs and INSTIs • Short-and long-term neuropsychiatric (CNS) side effects, including depression and, in some studies, suicidality • Teratogenic in non-human primates; avoid use in women who are trying to conceive or who are sexually active and not using contraception • Dyslipidemia • Greater risk of resistance at the time of treatment failure than with PIs • Skin rash • Potential for CYP450 drug interactions (see Tables 18, 19b, and 20a) • Should be taken on an empty stomach (food increases drug absorption and CNS toxicities)

	RPV	• Once-daily dosing
		• Co-formulated with TDF/FTC
		• Smaller pill size than co-formulated DTG/ABC/3TC, EFV/TDF/FTC, and EVG/c/TDF/FTC
		• Compared with EFV:
		  • Fewer discontinuations for CNS adverse effects
		  • Fewer lipid effects
		  • Fewer rashes
			• Not recommended in patients with pre-ART HIV RNA >100,000 copies/mL or CD4 count <200 cells/mm^3 because of higher rate of virologic failure in these patients
			• Transmitted resistance more common than with PIs and INSTIs
			• More NNRTI-, TDF-, and 3TC-associated mutations at virological failure than with regimen containing EFV and two NRTIs
			• Potential for CYP450 drug interactions (see Tables 18, 19b, and 20a)
			• Meal requirement (>390 kcal)
			• Requires acid for adequate absorption
			  • Contraindicated with PPIs
			  • Use with H2 antagonists or antacids with caution (see Table 19a for detailed dosing information).
			• Use with caution when coadministered with a drug known to increase the risk of torsades de pointes.

PIs	ATV/c or ATV/r	• Once-daily dosing • Higher genetic barrier to resistance than NNRTIs, EVG, and RAL • PI resistance at the time of treatment failure uncommon with pharmacologically-boosted PIs • ATV/c and ATV/r have similar virologic activity and toxicity profiles	• Commonly causes indirect hyperbilirubinemia, which may manifest as scleral icterus or jaundice • Food requirement • Absorption depends on food and low gastric pH (see Table 20a for interactions with H2 antagonists, antacids, and PPIs) • Nephrolithiasis, cholelithiasis, nephrotoxicity • GI adverse effects • CYP3A4 inhibitors and substrates: potential for drug interactions (see Tables 18 and 19a)
	ATV/c-specific consid-erations	• Co-formulated tablet	• COBI inhibits active tubular secretion of Cr and can increase serum Cr, without affecting renal glomerular function • Coadministration with TDF is not recommended in patients with CrCl <70 mL/min • Less long term clinical experience than for ATV/r • COBI is a potent CYP3A4 inhibitor, which can result in significant interactions with CYP3A substrates.

Table 8. Advantages and Disadvantages of Antiretroviral Components Recommended as Initial Antiretroviral Therapy (page 3 of 3)

ARV Class	ARV Agent(s)	Advantages	Disadvantages
PIs	**DRV/c or DRV/r**	• Once-daily dosing • Higher genetic barrier to resistance than NNRTIs, EVG, and RAL • PI resistance at the time of treatment failure uncommon with pharmacokinetically-boosted PIs	• Skin rash • Food requirement • GI adverse effects • CYP3A4 inhibitors and substrates: potential for drug interactions (see Tables 18 and 19a)
	DRV/c-specific consid-erations	• Co-formulated tablet	• Less long-term clinical experience than for DRV/r • COBI inhibits active tubular secretion of Cr and can increase serum Cr, without affecting renal glomerular function • Co-administration with TDF is not recommended in patients with CrCl <70 mL/min • Approval primarily based on pharmacokinetic data comparable to that for DRV/r rather than on trials comparing the efficacy of DRV/c and DRV/r • COBI is a potent CYP3A4 inhibitor, which can result in significant interactions with CYP3A substrates.
	LPV/r	• Only RTV-coformulated PI • No food requirement • Once or twice daily dosing	• Requires 200 mg per day of RTV • Once-daily dosing not recommended in pregnant women • Possible higher risk of MI associated with cumulative use of LPV/r • PR and QT interval prolongation have been reported. Use with caution in patients at risk of cardiac conduction abnormalities or receiving other drugs with similar effect • Possible nephrotoxicity • CYP3A4 inhibitors and substrates: potential for drug interactions (see Tables 18 and 19a)

Key to Acronyms: 3TC = lamivudine; ABC = abacavir; ART = antiretroviral therapy; Al = aluminum; ARV = antiretroviral; ATV = atazanavir; ATV/c = cobicistat-boosted atazanavir; ATV/r = ritonavir-boosted atazanavir; BMD = bone mineral density; Ca = calcium; $CaCO_3$ = calcium carbonate; CNS = central nervous system; COBI= cobicistat; Cr = creatinine; CrCl = creatinine clearance; CYP = cytochrome P; DRV/c = cobicistat-boosted darunavir; DRV/r = ritonavir-boosted darunavir; DTG = dolutegravir; EFV = efavirenz; EVG = elvitegravir; FTC = emtricitabine; GI = gastrointestinal; HBV = hepatitis B virus; HSR = hypersensitivity reaction; INSTI = integrase strand transfer inhibitor; LPV/r = ritonavir-boosted lopinavir; Mg = magnesium; MI = myocardial infarction; NNRTI = non-nucleoside reverse transcriptase inhibitor; NRTI = nucleoside reverse transcriptase inhibitor; PI = protease inhibitor; PPI = proton pump inhibitor; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; SJS = Stevens-Johnson syndrome; STR = single tablet regimen; TDF = tenofovir disoproxil fumarate; TEN = toxic epidermal necrosis

Table 9. Antiretroviral Components or Regimens Not Recommended as Initial Therapy (page 1 of 2)

ARV Drugs or Components	Reasons for Not Recommending as Initial Therapy
NRTIs	
ABC/3TC/ZDV (Co-Formulated) As triple-NRTI combination regimen	• Inferior virologic efficacy
ABC plus 3TC plus ZDV plus TDF As quadruple-NRTI combination regimen	• Inferior virologic efficacy
d4T plus 3TC	• Significant toxicities including lipoatrophy; peripheral neuropathy; and hyperlactatemia, including symptomatic and life-threatening lactic acidosis, hepatic steatosis, and pancreatitis
ddI plus 3TC (or FTC)	• Inferior virologic efficacy • Limited clinical trial experience in ART-naive patients • ddI toxicities such as pancreatitis, peripheral neuropathy
ddI plus TDF	• High rate of early virologic failure • Rapid selection of resistance mutations • Potential for immunologic nonresponse/CD4 cell decline • Increased ddI drug exposure and toxicities
ZDV/3TC	• ZDV/3TC is generally not recommended as initial therapy because greater toxicities (including bone marrow suppression; GI toxicities; and mitochondrial toxicities such as lipoatrophy, lactic acidosis, and hepatic steatosis; skeletal muscle myopathy, and cardiomyopathy) than Recommended NRTIs.
NNRTIs	
DLV	• Inferior virologic efficacy • Inconvenient (three times daily) dosing
ETR	• Insufficient data in ART-naive patients
NVP	• Associated with serious and potentially fatal toxicity (hepatic events, severe rash, including SJS and TEN) • When compared to EFV, NVP did not meet non-inferiority criteria
PIs	
ATV (Unboosted)	• Less potent than boosted ATV
DRV (Unboosted)	• Use without RTV has not been studied
FPV (Unboosted) or **FPV/r**	• Virologic failure with unboosted FPV-based regimen may result in selection of mutations that confer resistance to FPV and DRV. • Less clinical trial data for FPV/r than for other PI/r
IDV (Unboosted)	• Inconvenient dosing (three times daily with meal restrictions) • Fluid requirement • IDV toxicities such as nephrolithiasis, crystalluria
IDV/r	• Fluid requirement • IDV toxicities such as nephrolithiasis, crystalluria
NFV	• Inferior virologic efficacy • Diarrhea

Table 9. Antiretroviral Components or Regimens Not Recommended as Initial Therapy (page 2 of 2)

ARV Drugs or Components	Reasons for Not Recommending as Initial Therapy
RTV as sole PI	• High pill burden • GI intolerance • Metabolic toxicity
SQV (Unboosted)	• Inadequate bioavailability • Inferior virologic efficacy
SQV/r	• High pill burden • Can cause QT and PR prolongation; requires pre-treatment and follow-up ECG
TPV/r	• Inferior virologic efficacy • Higher rate of adverse events than other RTV-boosted PIs • Higher dose of RTV required for boosting than other RTV-boosted PIs
CCR5 Anagonist	
MVC	• Requires testing for CCR5 tropism before initiation of therapy • No virologic benefit when compared with other recommended regimens • Requires twice-daily dosing

Key to Acronyms: 3TC = lamivudine; ABC = abacavir; ART = antiretroviral therapy; ARV = antiretroviral; ATV = atazanavir; d4T = stavudine; ddI = didanosine; DLV = delavirdine; DRV = darunavir; ETR = etravirine; FPV = fosamprenavir; FPV/r = ritonavir-boosted fosamprenavir; FTC = emtricitabine; GI = gastrointestinal; IDV = indinavir; MVC = maraviroc; NFV = nelfinavir; NVP = nevirapine; NRTI = nucleoside reverse transcriptase inhibitor; PI = protease inhibitor; RTV = ritonavir; SJS = Stevens Johnson Syndrome; SQV = saquinavir; SQV/r = ritonavir-boosted saquinavir; TDF = tenofovir disoproxil fumarate; TEN = toxic epidermal necrolysis; TPV = tipranavir; ZDV = zidovudine

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What Not to Use (Last updated March 27, 2012; last reviewed March 27, 2012)

Some antiretroviral (ARV) regimens or components are not generally recommended because of suboptimal antiviral potency, unacceptable toxicities, or pharmacologic concerns. These are summarized below.

Antiretroviral Regimens Not Recommended

Monotherapy with nucleoside reverse transcriptase inhibitor (NRTI). Single-NRTI therapy does not demonstrate potent and sustained antiviral activity and **should not be used (AII)**. For prevention of mother-to-child transmission (PMTCT), zidovudine (ZDV) monotherapy is not recommended but might be considered in certain unusual circumstances in women with HIV RNA <1,000 copies/mL, although the use of a potent combination regimen is preferred. (See Perinatal Guidelines,[1] available at http://aidsinfo.nih.gov.)

Single-drug treatment regimens with a ritonavir (RTV)-boosted protease inhibitor (PI), either lopinavir (LPV),[2] atazanavir (ATV),[3] or darunavir (DRV)[4-5] are under investigation with mixed results, and **cannot be recommended** outside of a clinical trial at this time.

Dual-NRTI regimens. These regimens **are not recommended** because they have not demonstrated potent and sustained antiviral activity compared with triple-drug combination regimens **(AI)**.[6]

Triple-NRTI regimens. In general, triple-NRTI regimens other than abacavir/lamivudine/zidovudine (ABC/3TC/ZDV) **(BI)** and possibly lamivudine/zidovudine + tenofovir (3TC/ZDV + TDF) **(BII) should not be used** because of suboptimal virologic activity[7-9] or lack of data **(AI)**.

Antiretroviral Components Not Recommended

Atazanavir (ATV) + indinavir (IDV). Both of these PIs can cause Grade 3 to 4 hyperbilirubinemia and jaundice. Additive adverse effects may be possible when these agents are used concomitantly. Therefore, these two PIs **are not recommended** for combined use **(AIII)**.

Didanosine (ddI) + stavudine (d4T). The combined use of ddI and d4T as a dual-NRTI backbone can result in a high incidence of toxicities, particularly peripheral neuropathy, pancreatitis, and lactic acidosis.[10-13] This combination has been implicated in the deaths of several HIV-infected pregnant women secondary to severe lactic acidosis with or without hepatic steatosis and pancreatitis.[14] Therefore, the combined use of ddI and d4T **is not recommended (AII)**.

Didanosine (ddI) + tenofovir (TDF). Use of ddI + TDF may increase ddI concentrations[15] and serious ddI-associated toxicities including pancreatitis and lactic acidosis.[16-17] These toxicities may be lessened by ddI dose reduction. The use of this combination has also been associated with immunologic nonresponse or CD4 cell decline despite viral suppression,[18-19] high rates of early virologic failure,[20-21] and rapid selection of resistance mutations.[20-22] Because of these adverse outcomes, this dual-NRTI combination **is not generally recommended (AII)**. Clinicians caring for patients who are clinically stable on regimens containing ddI + TDF should consider altering the NRTIs to avoid this combination.

Two-non-nucleoside reverse transcriptase inhibitor (2-NNRTI) combinations. In the 2NN trial, ARV-naive participants were randomized to receive once- or twice-daily nevirapine (NVP) versus efavirenz (EFV) versus EFV plus NVP, all combined with d4T and 3TC.[23] A higher frequency of clinical adverse events that led to treatment discontinuation was reported in participants randomized to the two-NNRTI arm. Both EFV and NVP may induce metabolism of etravirine (ETR), which leads to reduction in ETR drug exposure.[24] Based on these findings, the Panel **does not recommend using two NNRTIs in combination in any regimen (AI)**.

Efavirenz (EFV) in first trimester of pregnancy and in women with significant childbearing potential. EFV use was associated with significant teratogenic effects in nonhuman primates at drug exposures similar to those representing human exposure. Several cases of congenital anomalies have been reported after early human gestational exposure to EFV.[25-26] EFV **should be avoided** in pregnancy, particularly during the first trimester, and in women of childbearing potential who are trying to conceive or who are not using effective and consistent contraception **(AIII)**. If no other ARV options are available for the woman who is pregnant or at risk of becoming pregnant, the provider should consult with a clinician who has expertise in both HIV infection and pregnancy. (See Perinatal Guidelines,[1] available at http://aidsinfo.nih.gov.)

Emtricitabine (FTC) + lamivudine (3TC). Both of these drugs have similar resistance profiles and have minimal additive antiviral activity. Inhibition of intracellular phosphorylation may occur *in vivo*, as seen with other dual-cytidine analog combinations.[27] These two agents **should not be used** as a dual-NRTI combination **(AIII)**.

Etravirine (ETR) + unboosted PI. ETR may induce the metabolism and significantly reduce the drug exposure of unboosted PIs. Appropriate doses of the PIs have not been established[24] **(AII)**.

Etravirine (ETR) + ritonavir (RTV)-boosted atazanavir (ATV) or fosamprenavir (FPV). ETR may alter the concentrations of these PIs. Appropriate doses of the PIs have not been established[24] **(AII)**.

Etravirine (ETR) + ritonavir (RTV)-boosted tipranavir (TPV). RTV-boosted TPV significantly reduces ETR concentrations. These drugs **should not be coadministered**[24] **(AII)**.

Nevirapine (NVP) initiated in ARV-naive women with CD4 counts >250 cells/mm^3 or in ARV-naive men with CD4 counts >400 cells/mm^3. Greater risk of symptomatic hepatic events, including serious and life-threatening events, has been observed in these patient groups. NVP **should not be initiated** in these patients **(BI)** unless the benefit clearly outweighs the risk.[28-30] Patients who experience CD4 count increases to levels above these thresholds as a result of antiretroviral therapy (ART) can be safely switched to NVP.[31]

Unboosted darunavir (DRV), saquinavir (SQV), or tipranavir (TPV). The virologic benefit of these PIs has been demonstrated only when they were used with concomitant RTV. Therefore, use of these agents as part of a combination regimen **without RTV is not recommended (AII)**.

Stavudine (d4T) + zidovudine (ZDV). These two NRTIs **should not be used** in combination because of antagonism demonstrated *in vitro*[32] and *in vivo*[33] **(AII)**.

Table 10. Antiretroviral Regimens or Components That Should Not Be Offered At Any Time (page 1 of 2)

	Rationale	Exception
Antiretroviral Regimens Not Recommended		
Monotherapy with NRTI (AII)	• Rapid development of resistance • Inferior ARV activity when compared with combination of three or more ARV agents	• No exception
Dual-NRTI regimens (AI)	• Rapid development of resistance • Inferior ARV activity when compared with combination of three or more ARV agents	• No exception
Triple-NRTI regimens (AI) except for ABC/ZDV/3TC (BI) or possibly TDF + ZDV/3TC (BII)	• High rate of early virologic nonresponse seen when triple-NRTI combinations, including ABC/TDF/3TC and TDF/ddI/3TC, were used as initial regimen in ART-naive patients. • Other triple-NRTI regimens have not been evaluated.	• ABC/ZDV/3TC **(BI)** and possibly TDF + ZDV/3TC **(BII)** in patients in whom other combinations are not desirable
Antiretroviral Components Not Recommended as Part of an Antiretroviral Regimen		
ATV + IDV (AIII)	• Potential additive hyperbilirubinemia	• No exception
ddI + d4T (AII)	• High incidence of toxicities: peripheral neuropathy, pancreatitis, and hyperlactatemia • Reports of serious, even fatal, cases of lactic acidosis with hepatic steatosis with or without pancreatitis in pregnant women	• No exception
ddI + TDF (AII)	• Increased ddI concentrations and serious ddI-associated toxicities • Potential for immunologic nonresponse and/or CD4 cell count decline • High rate of early virologic failure • Rapid selection of resistance mutations at failure	• Clinicians caring for patients who are clinically stable on regimens containing TDF + ddI should consider altering the NRTIs to avoid this combination.
2-NNRTI combination (AI)	• When EFV combined with NVP, higher incidence of clinical adverse events seen when compared with either EFV- or NVP-based regimen. • Both EFV and NVP may induce metabolism and may lead to reductions in ETR exposure; thus, they should not be used in combination with ETR.	• No exception
EFV in first trimester of pregnancy or in women with significant childbearing potential (AIII)	• Teratogenic in nonhuman primates	• When no other ARV options are available and potential benefits outweigh the risks **(BIII)**
FTC + 3TC (AIII)	• Similar resistance profiles • No potential benefit	• No exception
ETR + unboosted PI (AII)	• ETR may induce metabolism of these PIs; appropriate doses not yet established	• No exception
ETR + RTV-boosted ATV or FPV (AII)	• ETR may alter the concentrations of these PIs; appropriate doses not yet established	• No exception
ETR + RTV-boosted TPV (AII)	• ETR concentration may be significantly reduced by RTV-boosted TPV	• No exception

Table 10. Antiretroviral Regimens or Components That Should Not Be Offered At Any Time (page 2 of 2)

	Rationale	Exception
NVP in ARV-naive women with CD4 count >250 cells/mm^3 or men with CD4 count >400 cells/mm^3 (BI)	• High incidence of symptomatic hepatotoxicity	• If no other ARV option available; if used, patient should be closely monitored
d4T + ZDV (AII)	• Antagonistic effect on HIV-1	• No exception
Unboosted DRV, SQV, or TPV (AII)	• Inadequate bioavailability	• No exception

Acronyms: 3TC = lamivudine, ABC = abacavir, ATV = atazanavir, d4T = stavudine, ddI = didanosine, DRV = darunavir, EFV = efavirenz, ETR = etravirine, FPV = fosamprenavir, FTC = emitricitabine, IDV = indinavir, NVP = nevirapine, RTV = ritonavir, SQV = saquinavir, TDF = tenofovir, TPV = tipranavir, ZDV = zidovudine

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Management of the Treatment-Experienced Patient

Virologic Failure (Last updated April 8, 2015; last reviewed April 8, 2015)

Panel's Recommendations

- Assessing and managing a patient experiencing failure of antiretroviral therapy (ART) is complex. Expert advice is critical and should be sought.
- Evaluation of virologic failure should include an assessment of adherence, drug-drug or drug-food interactions, drug tolerability, HIV RNA and CD4 T lymphocyte (CD4) cell count trends over time, treatment history, and prior and current drug-resistance testing results.
- Drug-resistance testing should be performed while the patient is taking the failing antiretroviral (ARV) regimen **(AI)** or within 4 weeks of treatment discontinuation **(AII)**. Even if more than 4 weeks have elapsed since ARVs were discontinued, resistance testing—although it may not detect previously selected resistance mutations—can still provide useful information to guide therapy **(CIII)**.
- The goal of treatment for ART-experienced patients with drug resistance who are experiencing virologic failure is to establish virologic suppression (i.e., HIV RNA below the lower limits of detection of currently used assays) **(AI)**.
- A new regimen should include at least two, and preferably three, fully active agents **(AI)**. A fully active agent is one that is expected to have uncompromised activity on the basis of the patient's treatment history and drug-resistance testing results and/or the drug's novel mechanism of action.
- In general, adding a single ARV agent to a virologically failing regimen is **not** recommended because this may risk the development of resistance to all drugs in the regimen **(BII)**.
- For some highly ART-experienced patients, maximal virologic suppression is not possible. In this case, ART should be continued **(AI)** with regimens designed to minimize toxicity, preserve CD4 cell counts, and delay clinical progression.
- When it is not possible to construct a viable suppressive regimen for a patient with multidrug resistant HIV, the clinician should consider enrolling the patient in a clinical trial of investigational agents or contacting pharmaceutical companies that may have investigational agents available.
- Discontinuing or briefly interrupting therapy may lead to a rapid increase in HIV RNA and a decrease in CD4 cell count and increases the risk of clinical progression. Therefore, this strategy is **not** recommended in the setting of virologic failure **(AI)**.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Antiretroviral (ARV) regimens currently recommended for initial therapy of HIV-infected patients have a high likelihood of achieving and maintaining plasma HIV RNA levels below the lower limits of detection (LLOD) of currently used assays (see What to Start). Patients on antiretroviral therapy (ART) who do not achieve this treatment goal or who experience virologic rebound often develop resistance mutations to one or more components of their regimen. Based on surveillance data for HIV patients in care in selected cities in the United States in 2009, an estimated 89% of the patients were receiving ART, of whom 72% had viral loads <200 copies/mL.[1] Many patients with detectable viral loads are non-adherent to treatment. Depending on their treatment histories, some of these patients may have minimal or no drug resistance; others may have extensive resistance. Managing patients with extensive resistance is complex and usually requires consultation with an HIV expert. This section of the guidelines defines virologic failure in patients on ART and discusses strategies to manage these individuals.

Virologic Response Definitions

The following definitions are used in this section to describe the different levels of virologic response to ART.

Virologic suppression: A confirmed HIV RNA level below the LLOD of available assays

Virologic failure: The inability to achieve or maintain suppression of viral replication to an HIV RNA level <200 copies/mL

Incomplete virologic response: Two consecutive plasma HIV RNA levels ≥200 copies/mL after 24 weeks on an ARV regimen in a patient who has not yet had documented virologic suppression on this regimen. A patient's baseline HIV RNA level may affect the time course of response, and some regimens will take longer than others to suppress HIV RNA levels.

Virologic rebound: Confirmed HIV RNA ≥200 copies/mL after virologic suppression

Virologic blip: After virologic suppression, an isolated detectable HIV RNA level that is followed by a return to virologic suppression

ART Treatment Goals and Virologic Responses

The goal of ART is to suppress HIV replication to a level below which drug-resistance mutations do not emerge. Although not conclusive, the evidence suggests that selection of drug-resistance mutations does not occur in patients with HIV RNA levels persistently suppressed to below the LLOD of current assays.[2]

Viremia "blips"—defined by viral suppression followed by an isolated detectable HIV RNA level and subsequent return to undetectable levels—are not usually associated with subsequent virologic failure.[3] In contrast, there is controversy regarding the clinical implications of persistent HIV RNA levels between the LLOD and <200 copies/mL in patients on ART. Furthermore, viremia at this threshold is detected with some frequency by commonly used real-time polymerase chain reaction (PCR) assays, which are more sensitive than PCR-based viral load platforms used in the past.[4-6] Findings from a large retrospective analysis showed that, as a threshold for virologic failure, HIV RNA levels of 200 copies/mL and <50 copies/mL had the same predictive value for subsequent rebound to >200 copies/mL.[7] Two other retrospective studies also support the supposition that virologic rebound is more likely to occur in patients with viral loads >200 copies/mL than in those with low-level viremia between 50 to 199 copies/mL.[8,9] However, other studies have suggested that viremia at this low level (<200 copies/mL) can be predictive of progressive viral rebound[10,11] and can be associated with the evolution of drug resistance.[12]

Persistent HIV RNA levels ≥200 copies/mL are often associated with evidence of viral evolution and accumulation of drug-resistance mutations.[13] This association is particularly common when HIV RNA levels are >500 copies/mL.[14] Therefore, persistent plasma HIV RNA levels ≥200 copies/mL should be considered virologic failure.

Causes of Virologic Failure

Virologic failure can occur for many reasons. Data from patient cohorts in the earlier era of combination ART suggested that suboptimal adherence and drug intolerance/toxicity accounted for 28% to 40% of virologic failure and regimen discontinuations.[15,16] Presence of pre-existing (transmitted) drug resistance may also be the cause of virologic failure.[17] Virologic failure may be associated with both patient- and regimen-related factors, as listed below:

- **Patient-Related Factors**
  - Higher pretreatment or baseline HIV RNA level (depending on the specific regimen used)
  - Lower pretreatment or nadir CD4 T lymphocyte (CD4) cell count (depending on the specific regimen used)
  - Comorbidities that may affect adherence (e.g., active substance abuse, psychiatric disease, neurocognitive deficits)
  - Presence of drug-resistant virus, either transmitted or acquired

- Prior treatment failure
- Incomplete medication adherence and missed clinic appointments
- Interruption of or intermittent access to ART

- **ARV Regimen-Related Factors**
  - Drug adverse effects
  - Suboptimal pharmacokinetics (variable absorption, metabolism, or possibly penetration into reservoirs)
  - Suboptimal virologic potency
  - Reduced efficacy because of a patient's prior exposure to suboptimal regimens (e.g., functional monotherapy)
  - Food requirements
  - High pill burden and/or dosing frequency
  - Adverse drug-drug interactions with concomitant medications
  - Prescription errors
  - Cost and affordability of ARVs (i.e., may affect a patient's ability to access or continue therapy)

Management of Patients with Virologic Failure

Assessment of Virologic Failure

If virologic failure is suspected or confirmed, a thorough assessment that includes consideration of the factors listed in the Causes of Virologic Failure section above is indicated. Often the causes of virologic failure can be identified, but in some cases, the causes are not obvious. It is important to distinguish among the causes of virologic failure because the approaches to subsequent therapy differ. The following potential causes of virologic failure should be explored in depth:

- **Suboptimal Adherence.** Assess the patient's adherence to the regimen. Identify and address the underlying cause(s) for incomplete adherence (e.g., drug intolerance, difficulty accessing medications, depression, active substance abuse) and, if possible, simplify the regimen (e.g., decrease pill count or dosing frequency). (See Adherence.)
- **Medication Intolerance.** Assess the patient's tolerance of the current regimen and the severity and duration of side effects, keeping in mind that even minor side effects can affect adherence. Management strategies to address intolerance in the absence of drug resistance may include:
  - Symptomatic treatment (e.g., antiemetics, antidiarrheals)
  - A switch from one ARV in a regimen to another agent in the same drug class (see the Adverse Effects section)
  - A switch from one drug class to another class (e.g., from a non-nucleoside reverse transcriptase inhibitor [NNRTI] to a protease inhibitor [PI] or an integrase strand transfer inhibitor [INSTI]), if necessary (see the Adverse Effects section)

- **Pharmacokinetic Issues**
  - Review food requirement for each medication, and assess whether the patient adheres to the requirement.
  - Review the patient's recent history of gastrointestinal symptoms such as vomiting or diarrhea that may result in short-term malabsorption.
  - Review concomitant medications and dietary supplements for possible adverse drug-drug interactions (consult the Drug Interactions section and tables for common interactions) and, if possible, make appropriate substitutions for ARV agents and/or concomitant medications.
  - Consider therapeutic drug monitoring if pharmacokinetic drug-drug interactions or impaired drug absorption leading to decreased ARV exposure is suspected (see also Exposure-Response

Relationship and Therapeutic Drug Monitoring).

- **Suspected Drug Resistance.** Perform resistance testing while the patient is still taking the failing regimen or within 4 weeks of regimen discontinuation if the patient's plasma HIV RNA level is >1,000 copies/mL **(AI)**, and possibly even if between 500 to 1,000 copies/mL **(BII)**. (See Drug-Resistance Testing.) In some patients, resistance testing should be considered even after treatment interruptions of more than 4 weeks, recognizing that the lack of evidence of resistance in this setting does not exclude the possibility that resistance mutations may be present at low levels **(CIII)**. Evaluate the extent of drug resistance, taking into account the patient's past treatment history and prior resistance-test results. Drug resistance is cumulative; thus, all prior treatment history and resistance test results should be considered when evaluating resistance. Genotypic or phenotypic testing provides information relevant for selecting nucleoside reverse transcriptase inhibitors (NRTIs), NNRTIs, PIs, and INSTIs. Additional drug-resistance tests for patients experiencing failure on a fusion inhibitor **(AII)** and viral tropism tests for patients experiencing failure on a CCR5 antagonist **(BIII)** are also available. (See Drug-Resistance Testing.)

Approach to Patients with Confirmed Virologic Failure

Once virologic failure is confirmed, every effort should be made to assess whether suboptimal adherence and drug-drug or drug-food interactions may be contributing to the inadequate virologic response to ART. If virologic failure persists after these issues have been adequately addressed, resistance testing should be performed, and the regimen should be changed as soon as possible to avoid progressive accumulation of resistance mutations.[18] In addition, several studies have shown that virologic responses to new regimens are greater in individuals with lower HIV RNA levels[10,19] and/or higher CD4 cell counts at the time of regimen changes.[10,19] Discontinuing or briefly interrupting therapy in a patient with viremia may lead to a rapid increase in HIV RNA and a decrease in CD4 cell count and increases the risk of clinical progression;[20,21] therefore, this strategy is **not** recommended **(AI)**. See Discontinuation or Interruption of Antiretroviral Therapy.

Ideally, a new ARV regimen should contain at least two, and preferably three, fully active drugs whose predicted activity is based on the patient's drug treatment history, resistance testing, or the mechanistic action of a new drug class **(AI)**.[10,22-31] Despite drug resistance, some ARV drugs (e.g., NRTIs) may contribute partial ARV activity to a regimen,[21] while other agents (e.g., enfuvirtide [T20], NNRTIs, the INSTI raltegravir [RAL]) likely will not.[32-34] Using a "new" drug that a patient has never used previously does not ensure that the drug will be fully active; there is potential for cross-resistance, particularly among drugs from the same class. In addition, archived drug-resistance mutations may not be detected by standard drug-resistance tests, particularly if testing is performed when the patient is not taking the drug in question. Therefore, both treatment history and prior and current drug-resistance test results must be considered when designing a new regimen. When designing a new ART regimen, drug potency and viral susceptibility are more important factors to consider than the number of component drugs.

In general, patients who receive at least three active drugs, selected based on a review of the patient's treatment history and past and most current drug-resistance test results, experience better and more sustained virologic response than those receiving fewer active drugs in the regimen.[23,24,26,27,35,36] However, there are increasing data in treatment-naive and treatment-experienced patients showing that an active pharmacokinetically enhanced PI plus one other active drug or several partially active drugs will effectively reduce viral load in most patients.[37-40] Active drugs are ARVs that, based on resistance test results and treatment history, are expected to have antiviral activity equivalent to that seen when there is no resistance to the specific drugs; ARVs with partial activity are those predicted to reduce HIV RNA but to a lesser extent than when there is no underlying drug resistance. The activity of a given drug must be uniquely defined for each patient. Active drugs may be newer members of existing drug classes that are active against HIV isolates that are resistant to older drugs in the same classes (e.g., etravirine [ETR], darunavir [DRV] and tipranavir, and dolutegravir [DTG]) An active drug may also be one with unique mechanisms of action (e.g.,

the fusion inhibitor T20, the CCR5 antagonist maraviroc in patients with no detectable CXCR4-using virus). In the presence of certain drug resistance mutations, some ARVs such as DTG, ritonavir-boosted DRV, and ritonavir-boosted lopinavir (LPV/r) need to be given twice daily instead of once daily to achieve higher drug concentrations necessary to be active against the less sensitive virus.[41,42]

Addressing Detectable Viral Load in Different Clinical Situations

- **HIV RNA above the LLOD and <200 copies/mL.** Confirm that levels remain above the LLOD and assess adherence, drug-drug interactions (including those with over-the-counter products and supplements), and drug-food interactions. Patients with HIV RNA typically below the LLOD with transient increases in HIV RNA (i.e., blips) do not require a change in treatment **(AII)**.[5] Although there is no consensus on how to manage patients with persistent HIV RNA levels above the LLOD and <200 copies/mL, the risk of emerging resistance is believed to be relatively low. Therefore, these patients should maintain on their current regimens and have HIV RNA levels monitored at least every 3 months to assess the need for changes in ART in the future **(AIII)**.
- **HIV RNA ≥200 and <1,000 copies/mL.** Confirm that HIV RNA levels remain in this range and assess adherence and potential drug-drug interactions (including those with over-the-counter products and supplements) and drug-food interactions. In contrast to patients with HIV RNA levels persistently <200 copies/mL, those with levels persistently ≥200 copies/mL often develop drug resistance, particularly with HIV RNA levels >500 copies/mL.[8,9] Persistent plasma HIV RNA levels in the 200 to 1,000 copies/mL range should be considered as virologic failure, and resistance testing should be attempted, particularly if HIV RNA >500 copies/mL. When resistance testing can successfully be performed and no resistance is detected, manage the patient as outlined below in the section on **HIV RNA >1,000 copies/mL and no drug resistance identified**. If drug resistance is detected, manage the patient as outlined below in the section on **HIV RNA >1,000 copies/mL and drug resistance identified**. When resistance testing cannot be performed because of low-level viremia, the decision whether to empirically change ARVs should be made on a case-by-case basis.
- **HIV RNA >1,000 copies/mL and no drug resistance identified.** This scenario is almost always associated with suboptimal adherence. Conduct a thorough assessment to determine the level of adherence and identify any drug-drug and drug-food interactions. Consider the timing of the drug-resistance test (e.g., was the patient mostly or completely ART-non-adherent for more than 4 weeks before testing). If the current regimen is well tolerated and there are no significant drug-drug or drug-food interactions, it is reasonable to resume the same regimen. If the agents are poorly tolerated or there are important drug-drug or drug-food interactions, consider changing the regimen. Two to four weeks after treatment is resumed or started, repeat viral load testing; if viral load remains >500 copies/mL, perform genotypic testing to determine whether a resistant viral strain emerges **(CIII)**.
- **HIV RNA >1,000 copies/mL and drug resistance identified.** The availability of newer ARVs, including some with new mechanisms of action, makes it possible to suppress HIV RNA levels to below the LLOD in most of these patients. The options in this setting depend on the extent of drug resistance present and are addressed in the clinical scenarios outlined below.

Management of Virologic Failure in Different Clinical Scenarios

First Regimen Failure

- **Failing an NNRTI plus NRTI regimen.** Patients failing an NNRTI-based regimen often have viral resistance to the NNRTI, with or without lamivudine (3TC) and emtricitabine (FTC) resistance. Although several options are available for these patients, several studies have explored the activity of a pharmacokinetically boosted PI with NRTIs or an INSTI.[43-45] Two of the studies found that regimens containing a ritonavir-boosted PI (PI/r) combined with NRTIs were as active as regimens containing the PI/r

combined with RAL.[43,45] Two studies also demonstrated higher rates of virologic suppression with use of a PI/r plus NRTIs than with a PI/r alone.[44,45] On the basis of these studies, even patients with NRTI resistance can often be treated with a pharmacokinetically boosted PI plus NRTIs or RAL (AI). Although LPV/r was used in these studies, it is likely that other pharmacokinetically boosted PIs would behave similarly. Although data are limited, the second-generation NNRTI ETR or the other INSTIs (i.e., elvitegravir [EVG] or DTG) combined with a pharmacokinetically boosted PI may also be options in this setting.

- **Failing a pharmacokinetically boosted PI plus NRTI regimen.** In this scenario, most patients will have either no resistance or resistance limited to 3TC and FTC.[46,47] Failure in this setting is often attributed to poor adherence, drug-drug interactions, or drug-food interactions. A systematic review of multiple randomized trials of PI/r first-line failure showed that maintaining the same regimen, presumably with efforts to enhance adherence, is as effective as changing to new regimens with or without drugs from new classes.[48] In this setting, resistance testing should be performed along with an assessment of overall adherence and tolerability of the regimen. If the regimen is well tolerated and there are no concerns regarding drug-drug or drug-food interactions, the regimen can be continued with adherence support and viral monitoring. Alternatively, if poor tolerability or interactions may be contributing to virologic failure, the regimen can be modified to include a different pharmacokinetically boosted PI plus NRTIs—even if not all of the NRTIs are fully active—or to a new non-PI-based regimen that includes more than two fully active agents **(AII)**.
- **Failing an INSTI plus NRTI regimen.** Virologic failure with a regimen consisting of RAL plus two NRTIs or with EVG/cobicistat/tenofovir disoproxil fumarate/FTC may be associated with emergent resistance to 3TC and FTC and possibly the INSTI.[49] Viruses with INSTI resistance often have virus still susceptible to DTG.[19] In contrast, persons failing DTG plus two NRTI first-line therapy in clinical trials have not yet been shown to develop phenotypic resistance to DTG.[49] There are no clinical trial data to guide therapy for first-line INSTI failures, although one can likely extrapolate from the data for NNRTI failures. Thus, patients with first-line INSTI failure should respond to a pharmacokinetically boosted PI plus NRTIs **(AII)**. A pharmacokinetically boosted PI plus an INSTI may also be a viable option in patients with no INSTI resistance **(BII)**. In the setting the virus is found to have resistance to RAL and EVG but remains susceptible to DTG, DTG can be used in combination with a pharmacokinetically boosted PI. If no resistance is identified, the patient should be managed as outlined above in the section on virologic failure without resistance.

Second-Line Regimen Failure and Beyond

- **Drug resistance with treatment options allowing for full virologic suppression.** Depending on treatment history and drug-resistance data, one can predict whether or not to have a fully active pharmacokinetically boosted PI to include in future regimens. For example, those who have no documented PI resistance and previously have never been treated with an unboosted PI are likely to harbor virus that is fully susceptible to ARVs in the PI class. In this setting, viral suppression should be achievable using a pharmacokinetically boosted PI combined with either NRTIs or an INSTI—provided the virus is susceptible to the INSTI. If a fully susceptible pharmacokinetically boosted PI is not an option, the new regimen should include at least two, and preferably three, fully active agents, if possible. Drugs to be included in the regimen should be selected based on the likelihood that they will be active as determined by the patient's treatment history, past and present drug-resistance testing, and tropism testing if a CCR5 antagonist is being considered.
- **Multidrug resistance without treatment options allowing for full virologic suppression.** Use of currently available ARVs has resulted in a dramatic decline in the number of patients who have few treatment options because of multi-class drug resistance.[50,51] Despite this progress, there remain patients who have experienced toxicities and/or developed resistance to all or most currently available drugs. If maximal virologic suppression cannot be achieved, the goals of ART will be to preserve immunologic

function, prevent clinical progression, and minimize increasing resistance to drug classes that may eventually include new drugs that may be important for future regimens. Consensus on the optimal management of these patients is lacking. If resistance to NNRTIs, T20, EVG or RAL are identified, there is rarely a reason to continue these drugs, as there is little evidence that keeping them in the regimen helps delay disease progression **(BII)**. Moreover, continuing these drugs, in particular INSTIs, may allow for further increasing resistance and within-class cross resistance that may limit future treatment options.

It should be noted that even partial virologic suppression of HIV RNA to >0.5 $\log_{10}$ copies/mL from baseline correlates with clinical benefits.[50,52] Cohort studies provide evidence that continuing therapy, even in the presence of viremia and the absence of CD4 count increases, reduces the risk of disease progression.[53] Other cohort studies suggest continued immunologic and clinical benefits with even modest reductions in HIV RNA levels.[54,55] However, all these potential benefits must be balanced with the ongoing risk of accumulating additional resistance mutations. In general, adding a single fully active ARV to the regimen is **not** recommended because of the risk of rapid development of resistance **(BII)**.

Patients with ongoing viremia who lack sufficient treatment options to construct a fully suppressive regimen may be candidates for research studies or expanded access programs or may qualify for single-patient access of an investigational new drug as specified in Food and Drug Administration regulations: http://www.fda.gov/AboutFDA/CentersOffices/OfficeofMedicalProductsandTobacco/CDER/ucm163982.htm. Information about these programs may also be available from the sponsoring pharmaceutical manufacturer.

- **Previously treated patient with suspected drug resistance who need care but present with limited information (i.e., incomplete or no self-reported history, medical records, or resistance-testing results).** Every effort should be made to obtain the patient's medical records and prior drug-resistance testing results; however, this may not always be possible. One strategy is to restart the most recent ARV regimen and assess drug resistance in 2 to 4 weeks to guide selection of the next regimen. Another strategy is to start two or three drugs predicted to be active on the basis of the patient's treatment history.

Isolated Central Nervous System (CNS) Virologic Failure and New Onset Neurologic Symptoms

Presentation with new-onset CNS signs and symptoms has been reported as a rare form of virologic failure. These patients present with new, usually subacute, neurological symptoms associated with breakthrough of HIV infection within the CNS compartment despite plasma HIV RNA suppression.[56,57] Clinical evaluation frequently shows abnormalities on MRI brain imaging and abnormal cerebrospinal fluid (CSF) findings with characteristic lymphocytic pleocytosis. When available, measurement of CSF HIV RNA shows higher concentrations in the CSF than in plasma, and in most patients, evidence of drug-resistant CSF virus. Drug-resistance testing of HIV in CSF, if available, can be used to guide changes in the treatment regimen according to principles outlined above for plasma HIV RNA resistance **(CIII)**. In these patients it may be useful to consider CNS pharmacokinetics in drug selection **(CIII)**. If CSF HIV resistance testing is not available, the regimen may be changed based on the patient's treatment history or on predicted drug penetration into the CNS[58-60] **(CIII)**. This "neurosymptomatic" CNS viral escape should be distinguished from: (1) other CNS infections that can induce a transient increase in CSF HIV RNA (e.g., herpes zoster[61]), (2) incidental detection of asymptomatic mild CSF HIV RNA elevation likely equivalent to plasma blips,[62] or (3) relatively common chronic, usually mild, neurocognitive impairment in HIV-infected patients without evidence of CNS viral breakthrough.[63] None of these latter conditions currently warrant a change in ART.[64]

Summary

In summary, the management of treatment-experienced patients with virologic failure often requires expert advice to construct virologically suppressive regimens. Before modifying a regimen, it is critical to carefully evaluate the cause(s) of virologic failure, including incomplete adherence, poor tolerability, and drug and food interactions, as well as review HIV RNA and CD4 cell count changes over time, treatment history, and

drug-resistance test results. If HIV RNA suppression is not possible with currently approved agents, consider use of investigational agents through participation in clinical trials or expanded/single-patient access programs. If virologic suppression is still not achievable, the choice of regimens should focus on minimizing toxicity and preserving treatment options while maintaining CD4 cell counts to delay clinical progression.

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Poor CD4 Cell Recovery and Persistent Inflammation Despite Viral Suppression (Last updated April 8, 2015; last reviewed April 8, 2015)

Panel's Summary and Recommendations

- Morbidity and mortality from several AIDS and non-AIDS conditions are increased in HIV-infected individuals despite antiretroviral therapy (ART)-mediated viral suppression, and are predicted by persistently low CD4 T lymphocyte (CD4) cell counts and/or persistent immune activation.
- ART intensification by adding antiretroviral (ARV) drugs to a suppressive ART regimen does not consistently improve CD4 cell recovery or reduce immune activation and is not recommended **(AI)**.
- In individuals with viral suppression, switching ARV drug classes does not consistently improve CD4 cell recovery or reduce immune activation and is not recommended **(BIII)**.
- No interventions designed to increase CD4 cell counts and/or decrease immune activation are recommended at this time (in particular, interleukin-2 is **not recommended [AI]**) because none has been proven to decrease morbidity or mortality during ART-mediated viral suppression.
- Monitoring markers of immune activation and inflammation is not recommended because no immunologically targeted intervention has proven to improve the health of individuals with abnormally high biomarker levels, and many markers that predict morbidity and mortality fluctuate widely in individuals **(AII)**.
- Because there are no proven interventions to improve CD4 cell recovery and/or inflammation, efforts should focus on addressing modifiable risk factors for chronic disease (e.g., encouraging smoking cessation, a healthy diet, and exercise; treating hypertension, hyperlipidemia) **(AII)**.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Despite marked improvements in antiretroviral treatment (ART), morbidity and mortality in HIV-infected individuals continues to be greater than in the general population, particularly when ART is delayed until advanced disease stages. These morbidities include cardiovascular disease, many non-AIDS cancers, non-AIDS infections, chronic obstructive pulmonary disease, osteoporosis, type II diabetes, thromboembolic disease, liver disease, renal disease, neurocognitive dysfunction, and frailty.[1] Although health-related behaviors and toxicities of antiretroviral (ARV) drugs may also contribute to the increased risk of illness and death, poor CD4 T lymphocyte (CD4) cell recovery, persistent immune activation, and inflammation likely also contribute to the risk.

Poor CD4 Cell Recovery

As long as ART-mediated viral suppression is maintained, peripheral blood CD4 cell counts in most HIV-infected individuals will continue to increase for at least a decade. The rate of CD4 cell recovery is typically most rapid in the first 3 months of suppressive ART, followed by more gradual increases over time.[2-4] If ART-mediated viral suppression is maintained, most individuals will eventually recover CD4 counts in the normal range (>500 cells /mm^3); however, approximately 15% to 20% of individuals who initiate ART at very low CD4 counts (<200 cells/mm^3) may plateau at abnormally low CD4 cell counts.[3-5] Early initiation of ART in recently HIV-infected individuals likely provides the best opportunity for maximal CD4 cell recovery.[6]

Persistently low CD4 cell counts despite ART-mediated viral suppression are associated with increased risk of morbidity and mortality. For example, HIV-infected individuals with CD4 counts <200 cells/mm^3 despite at least 3 years of suppressive ART had a 2.6-fold greater risk of mortality than those with higher CD4 cell counts.[7] Lower CD4 cell counts during ART-mediated viral suppression are associated with an increased risk

of non-AIDS morbidity and mortality,[8-11] including cardiovascular disease,[12] osteoporosis and fractures,[13] liver disease,[14] and infection-related cancers.[15] The prognostic importance of higher CD4 cell counts likely spans all ranges of CD4 cell counts, though incremental benefits are harder to discern once CD4 counts increase to >500 cells/mm^3.[16]

Individuals with poor CD4 cell recovery should be evaluated for modifiable causes of CD4 cell lymphopenia. Concomitant medications should be reviewed, with a focus on those known to decrease white blood cells or, specifically, CD4 cells (e.g., cancer chemotherapy, interferon, zidovudine,[17] or the combination of tenofovir disoproxil fumarate (TDF) and didanosine (ddI).[18,19] If possible, these drugs should be substituted for or discontinued. Untreated coinfections (e.g., HCV, HIV-2) and serious medical conditions (e.g., malignancy) should also be considered as possible causes of CD4 lymphopenia, particularly in individuals with consistently declining CD4 cell counts (and percentages) and/or in those with CD4 counts consistently below 100 cells/mm^3. In many cases, no obvious cause for suboptimal immunologic response can be identified.

Despite strong evidence linking low CD4 cell counts and increased morbidity during ART-mediated viral suppression, no adjunctive therapies that increase CD4 cell count beyond levels achievable with ART alone have been proven to decrease morbidity or mortality. Adding ARV drugs to an already suppressive ART regimen does not improve CD4 cell recovery,[20-25] and does not reduce morbidity or mortality. Therefore, ART intensification is not recommended as a strategy to improve CD4 cell recovery **(AI)**. In individuals maintaining viral suppression, switching ARV drug classes in a suppressive regimen also does not consistently improve CD4 cell recovery and is not recommended **(BIII)**.[26] Two large clinical trials, powered to assess impact on clinical endpoints (AIDS and death), evaluated the role of interleukin-2, an immune-based therapy, in improving CD4 cell recovery. Interleukin-2 adjunctive therapy resulted in CD4 cell count increases but with no observable clinical benefit. Therefore, interleukin-2 is **not recommended (AI)**.[27] Other immune-based therapies that increase CD4 cell counts (e.g., growth hormone, interleukin-7) are under investigation. However, none of the therapies have been evaluated in clinical endpoint trials; therefore, whether any of these approaches will offer clinical benefit is unclear. Currently, such immune-based therapies should not be used except in the context of a clinical trial.

Persistent Immune Activation and Inflammation

Although poor CD4 cell recovery likely contributes to morbidity and mortality during ART-mediated viral suppression, there is increasing focus on persistent immune activation and inflammation as potentially independent mediators of risk. HIV infection results in heightened systemic immune activation and inflammation, effects that are evident during acute infection, persist throughout chronic untreated infection, and predict more rapid CD4 cell decline and progression to AIDS and death, independent of plasma HIV RNA levels.[28] Although immune activation declines with suppressive ART, it often persists at abnormal levels in many HIV-infected individuals maintaining long-term ART-mediated viral suppression—even in those with CD4 cell recovery to normal levels.[29,30] Immune activation and inflammatory markers (e.g., IL-6, D-dimer, hs-CRP) also predict mortality and non-AIDS morbidity during ART-mediated viral suppression, including cardiovascular and thromboembolic events, cancer, neurocognitive dysfunction, and frailty.[28] Although individuals with poor CD4 cell recovery (i.e., counts persistently <350 cells/mm^3) tend to have greater immune activation and inflammation than those with greater recovery,[29] the relationship between innate immune activation and inflammation and morbidity/mortality is largely independent of CD4 cell count.[31,32] Even in individuals with CD4 counts >500 cells/mm^3, there is evidence that immune activation and inflammation contribute to morbidity and mortality.[33] Thus, innate immune activation and inflammation are potentially important targets for future interventions.

Although the drivers of persistent immune activation during ART are not completely understood, HIV persistence, coinfections, and microbial translocation likely play important roles.[28] Interventions to reduce each of these presumed drivers are currently being investigated. Importantly, adding ARV drugs to an already

suppressive ART regimen (ART intensification) does not consistently improve immune activation.[20-23,25] Although some studies have suggested that switching an ART regimen to one with a more favorable lipid profile may improve some markers of immune activation and inflammation,[34,35] these studies have limitations and results are not consistent across markers and among studies. Thus, at this time, ART modification cannot be recommended as a strategy to reduce immune activation **(BIII)**. Other commonly used medications with anti-inflammatory properties (e.g., statins, aspirin) are being studied, and preliminary evidence suggests that some may reduce immune activation in treated HIV infection.[36,37] However, because no intervention specifically targeting immune activation or inflammation has been studied in a clinical outcomes trial in treated HIV infection, no interventions to reduce immune activation are recommended at this time.

In the absence of proven interventions, there is currently no clear rationale to monitor levels of immune activation and inflammation in treated HIV infection. Furthermore, many of the inflammatory markers that predict morbidity and mortality fluctuate significantly in HIV-infected individuals. Thus, clinical monitoring with immune activation or inflammatory markers is **not currently recommended (AII)**. The focus of care to reduce chronic non-AIDS morbidity and mortality should be on maintaining ART-mediated viral suppression and addressing strategies to reduce risk factors (e.g., smoking cessation, healthy diet, and exercise) and managing chronic comorbidities such as hypertension, hyperlipidemia, and diabetes **(AII)**.

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Regimen Switching In the Setting of Virologic Suppression (Last updated May 1, 2014; last reviewed May 1, 2014)

With use of currently available antiretroviral therapy (ART), most HIV-infected patients are able to achieve sustained HIV viral suppression. Furthermore, advances in treatment and better understanding about drug resistance make it possible to consider switching an effective regimen to an alternative regimen in some situations (see below). When contemplating such a switch, clinicians must consider several key principles to maintain viral suppression while addressing concerns with the current treatment.

Reasons to Consider Regimen Switching in the Setting of Viral Suppression:

- To simplify the regimen by reducing pill burden and dosing frequency to improve adherence
- To enhance tolerability and decrease short- or long-term toxicity (see Adverse Effects section)
- To change food or fluid requirements
- To avoid parenteral administration
- To minimize or address drug interaction concerns (see Drug Interactions section)
- To allow for optimal use of ART during pregnancy or should pregnancy occur (see Perinatal Guidelines)[1]
- To reduce costs (see Cost section)

Principles and Strategies of Regimen Switching

The cardinal principle of regimen switching is to maintain viral suppression without jeopardizing future treatment options. If a regimen switch results in virologic failure with emergence of new resistance mutations, the patient may require more complex, difficult to follow, or expensive regimens. Principles for successful regimen switching are highlighted below:

- It is critical to review a patient's full antiretroviral (ARV) history (including virologic responses, resistance test results, and past adverse events) before any treatment switch.
- Once a particular resistance mutation has been selected, it is generally archived in the HIV reservoir and is likely to reappear under the appropriate selective drug pressure, even if not detected in the most recent resistance test. If resistance data are unavailable, resistance may often be inferred from a patient's treatment history. For example, a clinician should assume that patients who have failed a cytosine analogue (e.g., a lamivudine (3TC)- or emtricitabine (FTC)-containing regimen), likely have the M184V substitution, even if the substitution is not documented. The same assumption of resistance may also apply to patients with documented failure to an non-nucleoside reverse transcriptase inhibitor (NNRTI)- or an integrase strand transfer inhibitors (INSTI)-based regimen because these drugs generally have a lower barrier to resistance. If there is uncertainty about prior resistance, it is generally not advisable to switch a suppressive ARV regimen unless the new regimen is likely to be as active against resistant virus as the suppressive regimen.
- Consultation with an HIV specialist is recommended when considering a regimen switch for a patient with a history of resistance to one or more drug classes.
- Switching from a ritonavir (RTV)-boosted protease inhibitor (PI) regimen to a regimen composed of drugs with a lower barrier to resistance generally maintains viral suppression provided there is no resistance to the other components of the regimen. However, such switches should be avoided if there is any doubt about the activity of the other agents in the regimen.
- Within-class switches prompted by adverse events usually maintain viral suppression provided that there is no drug resistance to the other ARV agents in the same drug class.

- In the absence of any likely drug resistance, switching from complex regimens, parenteral drug (i.e., enfuvirtide), or drugs known now to be more toxic (e.g., zidovudine, stavudine, or didanosine) or with higher pill burden or dosing frequency to simpler regimens (e.g., from a regimen including ritonavir-boosted saquinavir [SQV/r] to one including ritonavir-boosted darunavir [DRV/r]) or to ARVs in a new drug class (e.g., an INSTI) generally results in similar or improved adherence, continued viral suppression and possibly improved quality of life.
- More intensive monitoring of tolerability, viral suppression, adherence, and laboratory changes is recommended during the first 3 months after a regimen switch.

Alternative Switch Strategies for Patients with Virologic Suppression

RTV-Boosted PI Monotherapy

The strategy of switching virologically suppressed patients without PI resistance from one ART regimen to RTV-boosted PI monotherapy has been studied. The rationale for this strategy is to avoid nucleoside reverse transcriptase inhibitor (NRTI) toxicities and decrease costs, while taking advantage of the high barrier to resistance of RTV-boosted PIs. RTV-boosted PI monotherapy maintains virologic suppression in most patients, but at slightly lower rates than standard therapy that includes 2 NRTIs.[2,3] Low-level viremia, generally without the emergence of PI resistance, appears to be more common with monotherapy. In most studies, resumption of NRTIs in patients experiencing low level viral rebound has led to re-suppression.

No clinical trials comparing available RTV-boosted PI monotherapy regimens have been conducted. Findings from an observational study suggest that the rate of treatment failure is higher in patients on RTV-boosted atazanavir (ATV/r) than in those on RTV-boosted lopinavir (LPV/r) or DRV/r.[4] Another pilot study reported early viral rebound with use of ATV/r monotherapy.[5] There are rare reports of central nervous system virologic escape, sometimes with clinical symptoms, in patients on RTV-boosted PI monotherapy.[6,7]

On the basis of the results from these studies, RTV-boosted PI monotherapy should generally be avoided. Other strategies to avoid use of NRTIs (i.e., use of a RTV-boosted PI plus a NNRTI, an INSTI, or maraviroc [MVC]) are also being studied, but data on these strategies are limited.

Switching from a Ritonavir-Boosted Protease Inhibitor to Unboosted Atazanavir

Several clinical studies have evaluated switching a RTV-boosted PI to unboosted atazanavir (ATV) in virologically suppressed patients without NRTI resistance. Two comparative clinical trials reported that ATV/r and ATV, both in combination with 2 NRTIs (mostly ABC/3TC), demonstrated comparable levels of virologic suppression and a similar lack of treatment-emergent resistance. The benefits of the unboosted ATV regimen included a slightly improved lipid profile and a lower incidence of hyperbilirubinemia.[8,9] An additional study of 296 patients with virologic suppression on tenofovir disoproxil fumarate (TDF)/FTC plus ATV/r showed that patients switched to ABC/3TC plus ATV maintained viral suppression and showed improvements in certain bone and renal biomarkers.[10] The results of these and other non-comparative studies suggest that a regimen of ABC/3TC plus ATV can be considered in virologically suppressed patients, especially in those who have adverse effects from TDF or RTV.

Switching to Maraviroc

Co-receptor usage in virologically suppressed patients can be determined from proviral DNA obtained from peripheral blood mononuclear cells. Individuals found to have R5-tropic virus by this technique could potentially have a component of their regimens switched to MVC.[11,12] However, although the use of MVC after DNA tropism testing has potential, this strategy cannot be recommended until more data from larger clinical studies are available (see Tropism Testing section).

De-intensification

De-intensification of a standard RTV-boosted PI regimen from three to two active drugs (e.g., to a boosted PI plus one NRTI,[13] a boosted PI plus an INSTI,[14,15] or an NNRTI such as etravirine[15] or the CCR5 antagonist MVC[12]) may be more effective virologically than RTV-boosted PI monotherapy, but, thus far, comparative data on this approach are limited. In general, switching a regimen —even in a patient without known drug resistance—from an effective three-drug regimen to a two-drug regimen has not been validated and is not recommended.

Monitoring After Treatment Changes

Patients should be evaluated more closely for several months after a treatment switch (i.e., a clinic visit or phone call 1 to 2 weeks after the change and a viral load test to check for rebound viremia 4 to 8 weeks after the switch). The goal of the intensive monitoring is to assess medication tolerance and conduct targeted laboratory testing if the patient had pre-existing laboratory abnormalities or there are potential concerns with the new regimen. For example, if lipid abnormalities were present and/or were a reason for the ARV change or are a concern with the new regimen, fasting cholesterol subsets and triglycerides should be assessed within 3 months after the change in therapy. Absent any specific complaints, laboratory abnormalities, or evidence of viral rebound at this 3-month visit, clinical and laboratory monitoring of the patient may resume on a regularly scheduled basis (see Laboratory Testing section).

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Exposure-Response Relationship and Therapeutic Drug Monitoring (TDM) for Antiretroviral Agents (Last updated April 8, 2015; last reviewed April 8, 2015)

Panel's Recommendations
• Therapeutic drug monitoring for antiretroviral agents is not recommended for routine use in the management of HIV-infected patients **(BII)**. • TDM may be considered in selected clinical scenarios, as discussed in the text below.
Rating of Recommendations: *A = Strong; B = Moderate; C = Optional* ***Rating of Evidence:*** *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Knowledge about the relationship between a drug's systemic exposure (or concentration) and responses (beneficial and/or adverse) is key in selecting the dose of a drug, in understanding why patients may respond differently to the same drug and dose, and in designing strategies to optimize drug response and tolerability.

Therapeutic drug monitoring (TDM) is a strategy used to guide dosing of certain antiarrhythmics, anticonvulsants, antineoplastics, and antimicrobial agents by using measured drug concentrations to improve the likelihood of the desired therapeutic and safety outcomes. Drugs suitable for TDM are characterized by a known exposure-response relationship and a therapeutic range of concentrations. The therapeutic range is a range of concentrations established through clinical investigations that are associated with a greater likelihood of achieving the desired therapeutic response and/or reducing the frequency of drug-associated adverse reactions.

Several antiretroviral (ARV) agents meet most of the characteristics of agents suitable for a TDM strategy.[1] Specifically, some ARVs have considerable interpatient variability in drug concentrations; other ARVs have known drug concentrations associated with efficacy and/or toxicity; and in the case of other drugs, data from small prospective studies have demonstrated that TDM improved virologic response and/or decreased the incidence of concentration-related drug toxicities.[2,3]

TDM for ARV agents, however, is not recommended for routine use in the management of HIV-infected adults (BII). This recommendation is based on multiple factors that limit the routine use of TDM in HIV-infected patients. These limiting factors include lack of prospective studies that demonstrate routine use of TDM improves clinical outcomes, uncertain therapeutic thresholds for most ARV agents, great intra- and inter-patient variability in drug concentrations achieved, and a lack of commercial laboratories to perform real time quantitation of ARV concentrations.[2-5]

Scenarios for Consideration of Therapeutic Drug Monitoring

Although routine use of TDM is not recommended, in some scenarios, ARV concentration data may be useful in patient management. In these cases, assistance from a clinical pharmacologist or a clinical pharmacist to interpret the concentration data may be advisable. These scenarios include the following:

- Suspect clinically significant drug-drug or drug-food interactions that may result in reduced efficacy or increased dose-related toxicities;
- Changes in pathophysiologic states that may impair gastrointestinal, hepatic, or renal function, thereby potentially altering drug absorption, distribution, metabolism, or elimination;
- Among pregnant women who have risk factors for virologic failure (e.g., those not achieving viral suppression during earlier stage of pregnancy)—during the later stages of pregnancy, physiologic changes may result in reduced drug exposure and thus further increase the risk of virologic failure;

- Heavily pretreated patients experiencing virologic failure and who may have viral isolates with reduced susceptibility to ARVs;
- Use of alternative dosing regimens and ARV combinations for which safety and efficacy have not been established in clinical trials;
- Concentration-dependent, drug-associated toxicities; and
- Lack of expected virologic response in medication-adherent patients.

Resources for Therapeutic Drug Monitoring Target Concentrations

Most TDM-proposed target concentrations for ARVs focus on a minimum concentration (C_{min}) (i.e., the plasma concentration at the end of a dosing interval before the next ARV dose). A summary of population average ARV C_{min} can be found in a review on the role of ARV-related TDM.[2] Population average C_{min} for newer ARVs can be found in the Food and Drug Administration-approved product labels.

Guidelines for the collection of blood samples and other practical suggestions related to TDM can be found in a position paper by the Adult AIDS Clinical Trials Group Pharmacology Committee.[4]

Challenges and Considerations in Using Drug Concentrations to Guide Therapy

There are several challenges and considerations for implementation of TDM in the clinical setting. Use of TDM to monitor ARV concentrations in a patient requires the following:

- quantification of the concentration of the drug, usually in plasma or serum;
- determination of the patient's pharmacokinetic characteristics;
- integration of information on patient adherence;
- interpretation of the drug concentrations; and
- adjustment of the drug dose to achieve concentrations within the therapeutic range, if necessary.

A final caveat to the use of measured drug concentrations in patient management is a general one—drug concentration information cannot be used alone; it must be integrated with other clinical information, including the patient's ARV history and adherence before the TDM result. In addition, as knowledge of associations between ARV concentrations and virologic response evolves, clinicians who use a TDM strategy for patient management should evaluate the most up-to-date information regarding the exposure-response relationship of the tested ARV agent.

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Discontinuation or Interruption of Antiretroviral Therapy (Last updated April 8, 2015; last reviewed April 8, 2015)

Discontinuation of antiretroviral therapy (ART) may result in viral rebound, immune decompensation, and clinical progression.[1-5] Thus, planned interruptions of ART are not generally recommended. However, unplanned interruption of ART may occur under certain circumstances as discussed below.

Short-Term Therapy Interruptions

Reasons for short-term interruption (days to weeks) of ART vary and may include drug toxicity; intercurrent illnesses that preclude oral intake, such as gastroenteritis or pancreatitis; surgical procedures; or interrupted access to drugs. Stopping ART for a short time (i.e., less than 1 to 2 days) because of a medical/surgical procedure can usually be done by holding all drugs in the regimen. Recommendations for some other scenarios are listed below:

Unanticipated Short-Term Therapy Interruption

When a Patient Experiences a Severe or Life-Threatening Toxicity or Unexpected Inability to Take Oral Medications:

- All components of the drug regimen should be stopped simultaneously, regardless of drug half-life.

Planned Short-Term Therapy Interruption (Up to 2 Weeks)

When All Regimen Components Have Similar Half-Lives and Do Not Require Food for Proper Absorption:

- All drugs may be given with a sip of water, if allowed; otherwise, all drugs should be stopped simultaneously. All discontinued regimen components should be restarted simultaneously.

When All Regimen Components have Similar Half-Lives and Require Food for Adequate Absorption, and the Patient Cannot Take Anything by Mouth for a Short Time:

- Temporary discontinuation of all drug components is indicated. The regimen should be restarted as soon as the patient can resume oral intake.

When the ARV Regimen Contains Drugs with Different Half-Lives:

- Stopping all drugs simultaneously may result in functional monotherapy with the drug with the longest half-life (typically a non-nucleoside reverse transcriptase inhibitor [NNRTI]), which may increase the risk of selection of NNRTI-resistant mutations. Some experts recommend stopping the NNRTI first and the other ARV drugs 2 to 4 weeks later. Alternatively, the NNRTI may be replaced with a ritonavir (or cobicistat)-boosted protease inhibitor (PI/r or PI/c) for 4 weeks. The optimal time sequence for staggered discontinuation of regimen components, or replacement of the NNRTI with a PI/r (or PI/c), has not been determined.

Planned Long-Term Therapy Interruptions

Planned long-term therapy interruptions are **not recommended** outside of controlled clinical trials (AI). Several research studies are evaluating approaches to a functional (virological control in the absence of therapy) or sterilizing (virus eradication) cure of HIV infection. Currently, the only way to reliably test the effectiveness of these strategies may be to interrupt ART and closely monitor viral rebound over time in the setting of a clinical trial.

If therapy must be discontinued, patients should be aware of and understand the risks of viral rebound, acute retroviral syndrome, increased risk of HIV transmission, decline of CD4 count, HIV disease progression, development of minor HIV-associated manifestations such as oral thrush or serious non-AIDS complications

(e.g., renal, cardiac, hepatic, or neurologic complications), development of drug resistance, and the need for chemoprophylaxis against opportunistic infections as a result of CD4 decline. Patients should be counseled about the need for close clinical and laboratory monitoring during therapy interruptions.

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Considerations for Antiretroviral Use in Special Patient Populations

Acute and Recent (Early[a]) HIV Infection (Last updated April 8, 2015; last reviewed April 8, 2015)

Panel's Recommendations

- Antiretroviral therapy (ART) is recommended for all individuals with HIV-1 infection and should be offered to those with early[a] HIV-1 infection **(BII)**, although definitive data to confirm whether this approach will result in long-term virologic, immunologic, or clinical benefits are lacking.
- All pregnant women with early HIV-1 infection should start ART as soon as possible to prevent perinatal transmission of HIV-1 **(AI)**.
- If treatment is initiated in a patient with early HIV-1 infection, the goal is to suppress plasma HIV-1 RNA to undetectable levels **(AIII)**.
- In patients with early HIV-1 infection in whom therapy is initiated, testing for plasma HIV-1 RNA levels, CD4 T lymphocyte counts, and toxicity monitoring should be performed as described for patients with chronic HIV-1 infection **(AII)**.
- Genotypic drug resistance testing should be performed before initiation of ART to guide the selection of the regimen **(AII)**. If therapy is deferred, genotypic resistance testing should still be performed because the results will be useful in selecting a regimen with the greatest potential for achieving optimal virologic response once therapy is initiated **(AII)**.
- In patients without transmitted drug resistant virus, therapy should be initiated with one of the combination regimens that is recommended for patients with chronic HIV-1 infection (see What to Start) **(AIII)**.
- ART can be initiated before drug resistance test results are available. Because resistance to pharmacokinetically enhanced protease inhibitors emerges slowly and clinically significant transmitted resistance to protease inhibitors is uncommon, these drugs and 2 nucleoside reverse transcriptase inhibitors should be used in this setting **(AIII)**.
- Patients starting ART should be willing and able to commit to treatment and should understand the possible benefits and risks of therapy and the importance of adherence **(AIII)**. Patients may choose to postpone therapy, and providers, on a case-by-case basis, may elect to defer therapy because of clinical and/or psychosocial factors.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

[a] Early infection represents either acute or recent infection.

Definitions: Acute HIV-1 infection is the phase of HIV-1 disease immediately after infection that is characterized by an initial burst of viremia; although, anti-HIV-1 antibodies are undetectable, HIV-1 RNA or p24 antigen are present. Recent infection generally is considered the phase up to 6 months after infection during which anti-HIV-1 antibodies are detectable. Throughout this section, the term "early HIV-1 infection" is used to refer to either acute or recent HIV-1 infection.

An estimated 40% to 90% of patients with acute HIV-1 infection will experience symptoms of acute retroviral syndrome, such as fever, lymphadenopathy, pharyngitis, skin rash, myalgias/arthralgias, and other symptoms.[1-6] However, because the self-limiting symptoms are similar to those of many other viral infections, such as influenza and infectious mononucleosis, primary care clinicians often do not recognize acute HIV-1 infection. Acute infection can also be asymptomatic. Table 11 provides practitioners with guidance to recognize, diagnose, and manage acute HIV-1 infection.

Diagnosing Acute HIV Infection

Health care providers should maintain a high level of suspicion of acute HIV-1 infection in patients who have a compatible clinical syndrome—especially in those who report recent high-risk behavior (see Table 11).[7] Patients may not always disclose or admit to high-risk behaviors or perceive that their behaviors put them at risk for HIV-1 acquisition. Thus, even in the absence of reported high-risk behaviors, signs and symptoms

consistent with acute retroviral syndrome should motivate consideration of a diagnosis of acute HIV-1 infection.

Acute HIV-1 infection is usually defined as detectable HIV-1 RNA or p24 antigen in serum or plasma in the setting of a negative or indeterminate HIV-1 antibody test result.[7,8] Combination immunoassays that detect HIV-1 and HIV-2 antibodies and HIV-1 p24 antigen are now approved by the Food and Drug Administration (FDA), and the most recent Centers for Disease Control and Prevention testing algorithm recommends them as the preferred assay to use for HIV screening, including for possible acute HIV-1 infection. Specimens that are reactive on this initial assay should be tested with an immunoassay that differentiates HIV-1 and HIV-2 antibodies.[9] Specimens that are reactive on the initial assay and have either negative or indeterminate antibody differentiation test results should undergo testing using an FDA-approved quantitative or qualitative HIV-1 RNA test; a negative HIV-1 RNA test result indicates that the original Ag/Ab test result was a false positive. Detection of HIV-1 RNA indicates that acute HIV-1 infection is highly likely,[9] and that antiretroviral therapy (ART) may be warranted (see Treatment for Early HIV-1 Infection). HIV-1 infection should be confirmed by subsequent testing to document HIV antibody seroconversion.

Some health care facilities may still be following HIV testing algorithms that recommend initial testing with an assay that only tests for the presence of HIV antibody. In such settings, when acute HIV-1 infection is suspected in a patient with a negative or indeterminate HIV antibody result, a quantitative or qualitative FDA-approved HIV-1 RNA test should be performed **(AII)**. A presumptive diagnosis of acute HIV-1 infection can be made on the basis of a negative or indeterminate HIV antibody test result and a positive HIV-1 RNA test result, in which case, ART may be warranted (see Treatment for Early HIV-1 Infection). Providers should be aware that a low-positive quantitative HIV-1 RNA level (e.g., <10,000 copies/mL) may represent a false-positive result because HIV-1 RNA levels in acute infection are generally very high (e.g., >100,000 copies/mL).[5,6] Therefore, when a low-positive quantitative HIV-1 RNA result is obtained, the HIV-1 RNA test should be repeated using a different specimen from the same patient.[6] In this setting, the diagnosis of HIV-1 infection should be confirmed by subsequent documentation of HIV antibody seroconversion (see Table 11).

Treating Early HIV-1 Infection

Clinical trial data regarding the treatment of early HIV-1 infection is limited. Many patients who enrolled in studies to assess the role of ART in early HIV-1 infection (outlined below) were identified as trial participants because they presented with signs or symptoms of acute infection. With the introduction of HIV screening tests that include assays for HIV-1 RNA or p24 antigen and wider HIV screening in healthcare systems, the number of asymptomatic patients identified with early infection may increase. The natural history of HIV-1 disease in these patients may differ from that in individuals with symptomatic infections, thus further studies on the impact of ART on the natural history of asymptomatic acute HIV-1 infection are needed. The initial burst of high level viremia in infected individuals usually declines shortly after acute infection (e.g., within 2 months); however, a rationale for treatment during recent infection (e.g., 2–6 months after infection) remains, because during this transition period the immune system may not yet have maximally contained viral replication in the lymphoid tissue.[10] Several trials have addressed the question of the long-term benefit of potent treatment regimens initiated during early HIV-1 infection. The potential benefits and risks of treating HIV-1 during this stage of disease are discussed below.

Potential Benefits of Treatment During Early HIV-1 Infection

Preliminary data indicate that treatment of early HIV-1 infection with combination ART improves laboratory markers of disease progression.[11-15] The data, though limited, indicate that treatment of early HIV-1 infection may also reduce the severity of acute disease; lower the viral set point,[16-18] which can affect the rate of disease progression if therapy is stopped; reduce the size of the viral reservoir;[19] and decrease the rate of viral

mutation by suppressing viral replication and preserving immune function.[20] Because early HIV-1 infection is often associated with high viral loads and increased infectiousness,[21] and ART use by HIV-1-infected individuals reduces transmission to serodiscordant sexual partners,[22] treatment during early HIV-1 infection is expected to substantially reduce the risk of HIV-1 transmission. In addition, although data are limited and the clinical relevance unclear, the profound loss of gastrointestinal lymphoid tissue that occurs during the first weeks of infection may be mitigated by initiating ART during early HIV-1 infection.[23,24] Many of the potential benefits described above may be more likely to occur with treatment of acute infection, but they also may occur if treatment is initiated during recent HIV-1 infection.

Potential Risks of Treatment During Early HIV-1 Infection

The potential disadvantages of initiating therapy during early HIV-1 infection include more prolonged exposure to ART without a known long-term clinical benefit. This prolonged exposure to ART could result in drug toxicities, development of drug resistance if the patient is non-adherent to the regimen, and adverse effects on the patient's quality of life due to earlier initiation of lifelong therapy that requires strict adherence.

Clinical Trial Data on Treatment During Early Infection

Several randomized controlled trials have studied the effect of ART during acute and recent infection to assess whether initiating early therapy would allow patients to stop treatment and still maintain lower viral loads and higher CD4 T lymphocyte (CD4) counts while off ART for prolonged periods of time. This objective was of interest when these studies were initiated but is now less relevant because treatment is recommended for virtually all HIV-1-infected patients and treatment interruptions are not recommended (see Initiating Antiretroviral Therapy in Treatment-Naive Patients).

The Setpoint Study (ACTG A5217 Study) randomized patients with recent but not acute HIV-1 infection to either defer therapy or immediately initiate ART for 36 weeks and then stop treatment.[16] The primary study end point was a composite of meeting criteria for ART or re-initiation of ART and viral load results at week 72 in both groups and at week 36 in the deferred treatment group. The study was stopped prematurely by the Data and Safety Monitoring Board because of an apparent benefit associated with early therapy that was driven mostly by the greater proportion of participants meeting the criteria for ART initiation in the deferred treatment group (50%) than in the immediate treatment group (10%). Nearly half of the patients in the deferred treatment group needed to start therapy during the first year of study enrollment.

The Randomized Primo-SHM Trial randomized patients with acute (~70%) or recent (~30%) infection to either defer ART or undergo treatment for 24 or 60 weeks and then stop.[17] Significantly lower viral loads were observed 36 weeks after treatment interruption in the patients who had been treated early. These patients also took longer to reach a CD4 count threshold of <350 cells/mm^3 for restarting ART. The median time to starting treatment was 0.7 years for the deferred therapy group and 3.0 and 1.8 years for the 24- and 60-week treatment arms, respectively. The time to reaching a CD4 count of <500 cells/mm^3 was only 0.5 years in the deferred group.

The SPARTAC Trial included patients with acute and recent infection randomized to either defer therapy or received ART for 12 or 48 weeks and then stop.[18] In this trial, the time to reach CD4 <350 cells/mm^3 or initiate therapy was significantly longer in the group treated for 48 weeks than in the deferred treatment group or the group treated for 12 weeks. However, no difference was observed between the participants who received 12 weeks of ART and those who deferred treatment during early infection.

The strategies tested in these studies are of limited relevance today given that treatment interruption is not recommended. The study results may not fully reflect the natural history of HIV-1 disease in persons with asymptomatic acute infection because most patients in these trials were enrolled on the basis of identified early symptomatic HIV-1 infections. Nevertheless, the results do demonstrate that some immunologic and virologic

benefits may be associated with the treatment of early HIV-1 infection. Moreover, all the findings suggest, at least in the population recruited for these studies, that the time to initiating ART after identification of early infection is quite short when the threshold for ART initiation is 350 CD4 cells/mm^3, and nonexistent when therapy is advised for all individuals regardless of CD4 cell count as currently recommended in these guidelines. These observations must be balanced with the risks of early treatment, risks that are largely the same as those when therapy is initiated in chronically infected asymptomatic patients with high CD4 counts. Consequently, the health care provider and the patient should be fully aware that the rationale for initiating therapy during early HIV-1 infection is based on theoretical benefits and the extrapolation of data from the strategy trials outlined above. These potential benefits must be weighed against the risks. For these reasons, and because ART is currently recommended for all HIV-1-infected patients (see Initiating Antiretroviral Therapy in Treatment Naive Patients), ART should be offered to all patients with early HIV-1 infection **(BII)**. However, patients must be willing and able to commit to treatment, and providers, on a case-by-case basis, may elect to defer therapy for clinical and/or psychosocial reasons. Providers also should consider enrolling patients with early HIV-1 infection in clinical studies to further evaluate the natural history of this stage of HIV-1 infection and to further define the role of ART in this setting. Providers can obtain information regarding such trials at www.clinicaltrials.gov or from local HIV treatment experts.

Treating Early HIV-1 Infection During Pregnancy

Because early HIV-1 infection is associated with a high risk of perinatal transmission, all HIV-1-infected pregnant women should start combination ART as soon as possible to prevent perinatal transmission of HIV-1 **(AI)**.[25]

Treatment Regimen for Early HIV-1 Infection

Data from the United States and Europe demonstrate that transmitted virus may be resistant to at least 1 antiretroviral drug in 6% to 16% of patients.[26-28] In one study, 21% of isolates from patients with acute HIV-1 infection demonstrated resistance to at least 1 drug.[29] Therefore, before initiating ART in a person with early HIV-1 infection, genotypic antiretroviral (ARV) drug resistance testing should be performed to guide selection of a regimen **(AII)**. If the decision is made to initiate therapy during early infection, especially in the setting of acute infection, treatment initiation should not be delayed pending resistance testing results. Once results are available, the treatment regimen can be modified if warranted. If therapy is deferred, resistance testing still should be performed because the results will help guide selection of a regimen that has the greatest potential to optimize virologic response once therapy is initiated **(AII)**.

The goal of therapy during early HIV-1 infection is to suppress plasma HIV-1 RNA to undetectable levels **(AIII)**. Because data are insufficient to draw firm conclusions regarding specific drug combinations to use in this stage of HIV-1 infection, ART should be initiated with one of the combination regimens recommended for patients with chronic infection **(AIII)** (see What to Start). If therapy is started before the results of drug resistance testing are available, a pharmacologically boosted protease inhibitor (PI) should be used because resistance to these agents emerges slowly and clinically significant transmitted resistance is uncommon **(AIII)**. If available, the results of ARV drug resistance testing or the ARV resistance pattern of the source person's virus should be used to guide selection of the ARV regimen. Given the increasing use of daily tenofovir disoproxil fumarate/emtricitabine (TDF/FTC) for pre-exposure prophylaxis (PrEP) in HIV-negative individuals,[30-32] early infection may be diagnosed in some patients while they are taking TDF/FTC as PrEP. In this setting, resistance testing should be performed; however, because PI resistance is unlikely, use of a pharmacologically boosted PI and TDF/FTC remains a reasonable option pending resistance testing results (see What to Start).

Patient Follow-Up

Testing for plasma HIV-1 RNA levels, CD4 cell counts, and toxicity monitoring should be performed as described in Laboratory Testing for Initial Assessment and Monitoring While on Antiretroviral Therapy (i.e.,

HIV-1 RNA at initiation of therapy, after 2 to 8 weeks, then every 4 to 8 weeks until viral suppression, and thereafter, every 3 to 4 months) **(AII)**.

Duration of Therapy for Early HIV-1 Infection

The optimal duration of therapy for patients with early HIV-1 infection is unknown. Recent studies of early HIV-1 infection have evaluated starting and then stopping treatment as a potential strategy.[16-18] Although these studies showed some benefits associated with this strategy, a large randomized controlled trial of patients with chronic HIV-1 infection found that treatment interruption was harmful in terms of increased risk of AIDS and non-AIDS events,[33] and that the strategy was associated with increased markers of inflammation, immune activation, and coagulation.[34] For these reasons and the potential benefit of ART in reducing the risk of HIV-1 transmission, the Panel does not recommend discontinuation of ART in patients treated for early HIV-1 infection **(AIII)**.

Table 11. Identifying, Diagnosing, and Managing Acute and Recent HIV-1 Infection

Suspicion of Acute HIV-1 Infection:

- Acute HIV-1 infection should be considered in individuals with signs or symptoms of acute HIV-1 infection and recent (within 2 to 6 weeks) high risk of exposure to HIV-1.[a]
- Signs, symptoms, or laboratory findings may include but are not limited to one or more of the following: fever, lymphadenopathy, skin rash, myalgia/arthralgia, headache, diarrhea, oral ulcers, leucopenia, thrombocytopenia, transaminase elevation.
- High-risk exposures include sexual contact with an HIV-1-infected person or a person at risk of HIV-1 infection, sharing injection drug use paraphernalia, or contact of mucous membranes or breaks in skin with potentially infectious fluids.
- **Differential diagnosis:** The differential diagnosis of patients presenting with HIV-1 infection may include but is not limited to viral illnesses such as Epstein-Barr virus (EBV) and non-EBV (e.g., cytomegalovirus) infectious mononucleosis syndromes, influenza, viral hepatitis, streptococcal infection, or syphilis.

Evaluation/Diagnosis of Acute HIV-1 Infection:

- Acute HIV-1 infection is defined as detectable HIV-1 RNA or p24 antigen (the antigen used in currently available HIV antigen/antibody [Ag/Ab] combination assays) in the setting of a negative or indeterminate HIV-1 antibody test result.
  - A reactive HIV antibody test result or Ag/Ab combination test result must be followed by supplemental confirmatory testing.
  - A negative or indeterminate HIV-1 antibody test result in a person with a reactive Ag/Ab test result or in whom acute HIV-1 infection is suspected requires assessment of plasma HIV-1 RNA to diagnose acute HIV-1 infection.
  - A positive result on an FDA-approved quantitative or qualitative plasma HIV-1 RNA test in the setting of a negative or indeterminate antibody test result is consistent with acute HIV-1 infection.

Considerations for ART During Early HIV-1 Infection:

- All pregnant women with early HIV-1 infection should begin taking combination ART as soon as possible to prevent perinatal transmission of HIV-1 **(AI)**.
- Treatment for early HIV-1 infection should be offered to all non-pregnant individuals **(BII)**.
- The risks of ART during early HIV-1 infection are largely the same as those when ART is initiated in chronically infected asymptomatic patients with high CD4 counts.
- If therapy is initiated, the goal should be sustained plasma virologic suppression **(AIII)**.

[a] In some settings, behaviors that increase the risk of HIV-1 infection may not be recognized or perceived as risky by the health care provider or the patient or both. Thus, even in the absence of reported high-risk behaviors, symptoms and signs consistent with acute retroviral syndrome should motivate consideration of a diagnosis of acute HIV-1 infection.

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HIV-Infected Adolescents and Young Adults (Last updated May 1, 2014; last reviewed May 1, 2014)

Older children and adolescents now make up the largest percentage of HIV-infected children cared for at pediatric HIV clinics in the United States. The Centers for Disease Control and Prevention (CDC) estimates that 26% of the approximately 50,000 new HIV infections diagnosed in 2010 were among youth 13 to 24 years of age. In this age group, 57% of the infections were among young black/African Americans and 75% among young men who have sex with men (MSM).[1] Among youth living with HIV infection in 2010, CDC estimates that almost 60% had undiagnosed infections and were unaware they were HIV-infected.[2] Recent trends in HIV/AIDS prevalence reveal that the disproportionate burden of AIDS among racial minorities is even greater among minority youth 13 to 24 years of age (64% to 66% of cases) than among those older than 24 years (48% of cases).[3] Furthermore, trends for all HIV diagnoses among adolescents and young adults in 46 states and 5 U.S. dependent areas from 2007 to 2010 decreased or remained stable for all transmission categories except among young MSM. HIV-infected adolescents represent a heterogeneous group in terms of sociodemographics, mode of HIV infection, sexual and substance abuse history, clinical and immunologic status, psychosocial development, and readiness to adhere to medications. Many of these factors may influence decisions concerning when to start antiretroviral therapy (ART) and what antiretroviral (ARV) medications to use.

Most adolescents who acquire HIV are infected through sexual risk behaviors. Many of them are recently infected and unaware of their HIV infection status. Thus, many are in an early stage of HIV infection, which makes them ideal candidates for early interventions, such as prevention counseling and linkage to and engagement in care.[4] High grade viremia was reported among a cohort of youth identified as HIV-infected by adolescent HIV specialty clinics in 15 major metropolitan U.S. cities. The mean HIV viral load for the cohort was 94,398 copies/ml; 30% of the youth were not successfully linked to care.[5] A study among HIV-infected adolescents and young adults presenting for care identified primary genotypic resistance mutations to ARV medications in up to 18% of the evaluable sample of recently infected youth, as determined by the detuned antibody testing assay strategy that defined recent infection as occurring within 180 days of testing.[6] Recently, substantial multiclass resistance was noted in a cohort of behaviorally-infected, treatment-naive youth who were screened for an ARV treatment trial.[7] As these youth were naive to all ART, this reflects transmission of resistant virus. This transmission dynamic reflects that a substantial proportion of youth's sexual partners are likely older and may be more ART experienced; thus, awareness of the importance of baseline resistance testing among recently infected youth naive to ART is imperative.

A limited but increasing number of HIV-infected adolescents are long-term survivors of HIV infection acquired perinatally or in infancy through blood products. Such adolescents are usually heavily ART experienced and may have a unique clinical course that differs from that of adolescents infected later in life.[8] Those adolescents infected perinatally or in infancy were often started on ART early in life with mono or dual therapy regimens resulting in incomplete viral suppression and emergence of resistance. If these heavily ART-experienced adolescents harbor resistant virus, optimal ARV regimens should be selected on the basis of the same guiding principles used for heavily ART-experienced adults (see Virologic Failure and Suboptimal Immunologic Response).

Adolescents are developmentally at a difficult crossroad. Their needs for autonomy and independence and their evolving decisional capacity intersect and compete with their concrete thinking processes, risk-taking behaviors, preoccupation with self-image, and need to fit in with their peers. This makes it challenging to attract and sustain adolescents' focus on maintaining their health, particularly for those with chronic illnesses. These challenges are not specific to any particular transmission mode or stage of disease. Thus, irrespective of disease duration or mode of HIV transmission, every effort must be made to engage and maintain adolescents in care so they can improve and maintain their health for the long term. Adolescents may seek care in several settings including pediatric-focused HIV clinics, adolescent/young adult clinics, and adult-focused clinics.[9] Regardless of the setting, expertise in caring for adolescents is critical to creating a

supportive environment for engaging youth in care.[9,10]

Antiretroviral Therapy Considerations in Adolescents

Adult guidelines for ART are usually appropriate for postpubertal adolescents because the clinical course of HIV infection in adolescents who were infected sexually or through injection drug use during adolescence is more similar to that in adults than that in children. Adult guidelines can also be useful for postpubertal youth who were perinatally infected. These patients often have treatment challenges associated with the long-term use of ART that mirror those of ART-experienced adults, such as extensive resistance, complex regimens, and adverse drug effects.

Dosage of medications for HIV infection and opportunistic infections should be prescribed according to Tanner staging of puberty and not solely on the basis of age.[11,12] Adolescents in early puberty (i.e., Tanner Stages I and II) should be administered doses on pediatric schedules, whereas those in late puberty (i.e., Tanner Stage V) should follow adult dosing schedules. However, Tanner stage and age are not necessarily directly predictive of drug pharmacokinetics. Because puberty may be delayed in children who were infected with HIV perinatally,[13] continued use of pediatric doses in puberty-delayed adolescents can result in medication doses that are higher than the usual adult doses. Because data are not available to predict optimal medication doses for each ARV medication for this group of children, issues such as toxicity, pill or liquid volume burden, adherence, and virologic and immunologic parameters should be considered in determining when to transition from pediatric to adult doses. Youth who are in their growth spurt period (i.e., Tanner Stage III in females and Tanner Stage IV in males) and following adult or pediatric dosing guidelines and adolescents who have transitioned from pediatric to adult doses should be closely monitored for medication efficacy and toxicity. Therapeutic drug monitoring can be considered in each of these selected circumstances to help guide therapy decisions. Pharmacokinetic studies of drugs in youth are needed to better define appropriate dosing. For a more detailed discussion, see Guidelines for the Use of Antiretroviral Agents in Pediatric HIV Infection.[14]

Adherence Concerns in Adolescents

HIV-infected adolescents are especially vulnerable to specific adherence problems on the basis of their psychosocial and cognitive developmental trajectory. Comprehensive systems of care are required to serve both the medical and psychosocial needs of HIV-infected adolescents, who are frequently inexperienced with health care systems and who lack health insurance. Recent studies in adolescents infected through risk behaviors and in adolescents infected through perinatal transmission demonstrate that many adolescents in both groups face numerous barriers to adherence.[15-17] Compared with adults, these youth have lower rates of viral suppression and higher rates of virologic rebound and loss to follow up.[18] Many HIV-infected adolescents face challenges in adhering to medical regimens for reasons that include:

- Denial and fear of their HIV infection;
- Misinformation;
- Distrust of the medical establishment;
- Fear and lack of belief in the effectiveness of medications;
- Low self-esteem;
- Unstructured and chaotic lifestyles;
- Mood disorders and other mental illness;
- Lack of familial and social support;
- Absence of or inconsistent access to care or health insurance; and
- Risk of inadvertent parental disclosure of the youth's HIV infection status if parental health insurance is used.

In selecting treatment regimens for adolescents, clinicians must balance the goal of prescribing a maximally potent ART regimen with realistic assessment of existing and potential support systems to facilitate adherence. Adolescents benefit from reminder systems (e.g., beepers, timers, and pill boxes) that are stylish and/or inconspicuous.[19] In a recent randomized controlled study among non-adherent youth 15 to 24 years of age, youth who received cell phone medication reminders demonstrated significantly higher adherence and lower viral loads than youth who did not receive the reminder calls.[20] It is important to make medication adherence as user friendly and the least stigmatizing possible for the older child or adolescent. The concrete thought processes of adolescents make it difficult for them to take medications when they are asymptomatic, particularly if the medications have side effects. Adherence to complex regimens is particularly challenging at a time of life when adolescents do not want to be different from their peers.[21-23] Directly observed therapy may be considered for selected HIV-infected adolescents such as those with mental illness.[24-28]

Difficult Adherence Problems

Because adolescence is characterized by rapid changes in physical maturation, cognitive processes, and life style, predicting long-term adherence in an adolescent can be very challenging. The ability of youth to adhere to therapy needs to be considered as part of therapeutic decision making concerning the risks and benefits of starting treatment. Erratic adherence may result in the loss of future regimens because of the development of resistance mutations. Clinicians who care for HIV-infected adolescents frequently manage youth who, while needing therapy, pose significant concerns regarding their ability to adhere to therapy. In these cases, alternative considerations to initiation of therapy can be the following:

1. A short-term deferral of treatment until adherence is more likely or while adherence-related problems are aggressively addressed;
2. An adherence testing period in which a placebo (e.g., vitamin pill) is administered; and
3. The avoidance of any regimens with low genetic resistance barriers.

Such decisions are ideally individualized to each patient and should be made carefully in context with the individual's clinical status. For a more detailed discussion on specific therapy and adherence issues for HIV-infected adolescents, see Guidelines for Use of Antiretroviral Agents in Pediatric HIV Infection.[14]

Special Considerations in Adolescents

Sexually transmitted infections (STIs), in particular human papilloma virus (HPV), should also be addressed in all adolescents. In young MSM, screening for STIs may require sampling from several body sites because oropharyngeal, rectal, and urethral infections may be present in this population.[29] For a more detailed discussion on STIs, see the most recent CDC guidelines[30] and the adult and pediatric opportunistic infection treatment guidelines on HPV among HIV-infected adolescents.[31,32] Family planning counseling, including a discussion of the risks of perinatal transmission of HIV and methods to reduce risks, should be provided to all youth. Providing gynecologic care for HIV-infected female adolescents is especially important. Contraception, including the interaction of specific ARV drugs with hormonal contraceptives, and the potential for pregnancy also may alter choices of ART. As an example, efavirenz (EFV) should be used with caution in females of childbearing age and should only be prescribed after intensive counseling and education about the potential effects on the fetus, the need for close monitoring—including periodic pregnancy testing—and a commitment on the part of the teen to use effective contraception. For a more detailed discussion, see HIV-Infected Women and the Perinatal Guidelines.[33]

Transitioning Care

Given lifelong infection with HIV and the need for treatment through several stages of growth and development, HIV care programs and providers need flexibility to appropriately transition care for HIV-infected children, adolescents, and young adults. A successful transition requires an awareness of some

fundamental differences between many adolescent and adult HIV care models. In most adolescent HIV clinics, care is more teen-centered and multidisciplinary, with primary care highly integrated into HIV care. Teen services, such as sexual and reproductive health, substance abuse treatment, mental health, treatment education, and adherence counseling are all found in one clinic setting. In contrast, some adult HIV clinics may rely more on referral of the patient to separate subspecialty care settings, such as gynecology. Transitioning the care of an emerging young adult includes considerations of areas such as medical insurance; the adolescent's degree of independence/autonomy and decisional capacity; patient confidentiality; and informed consent. Also, adult clinic settings tend to be larger and can easily intimidate younger, less motivated patients. As an additional complication to this transition, HIV-infected adolescents belong to two epidemiologically distinct subgroups:

1. Those perinatally infected—who would likely have more disease burden history, complications, and chronicity; less functional autonomy; greater need for ART; and higher mortality risk—and
2. Those more recently infected because of high-risk behaviors.

Thus, these subgroups have unique biomedical and psychosocial considerations and needs.

To maximize the likelihood of a successful transition, interventions to facilitate transition are best implemented early on.[34] These include the following:

- Developing an individualized transition plan to address comprehensive care needs including medical, psychosocial and financial aspects of transitioning;
- Optimizing provider communication between adolescent and adult clinics;
- Identifying adult care providers willing to care for adolescents and young adults;
- Addressing patient/family resistance caused by lack of information, stigma or disclosure concerns, and differences in practice styles;
- Preparing youth for life skills development, including counseling them on the appropriate use of a primary care provider and appointment management, the importance of prompt symptom recognition and reporting, and the importance of self-efficacy in managing medications, insurance, and entitlements;
- Identifying an optimal clinic model for a given setting (i.e., simultaneous transition of mental health and/or case management versus a gradual phase-in);
- Implementing ongoing evaluation to measure the success of a selected model;
- Engaging in regular multidisciplinary case conferences between adult and adolescent care providers;
- Implementing interventions that may be associated with improved outcomes, such as support groups and mental health consultation;
- Incorporating a family planning component into clinical care; and
- Educating HIV care teams and staff about transitioning.

Discussions regarding transition should begin early and before the actual transition process.[35] Attention to these key areas will likely improve adherence to appointments and avert the potential for a youth to fall through the cracks, as it is commonly referred to in adolescent medicine. For a more detailed discussion on specific topics on transitioning care for adolescents and young adults, see http://www.hivguidelines.org/clinical-guidelines/adolescents/transitioning-hiv-infected-adolescents-into-adult-care/.

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HIV and Illicit Drug Users (Last updated March 27, 2012; last reviewed March 27, 2012)

Treatment Challenges of HIV-Infected Illicit Drug Users

Injection drug use is the second most common mode of HIV transmission in the United States. In addition, noninjection illicit drug use may facilitate sexual transmission of HIV. Injection and noninjection illicit drugs include the following: heroin, cocaine, marijuana, and club drugs (i.e., methamphetamine, ketamine, gamma-hydroxybutyrate [GHB], and amyl nitrate [i.e., poppers]). The most commonly used illicit drugs associated with HIV infection are heroin and stimulants (e.g., cocaine and amphetamines); however, the use of club drugs has increased substantially in the past several years and is common among individuals who have HIV infection or who are at risk of HIV infection. The association between club drugs and high-risk sexual behavior in men who have sex with men (MSM) is strongest for methamphetamine and amyl nitrate; this association is less consistent with the other club drugs.[1]

Illicit drug use has been associated with depression and anxiety, either as part of the withdrawal process or as a consequence of repeated use. This is particularly relevant in the treatment of HIV infection because depression is one of the strongest predictors of poor adherence and poor treatment outcomes.[2] Treatment of HIV disease in illicit drug users can be successful but HIV-infected illicit drug users present special treatment challenges. These challenges may include the following: (1) an array of complicating comorbid medical and mental health conditions; (2) limited access to HIV care; (3) inadequate adherence to therapy; (4) medication side effects and toxicities; (5) the need for substance abuse treatment; and (6) drug interactions that can complicate HIV treatment.[3]

Underlying health problems in injection and noninjection drug users result in increased morbidity and mortality, either independent of or accentuated by HIV disease. Many of these problems are the consequence of prior exposures to infectious pathogens from nonsterile needle and syringe use. Such problems can include hepatitis B or C virus infection, tuberculosis (TB), skin and soft tissue infections, recurrent bacterial pneumonia, and endocarditis. Other morbidities such as alteration in levels of consciousness and neurologic and renal disease are not uncommon. Furthermore, these comorbidities are associated with a higher risk of drug overdoses in illicit drug users with HIV disease than in HIV-uninfected illicit drug users, due in part to respiratory, hepatic, and neurological impairments associated with HIV infection.[4] Successful HIV therapy for illicit drug users often depends on clinicians becoming familiar with and managing these comorbid conditions and providing overdose prevention support.

Illicit drug users have less access to HIV care and are less likely to receive antiretroviral therapy (ART) than other populations.[5-6] Factors associated with low rates of ART use among illicit drug users include active drug use, younger age, female gender, suboptimal health care, recent incarceration, lack of access to rehabilitation programs, and health care providers' lack of expertise in HIV treatment.[5-6] The typically unstable, chaotic life patterns of many illicit drug users; the powerful pull of addictive substances; and common misperceptions about the dangers, impact, and benefits of ART all contribute to decreased adherence.[7] The chronic and relapsing nature of substance abuse as a biologic and medical disease, compounded by the high rate of mental illness that antedates and/or is exacerbated by illicit substance use, additionally complicate the relationship between health care workers and illicit drug users.[8-9] The first step in provision of care and treatment for these individuals is to recognize the existence of a substance abuse problem. It is often obvious that the problem exists, but some patients may hide these problem behaviors from clinicians. Assessment of a patient for substance abuse should be part of routine medical history taking and should be done in a professional, straightforward, and nonjudgmental manner.

Treatment Efficacy in HIV-Infected Illicit Drug Use Populations

Although illicit drug users are underrepresented in HIV therapy clinical trials, available data indicate that efficacy of ART in illicit drug users—when they are not actively using drugs—is similar to that seen in other

populations.[10] Furthermore, therapeutic failure in this population generally correlates with the degree that drug use disrupts daily activities rather than with drug use per se.[11] Providers need to remain attentive to the possible impact of disruptions caused by drug use on the patient both before and while receiving ART. Although many illicit drug users can sufficiently control their drug use for long enough time to benefit from care, substance abuse treatment is often necessary for successful HIV management.

Close collaboration with substance abuse treatment programs and proper support and attention to this population's special multidisciplinary needs are critical components of successful HIV treatment. Essential to this end are accommodating, flexible, community-based HIV care sites that are characterized by familiarity with and nonjudgmental expertise in management of drug users' wide array of needs and in development of effective strategies to promote medication adherence.[9] These strategies should include, if available, the use of adherence support mechanisms such as modified directly observed therapy (mDOT), which has shown promise in this population.[12]

Antiretroviral Agents and Opioid Substitution Therapy

Compared with noninjection drug users receiving ART, injection drug users (IDUs) receiving ART are more likely to experience an increased frequency of side effects and toxicities of ART. Although not systematically studied, this is likely because underlying hepatic, renal, neurologic, psychiatric, gastrointestinal (GI), and hematologic disorders are highly prevalent among IDUs. These comorbid conditions should be considered when selecting antiretroviral (ARV) agents in this population. Opioid substitution therapies such as methadone and buprenorphine/naloxone and extended-release naltrexone are commonly used for management of opioid dependence in HIV-infected patients.

Methadone and Antiretroviral Therapy. Methadone, an orally administered, long-acting opioid agonist, is the most common pharmacologic treatment for opioid addiction. Its use is associated with decreased heroin use, decreased needle sharing, and improved quality of life. Because of its opioid-induced effects on gastric emptying and the metabolism of cytochrome P (CYP) 450 isoenzymes 2B6, 3A4, and 2D6, pharmacologic effects and interactions with ARV agents may commonly occur.[13] These may diminish the effectiveness of either or both therapies by causing opioid withdrawal or overdose, increased methadone toxicity, and/or decreased ARV efficacy. Efavirenz (EFV), nevirapine (NVP), and lopinavir/ritonavir (LPV/r) have been associated with significant decreases in methadone levels. Patients and substance abuse treatment facilities should be informed of the likelihood of this interaction. The clinical effect is usually seen after 7 days of coadministration and may be managed by increasing the methadone dosage, usually in 5-mg to 10-mg increments daily until the desired effect is achieved.

Buprenorphine and Antiretroviral Therapy. Buprenorphine, a partial μ-opioid agonist, is administrated sublingually and is often coformulated with naloxone. It is increasingly used for opioid dependence treatment. Compared with methadone, buprenorphine has a lower risk of respiratory depression and overdose. This allows physicians in primary care to prescribe buprenorphine for the treatment of opioid dependency. The flexibility of the primary care setting can be of significant value to opioid-addicted HIV-infected patients who require ART because it enables one physician or program to provide both medical and substance abuse services. Limited information is currently available about interactions between buprenorphine and ARV agents.[13-14] Findings from available studies show that the drug interaction profile of buprenorphine is more favorable than that of methadone.

Naltrexone and Antiretroviral Therapy. A once-monthly extended-release intramuscular formulation of naltrexone was recently approved for prevention of relapse in patients who have undergone an opioid detoxification program. Naltrexone is also indicated for treatment of alcohol dependency. Naltrexone is not metabolized via the CYP450 enzyme system and is not expected to interact with protease inhibitors (PIs) or non-nucleoside reverse transcriptase inhibitors (NNRTIs).[15]

Currently available pharmacokinetic (PK) interaction data that clinicians can use as a guide for managing patients receiving ART and methadone or buprenorphine can be found in Tables 19a-d. Particular attention is needed concerning communication between HIV care providers and drug treatment programs regarding additive drug toxicities and drug interactions resulting in opiate withdrawal or excess.

Methylenedioxymethamphetamine (MDMA), GHB, ketamine, and methamphetamine all have the potential to interact with ARV agents because all are metabolized, at least in part, by the CYP450 system. Overdoses secondary to interactions between the party drugs (i.e., MDMA or GHB) and PI-based ART have been reported.[16]

Summary

It is usually possible over time to support most active drug users such that acceptable adherence levels with ARV agents can be achieved.[17-18] Providers must work to combine all available resources to stabilize an active drug user in preparation for ART. This should include identification of concurrent medical and psychiatric illnesses, drug treatment and needle and syringe exchange programs, strategies to reduce high-risk sexual behavior, and harm-reduction strategies. A history of drug use alone is insufficient reason to withhold ART because individuals with a history of prior drug use have adherence rates similar to those who do not abuse drugs.

Important considerations in the selection of successful regimens and the provision of appropriate patient monitoring in this population include need for supportive clinical sites; linkage to substance abuse treatment; and awareness of the interactions between illicit drugs and ARV agents, including the increased risk of side effects and toxicities. Simple regimens should be considered to enhance medication adherence. Preference should be given to ARV agents that have a lower risk of hepatic and neuropsychiatric side effects, simple dosing schedules, and minimal interaction with methadone.

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HIV-Infected Women (Last updated February 12, 2013; last reviewed February 12, 2013)

Panel's Recommendations

- The indications for initiation of antiretroviral therapy (ART) and the goals of treatment are the same for HIV-infected women as for other HIV-infected adults and adolescents **(AI)**.
- Women taking antiretroviral (ARV) drugs that have significant pharmacokinetic interactions with oral contraceptives should use an additional or alternative contraceptive method to prevent unintended pregnancy **(AIII)**.
- In pregnant women, an additional goal of therapy is prevention of perinatal transmission of HIV, with a goal of maximal viral suppression to reduce the risk of transmission of HIV to the fetus and newborn **(AI)**.
- When selecting an ARV combination regimen for a pregnant woman, clinicians should consider the known safety, efficacy, and pharmacokinetic data on use during pregnancy for each agent **(AIII)**.
- Women of childbearing potential should undergo pregnancy testing before initiation of efavirenz (EFV) and receive counseling about the potential risk to the fetus and desirability of avoiding pregnancy while on EFV-based regimens **(AIII)**.
- Alternative regimens that do not include EFV should be strongly considered in women who are planning to become pregnant or sexually active and not using effective contraception, assuming these alternative regimens are acceptable to the provider and are not thought to compromise the woman's health **(BIII)**.
- Because the risk of neural tube defects is restricted to the first 5 to 6 weeks of pregnancy and pregnancy is rarely recognized before 4 to 6 weeks of pregnancy, EFV can be continued in pregnant women receiving an EFV-based regimen who present for antenatal care in the first trimester, provided the regimen produces virologic suppression **(CIII)**.
- When designing a regimen for a pregnant woman, clinicians should consult the most current Health and Human Services (HHS) Perinatal Guidelines **(AIII)**.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

This section provides discussion of some basic principles and unique considerations to follow when caring for HIV-infected women, including during pregnancy. Clinicians who provide care for pregnant women should consult the current *Perinatal Guidelines*[1] for more in-depth discussion and management assistance. Additional guidance on the management of HIV-infected women can be found at http://hab.hrsa.gov/deliverhivaidscare/clinicalguide11.

Gender Considerations in Antiretroviral Therapy

In general, studies to date have not shown gender differences in virologic responses to antritretroviral therapy (ART),[2-4] but a number of studies have suggested that gender may influence the frequency, presentation, and severity of selected antiretroviral (ARV)-related adverse events.[5] Although data are limited, evidence also exists that pharmacokinetics for some ARV drugs may differ between men and women, possibly because of variations between men and women in factors such as body weight, plasma volume, gastric emptying time, plasma protein levels, cytochrome P (CYP) 450 activity, drug transporter function, and excretion activity.[6-8]

Adverse Effects:

- ***Nevirapine (NVP)-associated hepatotoxicity:*** NVP has been associated with an increased risk of symptomatic, potentially fatal, and often rash-associated liver toxicity in ARV-naive individuals; women with higher CD4 counts (>250 cells/mm^3) or elevated baseline transaminase levels appear to be at greatest risk.[9-12] It is generally recommended that NVP not be prescribed to ARV-naive women who have CD4 counts >250 cells/mm^3 unless there is no other alternative and the benefit from NVP outweighs the risk of hepatotoxicity **(AI)**.

- ***Lactic acidosis:*** There is a female predominance in the increased incidence of symptomatic and even fatal lactic acidosis associated with prolonged exposure to nucleoside reverse transcriptase inhibitors (NRTIs). Lactic acidosis is most common with stavudine (d4T), didanosine (ddI), and zidovudine (ZDV) but it can occur with other NRTIs.[13]
- ***Metabolic complications:*** A few studies have compared women and men in terms of metabolic complications associated with ARV use. Compared with HIV-infected men, HIV-infected women are more likely to experience increases in central fat with ART and are less likely to have triglyceride elevations on treatment.[14, 15] Women have an increased risk of osteopenia/osteoporosis, particularly after menopause, and this risk is exacerbated by HIV and ART.[16, 17] At the present time, none of these differences requires women-specific recommendations regarding treatment or monitoring.

Women of Childbearing Potential

All women of childbearing potential should be offered pre-conception counseling and care as a component of routine primary medical care. Counseling should include discussion of special considerations pertaining to ARV use when trying to conceive and during pregnancy (see *Perinatal Guidelines*[1]). Safe sexual practices, reproductive desires and options for conception, HIV status of sexual partner(s), and use of effective contraception to prevent unintended pregnancy should be discussed. An HIV-infected woman who wishes to conceive with an HIV-uninfected male partner should be informed of options to prevent sexual transmission of HIV while attempting conception. Interventions include initiation of maximally suppressive ART, which significantly decreases the risk of sexual transmission (see Preventing Secondary Transmission of HIV), and artificial insemination, including the option to self-inseminate with the partner's sperm during the periovulatory period[18] (for more extensive discussion on this topic, see the Reproductive Options for HIV-Concordant and Serodiscordant Couples section of the *Perinatal Guidelines*.[1]

Efavirenz (EFV) is teratogenic in non-human primates. Women of childbearing potential should undergo pregnancy testing before initiation of EFV and receive counseling about the potential risk to the fetus and desirability of avoiding pregnancy while on EFV-based regimens **(AIII)**. Alternative regimens that do not include EFV should be strongly considered in women who are planning to become pregnant or who are sexually active and not using effective contraception, assuming these alternative regimens are acceptable to the provider and are not thought to compromise the woman's health **(BIII)**. The most vulnerable period in fetal organogenesis is early in gestation, before pregnancy is recognized.

Hormonal Contraception

Safe and effective reproductive health and family planning services to reduce unintended pregnancy and perinatal transmission of HIV are an essential component of care for HIV-infected women of childbearing age. Counseling about reproductive issues should be provided on an ongoing basis.

Providers should be aware of potential interactions between ARV drugs and hormonal contraceptives that could lower contraceptive efficacy. Several protease inhibitors (PIs) and non-nucleoside reverse transcriptase inhibitors (NNRTIs) have drug interactions with combined oral contraceptives (COCs). Interactions include either a decrease or an increase in blood levels of ethinyl estradiol, norethindrone, or norgestimate (see Tables 20a and 20b), which potentially decreases contraceptive efficacy or increases estrogen- or progestin-related adverse effects (e.g., thromboembolism). Small studies of HIV-infected women receiving injectable depot-medroxyprogesterone acetate (DMPA) while on ART showed no significant interactions between DMPA and EFV, NVP, nelfinavir (NFV), or NRTI drugs.[19-21] Contraceptive failure of the etonogestrel implant in two patients on EFV-based therapy has been reported and a study has shown EFV may decrease plasma progestin concentrations of COCs containing ethinyl estradiol and norgestimate.[22, 23] Several RTV-boosted PIs decrease oral contraceptive estradiol levels.[24, 25] A small study from Malawi showed that NVP use did not significantly affect estradiol or progestin levels in HIV-infected women.[26] Overall, data are

relatively limited and the clinical implications of these findings are unclear. The magnitudes of change in drug levels that may reduce contraceptive efficacy or increase adverse effects are unknown. Concerns about pharmacokinetic interactions between oral and implant hormonal contraceptives and ARVs should not prevent clinicians from prescribing hormonal contraceptives for women on ART if that is their preferred contraceptive method. However, when women wish to use hormonal contraceptives and drug interactions with ARVs are known, additional or alternative contraceptive methods may be recommended (see drug interaction Tables 19a, 19b, and 19d and *Perinatal Guidelines*[1]). Consistent use of male or female condoms to prevent transmission of HIV and protect against other sexually transmitted diseases (STDs) is recommended for all HIV-infected women and their partners, regardless of contraceptive use.

The data on the association between hormonal contraception and the risk of acquisition of HIV are conflicting.[27] A retrospective secondary analysis of two studies of serodiscordant couples in Africa in which the HIV-infected partner was not receiving ART found that women using hormonal contraception (the vast majority using injectable DMPA) had a twofold increased risk of acquiring HIV (for HIV-infected male/HIV-uninfected female couples) or transmitting HIV (HIV-infected female/HIV-uninfected male couples). HIV-infected women using hormonal contraception had higher genital HIV RNA concentrations than did women not using hormonal contraceptives.[28] Oral contraceptive use was not significantly associated with transmission of HIV; however, the number of women using oral contraceptives in this study was insufficient to adequately assess risk. It is important to note that not all studies have supported a link between hormonal contraception and transmission or acquisition of HIV and that the individuals in this study were not receiving ART. Further research is needed to definitively determine if hormonal contraceptive use is an independent risk factor for acquisition and transmission of HIV, particularly in the setting of ART.[27, 29]

Intrauterine devices (IUDs) appear to be a safe and effective contraceptive option for HIV-infected women.[30-33] Although studies have focused primarily on non-hormone-containing IUDs (e.g., copper IUD), several small studies have also found levonorgestrel-releasing IUDs to be safe and not associated with increased genital tract shedding of HIV.[31, 34, 35]

Pregnant Women

Clinicians should review the *Perinatal Guidelines*[1] for a detailed discussion of the management of HIV-infected pregnant women. The use of combination ARV regimens is recommended for all HIV-infected pregnant women, regardless of virologic, immunologic, or clinical parameters **(AI)**. Pregnant HIV-infected women should be counseled regarding the known benefits and risks of ARV use during pregnancy to the woman, fetus, and newborn. A woman's decision regarding ARV use should be respected. Coercive and punitive approaches undermine provider-patient trust and could discourage women from seeking prenatal care and adopting health care behaviors that optimize maternal, fetal, and neonatal well-being.

Prevention of Perinatal Transmission of HIV. The use of ARVs and the resultant reduction of HIV RNA levels decrease perinatal transmission of HIV.[36-38] The goal of ARV use is to achieve maximal and sustained suppression of HIV RNA levels during pregnancy.

As in non-pregnant individuals, genotypic resistance testing is recommended for all pregnant women before ARV initiation **(AIII)** and for pregnant women with detectable HIV RNA levels while on therapy **(AI)**. Optimal prevention of perinatal transmission may require initiation of ARV drugs before results of resistance testing are available. If results demonstrate the presence of significant mutation(s) that may confer resistance to the prescribed ARV regimen, the regimen should be modified.

Long-term follow-up is recommended for all infants born to women who have received ARVs during pregnancy, regardless of the infant's HIV status (see the *Perinatal Guidelines*[1]).

Regimen Considerations. Pregnancy should not preclude the use of optimal drug regimens. Because recommendations on ARVs to use for treatment of HIV-infected pregnant women are subject to unique

considerations, recommendations specific to the timing of therapy initiation and the choice of ARVs for pregnant women may differ from those for non-pregnant individuals. These considerations include the following:

- Potential changes in pharmacokinetics and, thus, dosing requirements, which result from physiologic changes associated with pregnancy;
- potential ARV-associated adverse effects in pregnant women and the woman's ability to adhere to a particular regimen during pregnancy; and
- potential short- and long-term effects of the ARV on the fetus and newborn, which are unknown for many drugs.

Combination drug regimens are considered the standard of care in pregnancy, both for the treatment of HIV infection and for the prevention of perinatal transmission of HIV. Because the risk of neural tube defects is restricted to the first 5 to 6 weeks of pregnancy and pregnancy is rarely recognized before 4 to 6 weeks of pregnancy, and unnecessary changes in ARV drugs during pregnancy may be associated with loss of viral control and increased risk of perinatal transmission, EFV can be continued in pregnant women receiving an EFV-based regimen who present for antenatal care in the first trimester, provided the regimen produces virologic suppression **(CIII)**. Detailed recommendations on ARV choice in pregnancy are discussed in detail in the Perinatal Guidelines (see *Perinatal Guidelines*[1]).

Intravenous (IV) zidovudine (ZDV) infusion to the mother during labor is recommended if maternal HIV RNA is ≥400 copies/mL (or with unknown HIV RNA levels) near delivery, regardless of antepartum regimen or mode of delivery **(AI)**. Consideration can be given to omitting IV ZDV infusion during labor for HIV-infected women receiving combination ART regimens who have HIV RNA <400 copies/mL near delivery **(BII)**; however, the combination ART should continue to be administered during labor.

Clinicians who are treating HIV-infected pregnant women are strongly encouraged to report cases of prenatal exposure to ARVs (either administered alone or in combinations) to the Antiretroviral Pregnancy Registry (http://www.apregistry.com). The registry collects observational data regarding exposure to Food and Drug Administration-approved ARV drugs during pregnancy for the purpose of assessing potential teratogenicity. For more information regarding selection and use of ART during pregnancy, refer to the *Perinatal Guidelines*.[1]

Postpartum Management

Following delivery, clinical, immunologic, and virologic follow-up should continue as recommended for non-pregnant adults and adolescents. Because maternal ART reduces but does not eliminate the risk of transmission of HIV in breast milk and postnatal transmission can occur despite maternal ART, women should also be counseled to avoid breastfeeding.[1] HIV-infected women should avoid pre-mastication of food fed to their infants because the practice has been associated with transmission of HIV from mother to child.[39] Considerations regarding continuation of ART for maternal therapeutic indications are the same as those for ART use in other non-pregnant individuals. For more information regarding postpartum discontinuation of ART, refer to the *Perinatal Guidelines*.[1]

Several studies have demonstrated that adherence to ART may worsen in the postpartum period.[40-44] Clinicians caring for women postpartum who are receiving ART should specifically address adherence, including an evaluation of specific facilitators and barriers to adherence. Clinicians may consider an intervention to improve adherence (see Adherence to Antiretroviral Therapy).

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HIV-2 Infection (Last updated April 8, 2015; last reviewed April 8, 2015)

Summary of HIV-2 Infection
• Compared to HIV-1 infection, the clinical course of HIV-2 infection is generally characterized by a longer asymptomatic stage, lower plasma HIV-2 RNA levels, and lower mortality; however, progression to AIDS does occur. • There have been no randomized trials addressing the question of when to start antiretroviral therapy or the choice of initial or second-line therapy for HIV-2 infection; thus, the optimal treatment strategy has not been defined. • Although the optimal CD4 T lymphocyte (CD4) cell count threshold for initiating antiretroviral therapy in HIV-2 infection is unknown, therapy should be started before there is clinical progression. • HIV-2 is intrinsically resistant to non-nucleoside reverse transcriptase inhibitors and to enfuvirtide; thus, these drugs should not be included in an antiretroviral regimen for an HIV-2 infected patient. • Pending more definitive data on outcomes in an antiretroviral therapy -naive patient who has HIV-2 mono-infection or HIV-1/HIV-2 dual infection and requires treatment, an initial antiretroviral therapy regimen for these patients should include two nucleoside reverse transcriptase inhibitors plus an HIV-2 active boosted protease inhibitor or integrase strand transfer inhibitors. • A few laboratories now offer quantitative plasma HIV-2 RNA testing for clinical care (see section text). • Monitoring of HIV-2 RNA levels, CD4 cell counts, and clinical improvements can be used to assess treatment response, as is recommended for HIV-1 infection. • Resistance-associated viral mutations to nucleoside reverse transcriptase inhibitors, protease inhibitors, and/or integrase strand transfer inhibitors may develop in HIV-2 infected patients while on therapy. However, no validated HIV-2 genotypic or phenotypic antiretroviral resistance assays are available for clinical use. • In the event of virologic, immunologic, or clinical failure, second-line treatment should be instituted in consultation with an expert in HIV-2 management.

HIV-2 infection is endemic in West Africa. Although HIV-2 has had only limited spread outside this area, it should be considered in persons of West African origin or in those who have had sexual contact or shared needles with persons of West African origin. The prevalence of HIV-2 infection is also disproportionately high in countries with strong socioeconomic ties to West Africa (e.g., France; Spain; Portugal; and former Portuguese colonies such as Brazil, Angola, Mozambique, and parts of India).

Clinical Course of HIV-2 Infection

Compared to HIV-1 infection, the clinical course of HIV-2 infection is generally characterized by a longer asymptomatic stage, lower plasma HIV-2 viral loads, and lower mortality rate.[1,2] However, HIV-2 infection can also progress to AIDS over time. Concomitant HIV-1 and HIV-2 infection may occur and should be considered in patients from areas with a high prevalence of HIV-2.

Diagnosis of HIV-2 Infection

In the appropriate epidemiologic setting, HIV-2 infection should be suspected in patients with clinical conditions suggestive of HIV infection but with atypical serologic results (e.g., a positive screening assay with an indeterminate HIV-1 Western blotf[3] The possibility of HIV-2 infection should also be considered in the appropriate epidemiologic setting in patients with serologically confirmed HIV infection but low or undetectable HIV-1 RNA levels or in those with declining CD4 T lymphocyte (CD4) cell counts despite apparent virologic suppression on antiretroviral therapy (ART).

The 2014 Centers for Disease Control and Prevention guidelines for HIV diagnostic testing[4] recommend initial HIV testing using an HIV-1/HIV-2 antigen/antibody combination immunoassay and subsequent testing using an HIV-1/HIV-2 antibody differentiation immunoassay. The Multispot HIV-1/HIV-2 Rapid Test (Bio-Rad Laboratories) is Food and Drug Administration approved for differentiating HIV-1 from HIV-2 infection. Commercially available HIV-1 viral load assays do not reliably detect or quantify HIV-2.[5,6] Quantitative HIV-2 plasma RNA viral load testing has recently become available for clinical care at the University of Washington

(http://depts.washington.edu/labweb/AboutLM/Contact.htm)[7] and the New York State Department of Health (http://www.wadsworth.org/divisions/infdis/hiv/Diagnostic_HIV_Testing_Services.html).[8] However, it is important to note that approximately one-quarter to one-third of HIV-2-infected patients without ART will have HIV-2 RNA levels below the limits of detection; some of these patients will have clinical progression and CD4 cell count decline. No validated HIV-2 genotypic or phenotypic antiretroviral (ARV) resistance assays are available for clinical use.

Treatment of HIV-2 Infection

To date, no randomized trials addressing the question of when to start ART or the choice of initial or second-line therapy for HIV-2 infection have been completed;[9] thus, the optimal treatment strategy has not been defined. Three clinical trials to assess first-line ART for HIV-2 infection are currently underway; 2 are enrolling patients with CD4 counts <500 cells/mm^3 (NCT016058090 and NCT02180438) and 1 is enrolling patients with CD4 count >200 and ≤600 cells/mm^3 (NCT02150993). Although the optimal CD4 cell count threshold for initiating ART in HIV-2 infection is unknown, therapy should be started before there is clinical progression.

HIV-2 is intrinsically resistant to non-nucleoside reverse transcriptase inhibitors (NNRTI)[10] and to enfuvirtide (T20).[11] Data from *in vitro* studies suggest that HIV-2 is sensitive to the currently available nucleoside reverse transcriptase inhibitors (NRTIs), although with a lower barrier to resistance than HIV-1.[12,13] Darunavir (DRV), lopinavir (LPV), and saquinavir (SQV) are more active against HIV-2 than other approved protease inhibitors (PIs);[14-17] one of these boosted PIs should be used if a PI-based regimen is used. Other PIs should be avoided because of their lack of ARV activity and high failure rates. The integrase strand transfer inhibitors (INSTIs) raltegravir (RAL), elvitegravir (EVG), and dolutegravir (DTG) have potent activity against HIV-2.[18-21] The CCR5 antagonist maraviroc (MVC) appears active against some HIV-2 isolates;[22] however, no approved assays to determine HIV-2 co-receptor tropism exist and HIV-2 is known to use many other minor co-receptors in addition to CCR5 and CXCR4.[23]

Several small studies suggest poor responses in HIV-2 infected individuals treated with some ARV regimens including dual-NRTI regimens; regimens containing NNRTI plus 2NRTIs; and some unboosted PI-based regimens including nelfinavir (NFV) or indinavir (IDV) plus zidovudine (ZDV) and lamivudine (3TC); and atazanavir (ATV)-based regimens.[9,24-27] Clinical data on the effectiveness of triple-NRTI regimens are conflicting.[28,29] In general, HIV-2 active, boosted PI-containing regimens have resulted in more favorable virologic and immunologic responses than 2 or 3-NRTI-based regimens.[29-31] However, CD4 cell recovery on therapy are generally poorer than that observed for HIV-1.[31-33] INSTI-based regimens may also have favorable treatment responses.[34,35] A recent large systematic review of ART for HIV-2-infected patients (n = 17 studies, 976 HIV-2 infected patients) was unable to conclude which specific regimens are preferred.[36]

Resistance-associated viral mutations to NRTIs, PIs and/or INSTIs commonly develop in HIV-2 infected patients while on therapy.[24,29,37-40,41] Currently, HIV-2 transmitted drug resistance appears rare.[42] In one small study, DTG was found to have activity as a second-line INSTI in some HIV-2 patients with extensive ARV experience and RAL resistance.[43] Genotypic algorithms used to predict drug resistance in HIV-1 may not be applicable to HIV-2, because pathways and mutational patterns leading to resistance may differ between the HIV types.[13,29,44]

Some groups have recommended specific preferred and alternative regimens for initial therapy of HIV-2 infection;[45-48] however, currently, there are no controlled trial data to support the effectiveness of the recommended regimens. Pending more definitive data on outcomes in an ART-naive patient who has HIV-2 mono-infection or HIV-1/HIV-2 dual infection and requires treatment, a regimen containing two NRTIs plus an HIV-2 active boosted PI or INSTI should be initiated in HIV-2 infected individuals.

HIV-2 plasma RNA levels, CD4 cell counts, and clinical improvements can be monitored to assess treatment response, as is recommended for HIV-1. Patients who have HIV-2 RNA levels below the limits of detection before therapy should still have HIV-2 plasma RNA monitoring, in addition to CD4 cell count and clinical

monitoring. In the event of virologic, immunologic, or clinical failure, second-line treatment should be instituted in consultation with an expert in HIV-2 management.

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HIV and the Older Patient (Last updated March 27, 2012; last reviewed March 27, 2012)

Key Considerations When Caring for Older HIV-Infected Patients
• Antiretroviral therapy (ART) is recommended in patients >50 years of age, regardless of CD4 cell count **(BIII)**, because the risk of non-AIDS related complications may increase and the immunologic response to ART may be reduced in older HIV-infected patients.
• ART-associated adverse events may occur more frequently in older HIV-infected adults than in younger HIV-infected individuals. Therefore, the bone, kidney, metabolic, cardiovascular, and liver health of older HIV-infected adults should be monitored closely.
• The increased risk of drug-drug interactions between antiretroviral (ARV) drugs and other medications commonly used in older HIV-infected patients should be assessed regularly, especially when starting or switching ART and concomitant medications.
• HIV experts and primary care providers should work together to optimize the medical care of older HIV-infected patients with complex comorbidities.
• Counseling to prevent secondary transmission of HIV remains an important aspect of the care of the older HIV-infected patient.
Rating of Recommendations: *A = Strong; B = Moderate; C = Optional*
Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Effective antiretroviral therapy (ART) has increased survival in HIV-infected individuals, resulting in an increasing number of older individuals living with HIV infection. In the United States, approximately 30% of people currently living with HIV/AIDS are age 50 years or older and trends suggest that the proportion of older persons living with HIV/AIDS will increase steadily.[1] Care of HIV-infected patients increasingly will involve adults 60 to 80 years of age, a population for which data from clinical trials or pharmacokinetic studies are very limited.

There are several distinct areas of concern regarding the association between age and HIV disease.[2] First, older HIV-infected patients may suffer from aging-related comorbid illnesses that can complicate the management of HIV infection, as outlined in detail below. Second, HIV disease may affect the biology of aging, possibly resulting in early manifestations of many clinical syndromes generally associated with advanced age. Third, reduced mucosal and immunologic defenses (such as post-menopausal atrophic vaginitis) and changes in risk behaviors (for example, decrease in condom use because of less concern about pregnancy and increased use of erectile dysfunction drugs) in older adults could lead to increased risk of acquisition and transmission of HIV.[3-4] Finally, because older adults generally are perceived to be at low risk of HIV infection, screening for HIV in this population remains low. For these reasons, HIV infection in many older adults may not be diagnosed until late in the disease process. This section focuses on HIV diagnosis and treatment considerations in the older HIV-infected patient.

HIV Diagnosis and Prevention

Even though many older individuals are engaged in risk behaviors associated with acquisition of HIV, they may be perceived to be at low risk of infection and, as a result, they are less likely to be tested for HIV than younger persons.[5] According to one U.S. survey, 71% of men and 51% of women age 60 years and older continue to be sexually active,[6] with less concern about the possibility of pregnancy contributing to less condom use. Another national survey reported that among individuals age 50 years or older, condoms were not used during most recent intercourse with 91% of casual partners or 70% of new partners.[7] In addition, results from a CDC survey[8] show that in 2008 only 35% of adults age 45 to 64 years had ever been tested for HIV infection despite the 2006 CDC recommendation that individuals age 13 to 64 years be tested at least once and more often if sexually active.[9] Clinicians must be attuned to the possibility of HIV infection in older patients, including those older than 64 years of age who, based on CDC recommendations, would not

be screened for HIV. Furthermore, sexual history taking, risk-reduction counseling, and screening for sexually transmitted diseases (STDs) (if indicated), are important components of general health care for HIV-infected and -uninfected older patients.

Failure to consider a diagnosis of HIV in older persons likely contributes to later disease presentation and initiation of ART.[10] One surveillance report showed that the proportion of patients who progressed to AIDS within 1 year of diagnosis was greater among patients >60 years of age (52%) than among patients younger than 25 years (16%).[1] When individuals >50 years of age present with severe illnesses, AIDS-related opportunistic infections (OIs) need to be considered in the differential diagnosis of the illness.

Initiating Antiretroviral Therapy

Concerns about decreased immune recovery and increased risk of serious non-AIDS events are factors that favor initiating ART in patients >50 years of age regardless of CD4 cell count **(BIII)**. (See Initiating Antiretroviral Therapy in Treatment-Naive Patients.) Data that would favor use of any one of the Panel's recommended initial ART regimens (see What to Start) on the basis of age are not available. The choice of regimen should be informed by a comprehensive review of the patient's other medical conditions and medications. A noteworthy limitation of currently available information is lack of data on the long-term safety of specific antiretroviral (ARV) drugs in older patients, such as use of tenofovir disoproxil fumarate (TDF) in older patients with declining renal function. The recommendations on how frequently to monitor parameters of ART effectiveness and safety for adults age >50 years are similar to those for the general HIV-infected population; however, the recommendations for older adults focus particularly on the adverse events of ART pertaining to renal, liver, cardiovascular, metabolic, and bone health (see Table 15).

HIV, Aging, and Antiretroviral Therapy

The efficacy, pharmacokinetics, adverse effects, and drug interaction potentials of ART in the older adult have not been studied systematically. There is no evidence that the virologic response to ART is different in older patients than in younger patients. However, CD4 T-cell recovery after starting ART generally is less robust in older patients than in younger patients.[11-14] This observation suggests that starting ART at a younger age will result in better immunologic and possibly clinical outcomes.

Hepatic metabolism and renal elimination are the major routes of drug clearance, including the clearance of ARV drugs. Both liver and kidney function may decrease with age, which may result in impaired drug elimination and drug accumulation.[15] Current ARV drug doses are based on pharmacokinetic and pharmacodynamic data derived from studies conducted in subjects with normal organ function. Most clinical trials include only a small proportion of study participants >50 years of age. Whether drug accumulation in the older patient may lead to greater incidence and severity of adverse effects than seen in younger patients is unknown.

HIV-infected patients with aging-associated comorbidities may require additional pharmacologic intervention, making therapeutic management increasingly complex. In addition to taking medications to manage HIV infection and comorbid conditions, many older HIV-infected patients also are taking medications to ameliorate discomfort (e.g., pain medications, sedatives) or to manage adverse effects of medications (e.g., anti-emetics). They also may self-medicate with over-the-counter medicines or supplements. In the HIV-negative population, polypharmacy is a major cause of iatrogenic problems in geriatric patients.[16] This may be the result of medication errors (by prescribers or patients), nonadherence, additive drug toxicities, and drug-drug interactions. Older HIV-infected patients probably are at an even greater risk of polypharmacy and its attendant adverse consequences than younger HIV-infected or similarly aged HIV-uninfected patients.

Drug-drug interactions are common with ART and easily can be overlooked by prescribers.[17] The available drug interaction information on ARV agents is derived primarily from pharmacokinetic studies performed in a small number of relatively young, HIV-uninfected subjects with normal organ function (see Tables 18-19b). Data from these studies provide clinicians with a basis to assess whether a significant interaction may exist. However, the magnitude of the interaction may be different in older HIV-infected patients than in younger HIV-infected patients.

Nonadherence is the most common cause of treatment failure. Complex dosing requirements, high pill burden, inability to access medications because of cost or availability, limited health literacy including lack of numeracy skills, misunderstanding of instructions, depression, and neurocognitive impairment are among the key reasons for nonadherence.[18] Although many of these factors likely will be more prevalent in an aging HIV-infected population, some data suggest that older HIV-infected patients may be more adherent to ART than younger HIV-infected patients.[19-21] Clinicians should assess adherence regularly to identify any factors, such as neurocognitive deficits, that may make adherence a challenge. One or more interventions such as discontinuation of unnecessary medications; regimen simplification; or use of adherence tools, including pillboxes, daily calendars, and evidence-based behavioral approaches may be necessary to facilitate medication adherence (see Adherence to Antiretroviral Therapy).

Non-AIDS HIV-Related Complications and other Comorbidities

With the reduction in AIDS-related morbidity and mortality observed with effective use of ART, non-AIDS conditions constitute an increasing proportion of serious illnesses in ART-treated HIV-infected populations.[22-24] Heart disease and cancer are the leading causes of death in older Americans.[25] Similarly, for HIV-infected patients on ART, non-AIDS events such as heart disease, liver disease, and cancer have emerged as major causes of morbidity and mortality. Neurocognitive impairment, already a major health problem in aging patients, may be exacerbated by the effect of HIV infection on the brain.[26] That the presence of multiple non-AIDS comorbidities coupled with the immunologic effects of HIV infection could add to the disease burden of an aging HIV-infected person is a concern.[27-29] At present, primary care recommendations are the same for HIV-infected and HIV-uninfected adults and focus on identifying and managing risks of conditions such as heart, liver, and renal disease; cancer; and bone demineralization.[30-32]

Discontinuing Antiretroviral Therapy in Older Patients

Important issues to discuss with aging HIV-infected patients are living wills, advance directives, and long-term care planning including financial concerns. Health care cost sharing (e.g., co-pays, out-of-pocket costs), loss of employment, and other financial-related factors can cause interruptions in treatment. Clinic systems can minimize loss of treatment by helping patients maintain access to insurance.

For the severely debilitated or terminally ill HIV-infected patient, adding palliative care medications, while perhaps beneficial, further increases the complexity and risk of negative drug interactions. For such patients, a balanced consideration of both the expected benefits of ART and the toxicities and negative quality-of-life effects of ART is needed.

Few data exist on the use of ART in severely debilitated patients with chronic, severe, or non-AIDS terminal conditions.[33-34] Withdrawal of ART usually results in rebound viremia and a decline in CD4 cell count. Acute retroviral syndrome after abrupt discontinuation of ART has been reported. In very debilitated patients, if there are no significant adverse reactions to ART, most clinicians would continue therapy. In cases where ART negatively affects quality of life, the decision to continue therapy should be made together with the patient and/or family members after a discussion on the risks and benefits of continuing or withdrawing ART.

Conclusion

HIV infection may increase the risk of many major health conditions experienced by aging adults and possibly accelerate the aging process.[35] As HIV-infected adults age, their health problems become increasingly complex, placing additional demands on the health care system. This adds to the concern that outpatient clinics providing HIV care in the United States share the same financial problems as other chronic disease and primary care clinics and that reimbursement for care is not sufficient to maintain care at a sustainable level.[36] Continued involvement of HIV experts in the care of older HIV-infected patients is warranted. However, given that the current shortage of primary care providers and geriatricians is projected to continue, current HIV providers will need to adapt to the shifting need for expertise in geriatrics through continuing education and ongoing assessment of the evolving health needs of aging HIV-infected patients.[37] The aging of the HIV-infected population also signals a need for more information on long-term safety and efficacy of ARV drugs in older patients.

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Considerations for Antiretroviral Use in Patients with Coinfections

HIV/Hepatitis B Virus (HBV) Coinfection (Last updated January 10, 2011; last reviewed January 10, 2011)

Panel's Recommendations

- Prior to initiation of antiretroviral therapy (ART), all patients who test positive for hepatitis B surface antigen (HBsAg) should be tested for hepatitis B virus (HBV) DNA using a quantitative assay to determine the level of HBV replication **(AIII)**.
- Because emtricitabine (FTC), lamivudine (3TC), and tenofovir (TDF) have activity against both HIV and HBV, if HBV **or** HIV treatment is needed, ART should be initiated with the combination of TDF + FTC or TDF + 3TC as the nucleoside reverse transcriptase inhibitor (NRTI) backbone of a fully suppressive antiretroviral (ARV) regimen **(AI)**.
- If HBV treatment is needed and TDF cannot safely be used, the alternative recommended HBV therapy is entecavir in addition to a fully suppressive ARV regimen **(BI)**. Other HBV treatment regimens include peginterferon alfa monotherapy or adefovir in combination with 3TC or FTC or telbivudine in addition to a fully suppressive ARV regimen **(BII)**.
- Entecavir has activity against HIV; its use for HBV treatment without ART in patients with dual infection may result in the selection of the M184V mutation that confers HIV resistance to 3TC and FTC. Therefore, entecavir must be used in addition to a fully suppressive ARV regimen when used in HIV/HBV-coinfected patients **(AII)**.
- Discontinuation of agents with anti-HBV activity may cause serious hepatocellular damage resulting from reactivation of HBV; patients should be advised against self-discontinuation and carefully monitored during interruptions in HBV treatment **(AII)**.
- If ART needs to be modified due to HIV virologic failure and the patient has adequate HBV suppression, the ARV drugs active against HBV should be continued for HBV treatment in combination with other suitable ARV agents to achieve HIV suppression **(AIII)**.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Approximately 5%–10% of HIV-infected persons also have chronic HBV infection, defined as testing positive for HBsAg for more than 6 months.[1] The progression of chronic HBV to cirrhosis, end-stage liver disease, and/or hepatocellular carcinoma is more rapid in HIV-infected persons than in persons with chronic HBV alone.[2] Conversely, chronic HBV does not substantially alter the progression of HIV infection and does not influence HIV suppression or CD4 cell responses following ART initiation.[3-4] However, several liver-associated complications that are ascribed to flares in HBV activity, discontinuation of dually active ARVs, or toxicity of ARVs can affect the treatment of HIV in patients with HBV coinfection.[5-7] These include the following:

- FTC, 3TC, and TDF are approved ARVs that also have antiviral activity against HBV. Discontinuation of these drugs may potentially cause serious hepatocellular damage resulting from reactivation of HBV.[8]
- Entecavir has activity against HIV; its use for HBV treatment without ART in patients with dual infection may result in the selection of the M184V mutation that confers HIV resistance to 3TC and FTC. Therefore, entecavir must be used in addition to a fully suppressive ARV regimen when used in HIV/HBV-coinfected patients **(AII)**.[9]
- 3TC-resistant HBV is observed in approximately 40% of patients after 2 years on 3TC for chronic HBV and in approximately 90% of patients after 4 years when 3TC is used as the only active drug for HBV in coinfected patients. Therefore, 3TC or FTC should be used in combination with other anti-HBV drugs **(AII)**.[10]

- Immune reconstitution after initiation of treatment for HIV and/or HBV can be associated with elevation in transaminases, possibly because HBV is primarily an immune-mediated disease.[11]
- Some ARV agents can cause increases in transaminase levels. The rate and magnitude of these increases are higher with HBV coinfection.[12-13] The etiology and consequences of these changes in liver function tests are unclear because continuation of ART may be accompanied by resolution of the changes. Nevertheless, some experts suspend the implicated agent(s) when the serum alanine transferase (ALT) level is increased to 5–10 times the upper limit of normal. However, in HIV/HBV-coinfected persons, increases in transaminase levels can herald hepatitis B e antigen (HBeAg) seroconversion due to immune reconstitution, so the cause of the elevations should be investigated prior to the decision to discontinue medications. In persons with transaminase increases, HBeAg seroconversion should be evaluated by testing for HBeAg and anti-HBe as well as HBV DNA levels.

Recommendations for HBV/HIV-Coinfected Patients

- All patients with chronic HBV should be advised to abstain from alcohol, assessed for immunity to hepatitis A virus (HAV) infection (anti-HAV antibody total) and vaccinated if nonimmune, advised on methods to prevent HBV transmission (methods that do not differ from those to prevent HIV transmission), and evaluated for the severity of HBV infection as outlined in the Guidelines for Prevention and Treatment of Opportunistic Infections in HIV-Infected Adults and Adolescents.[14]
- Prior to intiation of ART, all persons who test positive for HBsAg should be tested for HBV DNA using a quantitative assay to determine the level of HBV replication **(AIII)**. Persons with chronic HBV infection already receiving ART active against HBV should undergo quantitative HBV DNA testing every 6–12 months to determine the effectiveness of therapy in suppressing HBV replication. The goal of HBV therapy with NRTIs is to prevent liver disease complications by sustained suppression of HBV replication to the lowest achievable level.
- **If not yet on therapy and HBV or HIV treatment is needed:** In persons without HIV infection, the recommended anti-HBV drugs for the treatment of persons naive to HBV therapy are TDF and entecavir.[15-16] In HIV-infected patients, however, only TDF can be considered part of the ARV regimen; entecavir has weak anti-HIV activity and must not be considered part of an ARV regimen. In addition, only TDF is fully active for the treatment of persons with known or suspected 3TC-resistant HBV infection. To avoid selection of HBV-resistant variants, when possible, these agents should not be used as the only agent with anti-HBV activity in an ARV regimen **(AIII)**.

Preferred regimen. The combination of TDF + FTC or TDF + 3TC should be used as the NRTI backbone of a fully suppressive ARV regimen and for the treatment of HBV infection **(AII)**.[17-19]

Alternative regimens. If TDF cannot safely be used, entecavir should be used in addition to a fully suppressive ARV regimen **(AII)**; importantly, entecavir should not be considered to be a part of the ARV regimen[20] **(BII)**. Due to a partially overlapping HBV-resistance pathway, it is not known if the combination of entectavir + 3TC or FTC will provide additional virologic or clinical benefit compared with entecavir alone. In persons with known or suspected 3TC-resistant HBV infection, the entecavir dose should be increased from 0.5 mg/day to 1 mg/day. However, entecavir resistance may emerge rapidly in patients with 3TC-resistant HBV infection. Therefore, entecavir should be used with caution in such patients with frequent monitoring (~ every 3 months) of the HBV DNA level to detect viral breakthrough. Other HBV treatment regimens include peginterferon alfa monotherapy or adefovir in combination with 3TC or FTC or telbivudine in addition to a fully suppressive ARV regimen;[17, 21-22] however, data on these regimens in persons with HIV/HBV coinfection are limited **(BII)**. Due to safety concerns, peginterferon alfa should not be used in HIV/HBV-coinfected persons with cirrhosis.

- **Need to discontinue medications active against HBV:** The patient's clinical course should be monitored with frequent liver function tests. The use of adefovir dipivoxil, entecavir, or telbivudine to prevent flares, especially in patients with marginal hepatic reserve such as persons with compensated or decompensated cirrhosis, can be considered.[8] These alternative HBV regimens should only be used in addition to a fully suppressive ARV regimen.
- **Need to change ART because of HIV resistance:** If the patient has adequate HBV suppression, the ARV drugs active against HBV should be continued for HBV treatment in combination with other suitable ARV agents to achieve HIV suppression **(AIII)**.

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HIV/Hepatitis C Virus Coinfection (Last updated April 8, 2015; last reviewed April 8, 2015)

Panel Recommendations

- All HIV-infected patients should be screened for hepatitis C virus infection (HCV). Patients at high risk of HCV infection should be screened annually and whenever HCV infection is suspected.
- Antiretroviral therapy may slow the progression of liver disease by preserving or restoring immune function and reducing HIV-related immune activation and inflammation. For most HIV/HCV-coinfected patients, including those with cirrhosis, the benefits of antiretroviral therapy outweigh concerns regarding drug-induced liver injury. Therefore, antiretroviral therapy should be initiated in most HIV/HCV-coinfected patients, regardless of CD4 T lymphocyte (CD4) cell count **(BII)**.
- Initial antiretroviral therapy combination regimens recommended for most HIV/HCV-coinfected patients are the same as those recommended for individuals without HCV infection. However, when treatment for both HIV and HCV is indicated, the antiretroviral regimen should be selected with special considerations of potential drug-drug interactions and overlapping toxicities with the HCV treatment regimen (see discussion in the text below and in Table 12).
- Combined treatment of HIV and HCV can be complicated by drug-drug interactions, increased pill burden, and toxicities. Although antiretroviral therapy should be initiated for most HIV/HCV-coinfected patients regardless of CD4 cell count, in antiretroviral therapy-naive patients with CD4 counts >500 cells/mm^3 some clinicians may choose to defer antiretroviral therapy until HCV treatment is completed **(CIII)**.
- In patients with lower CD4 counts (e.g., <200 cells/mm^3), antiretroviral therapy should be initiated promptly (AI) and HCV therapy may be delayed until the patient is stable on HIV treatment **(CIII)**.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

The management of hepatitis C virus (HCV)-infected patients is rapidly evolving. Data suggest that HIV/HCV-coinfected patients treated with all-oral HCV regimens have sustained virologic response rates comparable to those of HCV-monoinfected patients. The purpose of this section is to discuss hepatic safety and drug-drug interaction issues related to HIV/HCV coinfection and the concomitant use of antiretroviral (ARV) agents and HCV drugs. For specific guidance on HCV treatment, please refer to http://www.hcvguidelines.org/.

Among patients with chronic HCV infection, approximately one-third progress to cirrhosis, at a median time of less than 20 years.[1,2] The rate of progression increases with older age, alcoholism, male sex, and HIV infection.[3-6] A meta-analysis found that HIV/HCV-coinfected patients had a three fold greater risk of progression to cirrhosis or decompensated liver disease than HCV-monoinfected patients.[5] The risk of progression is even greater in HIV/HCV-coinfected patients with low CD4 T lymphocyte (CD4) cell counts. Although antiretroviral therapy (ART) appears to slow the rate of HCV disease progression in HIV/HCV-coinfected patients, several studies have demonstrated that the rate continues to exceed that observed in those without HIV infection.[7,8] Whether HCV infection accelerates HIV progression, as measured by AIDS-related opportunistic infections (OIs) or death,[9] is unclear. Although some older ARV drugs that are no longer commonly used have been associated with higher rates of hepatotoxicity in patients with chronic HCV infection,[10,11] newer ARV agents currently in use appear to be less hepatotoxic.

For more than a decade, the mainstay of treatment for HCV infection was a combination regimen of peginterferon and ribavirin (PegIFN/RBV), but this regimen was associated with a poor rate of sustained virologic response (SVR), especially in HIV/HCV-coinfected patients. Rapid advances in HCV drug development led to the discovery of new classes of direct acting antiviral (DAA) agents that target the HCV replication cycle. These new agents, when used with or without PegIFN and RBV, have been shown to achieve high SVR rates. The first DAA agents approved for the treatment of HCV infection in combination with PegIFN/RBV were the HCV protease inhibitors (PI), boceprevir and telaprevir. In HCV genotype 1

infected patients, the combined use of either boceprevir or telaprevir with PegIFN/RBV was associated with higher rates of SVR than use of PegIFN/RBV alone.[12-15] However, combined use of these drugs was associated with a large pill burden, increased dosing frequency, and adverse effects. Subsequently approved DAA agents in the same class and in newer classes that are used with or without RBV have higher SVR rates, reduced pill burden, less frequent dosing, fewer side effects, and shorter durations of therapy.[14,16-19] Therefore, the combination of boceprevir or telaprevir and PegIFN/RBV **is no longer recommended**, and has been replaced by newer combination regimens. Additional guidance on the treatment and management of HCV in HIV-infected and uninfected adults can be found at http://www.hcvguidelines.org/.[20]

Assessment of HIV/Hepatitis C Virus Coinfection

- All HIV-infected patients should be screened for HCV infection using sensitive immunoassays licensed for detection of antibody to HCV in blood.[21] At risk HCV-seronegative patients should undergo repeat testing annually. HCV-seropositive patients should be tested for HCV RNA using a sensitive quantitative assay to confirm the presence of active infection.[22,23] Patients who test HCV RNA-positive should undergo HCV genotyping and liver disease staging as recommended by the most updated HCV guidelines (see http://www.hcvguidelines.org/).
- Patients with HIV/HCV coinfection should be counseled to avoid consuming alcohol and to use appropriate precautions to prevent transmission of HIV and/or HCV to others. HIV/HCV-coinfected patients who are susceptible to hepatitis A virus (HAV) or hepatitis B virus (HBV) infection should be vaccinated against these viruses.
- All patients with HIV/HCV coinfection should be evaluated for HCV therapy.

Antiretroviral Therapy in HIV/Hepatitis C Virus Coinfection

When to Start Antiretroviral Therapy

The rate of liver disease (liver fibrosis) progression is accelerated in HIV/HCV-coinfected patients, particularly in individuals with low CD4 counts (≤350 cells/mm^3). Data largely from retrospective cohort studies are inconsistent regarding the effect of ART on the natural history of HCV disease;[6,24,25] however, some studies suggest that ART may slow the progression of liver disease by preserving or restoring immune function and by reducing HIV-related immune activation and inflammation.[26-28] Therefore, ART should be initiated in most HIV/HCV-coinfected patients, regardless of CD4 count **(BII)**. However, in HIV treatment-naive patients with CD4 counts >500 cells/mm^3, some clinicians may choose to defer ART until HCV treatment is completed to avoid drug-drug interactions **(CIII)**. Compared to patients with CD4 counts >350 cells/mm^3, those with CD4 counts <200 had lower HCV treatment response rates and higher rates of toxicity due to PegIFN/RBV.[29] Data regarding HCV treatment response to combination therapy with DAA agents in those with advanced immunosuppression is lacking. For patients with lower CD4 counts (e.g., <200 cells/mm^3), ART should be initiated promptly **(AI)** and HCV therapy may be delayed until the patient is stable on HIV treatment **(CIII)**.[23,30-32]

Antiretroviral Drugs to Start and Avoid

Initial ARV combination regimens recommended for most HIV treatment-naive patients with HCV are the same as those recommended for patients without HCV infection. Special considerations for ARV selection in HIV/HCV-coinfected patients include the folllowing:

- When both HIV and HCV treatments are indicated, the ARV regimen should be selected with special considerations of potential drug-drug interactions (see Table 12) and overlapping toxicities with the HCV treatment regimen.
- Cirrhotic patients should be carefully evaluated by an expert in advanced liver disease for signs of liver

decompensation according to the Child-Turcotte-Pugh classification system. This assessment is necessary because hepatically metabolized ARV and HCV DAA drugs may be contraindicated or require dose modification in patients with Child-Pugh class B and C disease (see Appendix B, Table 7).

Hepatotoxicity

Drug-induced liver injury (DILI) following the initiation of ART is more common in HIV/HCV-coinfected patients than in those with HIV monoinfection. The greatest risk of DILI may be observed in coinfected individuals with advanced liver disease (e.g., cirrhosis, end-stage liver disease).[33] Eradication of HCV infection with treatment may decrease the likelihood of ARV-associated DILI.[34]

- Given the substantial heterogeneity in patient populations and drug regimens, comparison of DILI incidence rates for individual ARV agents across clinical trials is difficult. The incidence of significant elevations in liver enzyme levels (more than 5 times the upper limit of the normal laboratory reference range) is low with currently recommended ART regimens. Hypersensitivity (or allergic) reactions associated with rash and elevations in liver enzymes can occur with certain ARVs. Alanine aminotransferase (ALT) and aspartate aminotransferase (AST) levels should be monitored 2 to 8 weeks after initiation of ART and every 3 to 6 months thereafter. Mild to moderate fluctuations in ALT and/or AST are typical in individuals with chronic HCV infection. In the absence of signs and/or symptoms of liver disease or increases in bilirubin, these fluctuations do not warrant interruption of ART. Patients with significant ALT and/or AST elevation should be careful evaluated for signs and symptoms of liver insufficiency and for alternative causes of liver injury (e.g., acute HAV or HBV infection, hepatobiliary disease, or alcoholic hepatitis). Short-term interruption of the ART regimen or of the specific drug suspected of causing the DILI may be required.[35]

Concurrent Treatment of HIV and Hepatitis C Virus Infection

Concurrent treatment of HIV and HCV is feasible but may be complicated by pill burden, drug-drug interactions, and toxicities. In this context, the stage of HCV disease should be assessed to determine the medical need for HCV treatment and inform decision making on when to start HCV. Additional guidance on the treatment and management of HCV in HIV-infected and uninfected adults can be found at http://www.hcvguidelines.org/. If the decision is to treat HCV, the ART regimen may need to be modified before HCV treatment is initiated to reduce the potential for drug-drug interactions and/or toxicities that may develop during the period of concurrent HIV and HCV treatment. (See Table 12 for recommendations on the concomitant use of selected drugs for treatment of HCV and HIV infection.) In patients with suppressed plasma HIV RNA and modified ART, HIV RNA should be measured within 4 to 8 weeks after changing HIV therapy to confirm the effectiveness of the new regimen. After completion of HCV treatment, the modified ART regimen should be continued for at least 2 weeks before reinitiating the original regimen. Continued use of the modified regimen is necessary because of the prolonged half-life of some HCV drugs and the potential risk of drug-drug interactions if a prior HIV regimen is resumed soon after HCV treatment is completed.

Drug-Drug Interaction

Considerations for the concurrent use of ART and recommended HCV agents (per http://hcvguidelines.org/) are discussed below. Table 12 provides recommendations on the concomitant use of selected drugs for treatment of HCV and HIV infection.

- Sofosbuvir is an HCV NS5B nucleotide polymerase inhibitors that is not metabolized by the cytochrome P450 enzyme system and, therefore, can be used in combination with most ARV drugs. Sofosbuvir is a substrate of p-glycoprotein (P-gp). P-gp inducers, such as tipranavir (TPV), may decrease sofosbuvir plasma concentrations and should not be co-administered with sofosbuvir. No other clinically significant pharmocokinetic intractions between sofosbuvir and ARVs have been identified. Drug-drug interaction studies in healthy volunteers did not find any significant interaction between sofosbuvir and

darunavir/ritonavir (DRV/r), efavirenz (EFV), rilpivirine (RPV), raltegravir (RAL), tenofovir disoproxil fumarate (TDF), or emtricitabine (FTC).[36] See Table 12 for recommendations on the concomitant use of selected drugs for treatment of HCV and HIV infection.

- Ledipasvir is an HCV NS5A inhibitor and is part of a fixed-dose drug combination of sofosbuvir and ledipasvir.[37] Similar to sofosbuvir, ledipasvir is not metabolized by the cytochrome P450 system (CYP) of enzymes and is a substrate for P-gp. Ledipasvir is an inhibitor of the drug transporters P-gp and breast cancer resistance protein (BCRP) and may increase intestinal absorption of coadministered substrates for these transporters. The use of P-gp inducers is not recommended with ledipasivir/sofosbuvir. The coadministration of ledipasvir/sofosbuvir and ARV regimens containing TDF is associated with increased exposure to TDF, especially when TDF is taken with an HIV PI boosted with either RTV or cobicistat (COBI) (see Table 12 for recommendations on the concomitant use of selected drugs for treatment of HCV and HIV infection). In some patients, alternative HCV or ARV drugs should be considered to avoid increases in TDF exposures. If the drugs are co-administered, the patient should be monitored for potential TDF-associated renal injury by assessing measurements of renal function (i.e., estimated creatinine clearance, serum phosphorus, urine glucose, and urine protein) before HCV treatment initiation and periodically during treatment.

- The fixed-dose drug combination of ombitasvir (a NS5A inhibitor), paritaprevir (an HCV PI), and RTV (a pharmacokinetic enhancer) is co-packaged and used in combination with dasabuvir, an NS5B inhibitor.[38] Paritaprevir is a substrate and inhibitor of the CYP3A4 enzymes and therefore may have significant interactions with certain ARVs that are metabolized by, or may induce or inhibit the same pathways. Dasabuvir is primarily metabolized by the CYP2C8 enzymes. Furthermore, ombitasvir, paritaprevir, and dasabuvir are inhibitors of UGT1A1 and also substrates of P-gp and BCRP. Paritaprevir is also a substrate and inhibitor of OATP1B1/3. Coadministration with drugs that are substrates or inhibitors of these enzymes and drug transporters may result in increased plasma concentrations of either the coadministered drug or the HCV drugs. Given that several CYP enzymes and drug transporters are involved in the metabolism of dasabuvir, ombitasvir, paritaprevir, and RTV, complex drug-drug interactions are likely. Therefore clinicians need to consider all coadministered drugs for potential drug-drug interactions. No significant drug-drug interactions have been found when dasabuvir, ombitasvir, paritaprevir, and RTV are used in conjunction with ATV or RAL. When either RTV or COBI is used in conjunction with ATV, the boosting agent should be discontinued during HCV therapy and ATV should be taken in the morning at the same time as ombitasvir, paritaprevir/r, and dasabuvir. RTV or COBI should be restarted after completion of HCV treatment. See Table 12 for other recommendations for concomitmant use of HCV drugs with ARVs. HIV-infected patients not on ART should be placed on an alternative HCV regimen because RTV has activity against HIV.

- Simeprevir is a HCV NS3/4A PI that has been studied in HIV/HCV-coinfected patients.[39] Simeprevir is a substrate and inhibitor of CYP3A4 and P gp enzymes, and therefore may have significant interactions with certain ARVs that are metabolized by the same pathways. Simeprevir is also an inhibitor of the drug transporter OATP1B1/3. On the basis of drug-drug interaction studies in healthy volunteers, simeprevir can be coadministered with RAL, DTG, RPV, and TDF.[40] However, coadministration of simeprevir with EFV, ETR, HIV PIs, COBI, or EVG/c/TDF/FTC **is not recommended**. (See Table 12 for recommendations on the concomitant use of selected drugs for treatment of HCV and HIV infection.)

Given that the treatment of HCV is rapidly evolving, this section will be updated when new HCV drugs are approved that may have an impact on the treatment of HIV. For guidance on the treatment of HCV infection, refer to http://www.hcvguidelines.org/.

Table 12. Concomitant Use of Selected HIV Drugs and FDA-Approved HCV Drugs for Treatment of HCV in HIV-Infected Adults (page 1 of 3)

Recommendations in this table are based on available pharmacokinetics interaction data or predictions based on the known metabolic pathways of the HIV and HCV drugs. Whenever HIV and HCV drugs are used concomitantly, patients should be closely monitored for HIV and HCV virologic efficacy and potential toxicities. Given that the field of HCV therapy is rapidly evolving, clinicians should also refer to the latest drug product labels and HCV guidelines (www.hcvguidelines.org/) for updated information.

Selected HIV Drugs	HCV DAA drugs				HCV Non-DAA Drugs	
	NS5B Inhibitor	Coformulated NS5A/NS5B Inhibitor	Coformulated NS5A/HCV PI Plus NS5B Inhibitor	HCV Protease Inhibitor[a]		
	Sofosbuvir	Ledipasvir/ Sofosbuvir	Ombitasvir/Paritaprevir/ Ritonavir Plus Dasabuvir[b]	Simeprevir	Ribavirin	Pegylated Interferon alpha
NRTIs						
3TC	✓	✓	✓	✓	✓	✓
ABC	✓	✓	✓	✓	✓	✓
FTC	✓	✓	✓	✓	✓	✓
TDF	✓	✓ Monitor for TDF toxicity	✓	✓	✓	✓
ZDV	✓	✓	✓	✓	✗[c]	✗[d]
PIs						
ATV (Unboosted)	✓	✓	✓ Reduce ATV dose to 300 mg and take in AM at same time as (ombitasvir/paritaprevir/r plus dasabuvir). If RTV cannot be used, choose an alternative HCV regimen.	✗	✓	✓
ATV/r or ATV/c	✓	✓ If PI/r [or ATV/c, DRV/c] is used with TDF, ↑ TDF concentrations are expected. If coadministration necessary, monitor for TDF-associated toxicities (see footnote[e])	✓ Take ATV 300 mg in AM at same time as (ombitasvir/paritaprevir /r plus dasabuvir); discontinue RTV or COBI in HIV regimen until HCV therapy completed.	✗	✓	✓
DRV/r or DRV/c	✓		✗	✗	✓	✓
FPV or FPV/r	✓		✗	✗	✓	✓
LPV/r	✓		✗	✗	✓	✓
SQV/r	✓		✗	✗	✓	✓

Table 12. Concomitant Use of Selected HIV Drugs and FDA-Approved HCV Drugs for Treatment of HCV in HIV-Infected Adults (page 2 of 3)

Selected HIV Drugs	HCV DAA drugs				HCV Non-DAA Drugs	
	NS5B Inhibitor	Coformulated NS5A/NS5B Inhibitor	Coformulated NS5A/HCV PI Plus NS5B Inhibitor	HCV Protease Inhibitor[a]		
	Sofosbuvir	Ledipasvir/ Sofosbuvir	Ombitasvir/Paritaprevir/ Ritonavir Plus Dasabuvir[b]	Simeprevir	Ribavirin	Pegylated Interferon alpha
PIs, continued						
TPV/r	✗	✗	✗	✗	✓	✓
NNRTIs						
EFV	✓	✓ If EFV used with TDF/FTC, monitor for TDF toxicity due to ↑ TDF concentrations	✗	✗	✓	✓
ETR	✓	✓	✗	✗	✓	✓
NVP	✓	✓	✗	✗	✓	✓
RPV	✓	✓	✗	✓	✓	✓
INSTIs						
DTG	✓	✓	?	✓	✓	✓
EVG/c/ TDF/FTC	✓	✗	✗	✗	✓	✓
EVG (plus PI/r Without COBI)	**Refer to recommendations specific to each PI/r.**					
RAL	✓	✓	✓	✓	✓	✓
CCR5 Antagonist						
MVC	✓	✓	✗	✓	✓	✓

✓ = ARV agents that can be used concomitantly

✗ = ARV agents not recommended

? = Data on PK interactions with the ARV drug are unavailable or insufficient to make a recommendation.

[a] Boceprevir is no longer recommended for HCV treatment and telaprevir is no longer available in the United States; therefore, these products have been removed from this table.

[b] Dasabuvir must be prescribed with ombitasvir/paritaprevir/ritonavir.

[c] Concomitant use of ZDV with ribavirin is not recommended given the potential for worsening anemia.

[d] Concomitant use of ZDV with pegylated interferon is not recommended given the potential for worsening neutropenia

[e] Consider alternative HCV or ARV therapy to avoid increases in TDF exposures. If coadministration is necessary, monitor for TDF-associated adverse reactions

Table 12. Concomitant Use of Selected HIV Drugs and FDA-Approved HCV Drugs for Treatment of HCV in HIV-Infected Adults (page 3 of 3)

Key to Acronyms: 3TC = lamivudine; ABC = abacavir; AM = morning; ART = antiretroviral therapy; ATV/r = atazanavir/ritonavir; ATV/c = atazanavir/cobicistat; COBI = cobicistat; DAA = direct-acting antiviral agents; DRV/r = darunavir/ritonavir; DRV/c = darunavir/cobicistat; DTG = dolutegravir; EFV = efavirenz; ETR = etravirine; EVG = elvitegravir; EVG/c = elvitegravir/cobicistat; FPV/r = fosamprenavir/ritonavir; FTC = emtricitabine; HCV = hepatitis C virus; INSTI = integrase strand transfer inhibitor; LPV/r = lopinavir/ritonavir; MVC = maraviroc; NVP = nevirapine; PI/r = ritonavir-boosted protease inhibitor; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; SQV/r = saquinavir/ritonavir; TDF = tenofovir disoproxil fumarate; TPV/r = tipranavir/ritonavir; ZDV = zidovudine

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Mycobacterium Tuberculosis Disease with HIV Coinfection (Last updated March 27, 2012; last reviewed March 27, 2012)

Panel's Recommendations

- The principles for treatment of active tuberculosis (TB) disease in HIV-infected patients are the same as those for HIV-uninfected patients **(AI)**.
- All HIV-infected patients with diagnosed active TB should be started on TB treatment immediately **(AI)**.
- All HIV-infected patients with diagnosed active TB should be treated with antiretroviral therapy (ART) **(AI)**.
- In patients with CD4 counts <50 cells/mm^3, ART should be initiated within 2 weeks of starting TB treatment **(AI)**.
- In patients with CD4 counts ≥50 cells/mm^3 who present with clinical disease of major severity as indicated by clinical evaluation (including low Karnofsky score, low body mass index [BMI], low hemoglobin, low albumin, organ system dysfunction, or extent of disease), ART should be initiated within 2 to 4 weeks of starting TB treatment. The strength of this recommendation varies on the basis of CD4 cell count:
  - CD4 count 50 to 200 cells/mm^3 **(BI)**
  - CD4 count >200 cells/mm^3 **(BIII)**
- In patients with CD4 counts ≥50 cells/mm^3 who do not have severe clinical disease, ART can be delayed beyond 2 to 4 weeks of starting TB therapy but should be started within 8 to 12 weeks of TB therapy initiation. The strength of this recommendation also varies on the basis of CD4 cell count:
  - CD4 count 50 to 500 cells/mm^3 **(AI)**
  - CD4 count >500 cells/mm^3 **(BIII)**
- In all HIV-infected pregnant women with active TB, ART should be started as early as feasible, both for maternal health and for prevention of mother-to-child transmission (PMTCT) of HIV **(AIII)**.
- In HIV-infected patients with documented multidrug-resistant (MDR) and extensively drug-resistant (XDR) TB, ART should be initiated within 2 to 4 weeks of confirmation of TB drug resistance and initiation of second-line TB therapy **(BIII)**.
- Despite pharmacokinetic drug interactions, a rifamycin (rifampin or rifabutin) should be included in TB regimens for patients receiving ART, with dosage adjustment if necessary **(AII)**.
- Rifabutin is the preferred rifamycin to use in HIV-infected patients with active TB disease on a protease inhibitor (PI)-based regimen because the risk of substantial drug interactions with PIs is lower with rifabutin than with rifampin **(AII)**.
- Coadministration of rifampin and PIs (with or without ritonavir [RTV] boosting) is not recommended **(AII)**.
- Rifapentine (RPT) is NOT recommended in HIV-infected patients receiving ART for treatment of latent TB infection (LTBI) or active TB, unless in the context of a clinical trial **(AIII)**.
- Immune reconstitution inflammatory syndrome (IRIS) may occur after initiation of ART. Both ART and TB treatment should be continued while managing IRIS **(AIII)**.
- Treatment support, which can include directly observed therapy (DOT) of TB treatment, is strongly recommended for HIV-infected patients with active TB disease **(AII)**.

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

Rating of Evidence: *I = Data from randomized controlled trials; II = Data from well-designed nonrandomized trials or observational cohort studies with long-term clinical outcomes; III = Expert opinion*

Treatment of Active Tuberculosis in HIV-Infected Patients

HIV infection significantly increases the risk of progression from latent to active TB disease. The CD4 cell count influences both the frequency and severity of active TB disease.[1-2] Active TB also negatively affects HIV disease. It may be associated with a higher HIV viral load and more rapid progression of HIV disease.[3]

Active pulmonary or extrapulmonary TB disease requires prompt initiation of TB treatment. The treatment of active TB disease in HIV-infected patients should follow the general principles guiding treatment for

individuals without HIV **(AI)**. Treatment of drug-susceptible TB disease should include a standard regimen that consists of isoniazid (INH) + a rifamycin (rifampin or rifabutin) + pyrazinamide + ethambutol given for 2 months, followed by INH + a rifamycin for 4 to 7 months.[4] The Guidelines for Prevention and Treatment of Opportunistic Infections in HIV-Infected Adults and Adolescents[4] include a more complete discussion of the diagnosis and treatment of TB disease in HIV-infected patients.

All patients with HIV/TB disease should be treated with ART **(AI)**. Important issues related to the use of ART in patients with active TB disease include: (1) when to start ART, (2) significant pharmacokinetic drug-drug interactions between rifamycins and some antiretroviral (ARV) agents, (3) the additive toxicities associated with concomitant ARV and TB drug use, (4) the development of TB-associated IRIS after ART initiation, and (5) the need for treatment support including DOT and the integration of HIV and TB care and treatment.

Antiretroviral Therapy in Patients with Active Tuberculosis

Patients Diagnosed with Tuberculosis While Receiving Antiretroviral Therapy

When TB is diagnosed in a patient receiving ART, the patient's ARV regimen should be assessed with particular attention to potential pharmacokinetic interactions with rifamycins (discussed below). The patient's regimen may need to be modified to permit use of the optimal TB treatment regimen (see Tables 17–19 for dosing recommendations).

Patients Not Yet Receiving Antiretroviral Therapy

Until recently, when to start ART in patients with active TB has been a subject of debate. Survival is improved when ART is started early following initiation of TB therapy, but a delay in initiating ART often was favored because of the potential complications of high pill burden, additive toxicities, drug interactions, adherence, and the potential for development of IRIS.Recent studies primarily conducted in resource-limited settings, including three randomized controlled trials, have helped clarify the question of when to start ART in patients with active TB.[5-8]

The SAPiT study conducted in South Africa convincingly demonstrated that starting ART during rather than after concluding treatment for TB can significantly reduce mortality. In this study, ambulatory HIV-infected patients with smear-positive TB and CD4 counts <500 cells/mm^3 were randomized to one of three treatment arms: integrated therapy with ART initiated either during the first 4 weeks of TB therapy or after the first 8 weeks of TB treatment (i.e., during the continuation phase of TB therapy) or sequential therapy with ART initiated after the conclusion of standard TB therapy. The median CD4 cell count of participants at study entry was 150 cells/mm^3. The sequential therapy arm was stopped when an early analysis demonstrated that the mortality rate in the combined two integrated arms was 56% lower than the rate in the sequential therapy arm. Treatment was continued in the two integrated arms until study completion.[5]

With the completion of SAPiT and 2 other randomized controlled trials, CAMELIA and STRIDE, the question on the optimal time to initiate ART during TB therapy has been addressed. Findings from these trials now serve as the basis for the Panel's recommendations on when to start ART in patients with active TB.

In the final analysis of the SAPiT trial, there were no differences in rates of AIDS or death between the 2 integrated arms of the study (patients who started ART within 4 weeks after initiating TB treatment vs. those who started ART at 8–12 weeks [i.e., within 4 weeks after completing the intensive phase of TB treatment]). However, in patients with baseline CD4 counts <50 cells/mm^3 (17% of the study population), the rate of AIDS or death was lower in the earlier therapy group than in the later therapy group (8.5 vs. 26.3 cases per 100 person-years, a strong trend favoring the earlier treatment arm, $P = 0.06$). For all patients, regardless of CD4

cell count, earlier therapy was associated with a higher incidence of IRIS and of adverse events that required a switch in ARV drugs than later therapy. Two deaths were attributed to IRIS.[6]

In the CAMELIA study, which was conducted in Cambodia[7], patients who had CD4 counts <200 cells/mm^3 were randomized to initiate ART at 2 weeks or 8 weeks after initiation of TB treatment. Study participants had advanced HIV disease, with a median entry CD4 count of 25 cells/mm^3; low BMIs (median = 16.8 kg/m^2), Karnofsky scores (87% <70), and hemoglobin levels (median = 8.7 g/dl); and high rates of disseminated TB disease. Compared with therapy initiated at 8 weeks, ART initiated at 2 weeks resulted in a 38% reduction in mortality (P = 0.006). A significant reduction in mortality was seen in patients with CD4 counts ≤50 cells/mm^3 and in patients with CD4 counts 51 to 200 cells/mm^3. Overall, 6 deaths associated with TB-IRIS were reported.

The ACTG 5221 (STRIDE) trial, a multinational study conducted at 28 sites, randomized ART-naive patients with confirmed or probable TB and CD4 counts <250 cells/mm^3 to earlier (<2 weeks) or later (8–12 weeks) ART.[8] At study entry, the participants' median CD4 count was 77 cells/mm^3. The rates of mortality and AIDS diagnoses were not different between the earlier and later arms, although higher rates of IRIS were seen in the earlier arm. However, a significant reduction in AIDS or death was seen in the subset of patients with CD4 counts <50 cells/mm^3 who were randomized to the earlier ART arm (P = 0.02).

In each of these 3 studies, IRIS was more common in patients initiating ART earlier than in patients starting ART later, but the syndrome was infrequently associated with mortality. Collectively these 3 trials demonstrate that in patients with active TB and with very low CD4 cell counts (i.e., <50 cells/mm^3), early initiation of ART can reduce mortality and AIDS progression, albeit at the risk of increased IRIS. These findings strongly favor initiation of ART within the first 2 weeks of TB treatment in patients with CD4 cell counts <50 cells/mm^3 **(AI)**.

The question of when to start ART in patients with CD4 counts ≥50 cells/mm^3 is also informed by these studies. The STRIDE and SAPiT studies—in which the patients with CD4 cell counts ≥50 cells/mm^3 were relatively healthy and with reasonable Karnofsky scores (note the SAPiT study excluded patients with Karnofsky scores <70) and BMIs—demonstrated that ART initiation in these patients can be delayed until 8 to 12 weeks after initiation of TB therapy (**AI** for CD4 counts 51–500 cells/mm^3 and **BIII** for CD4 counts >500 cells/mm^3).

However, the CAMELIA study, which included more patients who were severely ill than the STRIDE and SAPiT studies, showed that early initiation of ART improved survival both in patients with CD4 counts ≤50 cells/mm^3 and in patients with CD4 counts from 51 to 200 cells/mm^3. In a multivariate analysis, age >40 years, low BMI (<16), low Karnofsky score (<40), elevated aspartate aminotransferase (AST) level (>1.25 x the upper limit of normal [ULN]), disseminated and MDR TB were independently associated with poor survival; whereas in a univariate analysis, hemoglobin <10g/dl also was associated with poor survival.

Thus, recently published results from the three clinical trials are complementary in defining the need for ART and use of CD4 count and clinical status to inform decisions on the optimal time to initiate ART in patients with HIV and TB disease. Earlier initiation of ART within 2 to 4 weeks of TB treatment should be strongly considered for patients with CD4 cell counts from 50 to 200 cells/mm^3 who have evidence of clinical disease of major severity as indicated by clinical evaluation, low Karnofsky score, low BMI, low hemoglobin, low albumin, or organ system dysfunction **(BI)**. Initiation of ART within 2 to 4 weeks also should be considered for patients with CD4 counts >200 cells/mm^3 who present with evidence of severe disease **(BIII)**.

Of additional importance, each of the above studies demonstrated excellent responses to ART, with 90% and >95% of participants achieving suppressed viremia (HIV RNA <400 copies/mL) at 12 months in the SAPiT and CAMELIA studies, respectively, and 74% of participants at 2 years in the STRIDE study.

Mortality rates in patients with MDR or XDR TB and HIV coinfection are very high.[9] Retrospective case control studies and case series provide growing evidence of better outcomes associated with receipt of ART in such coinfected patients,[10] but the optimal timing for initiation of ART is unknown. However, given the high rates and rapid mortality, most experts recommend that ART be initiated within 2 to 4 weeks after confirmation of the diagnosis of drug resistance and initiation of second-line TB therapy **(BIII)**.

All HIV-infected pregnant women with active TB should be started on ART as early as feasible, both for maternal health and to prevent perinatal transmission of HIV **(AIII)**. The choice of ART should be based on efficacy and safety in pregnancy and take into account potential drug-drug interactions between ARVs and rifamycins (see Perinatal Guidelines for more detailed discussions).[11]

TB meningitis often is associated with severe complications and high mortality rate. In a randomized study conducted in Vietnam, patients were randomized to immediate ART or to therapy deferred until 2 months after initiation of TB treatment. A higher rate of severe (Grade 4) adverse events was seen in patients who received immediate ART than in those who deferred therapy (80.3% vs. 69.1%, respectively; $P = 0.04$).[12] In this study 59.8% of the immediate ART patients and 55.5% of the delayed ART patients died within 9 months. However, in the United States, where patients may be more closely monitored and treated for severe adverse events such as central nervous system (CNS) IRIS, many experts feel that ART should be initiated as for other HIV/TB-coinfected patients **(CIII)**.

Drug Interaction Considerations

A rifamycin is a crucial component in treatment of drug-sensitive TB. However, both rifampin and rifabutin are inducers of the hepatic cytochrome P (CYP) 450 and uridine diphosphate gluconyltransferase (UGT) 1A1 enzymes and are associated with significant interactions with most ARV agents including all PIs, non-nucleoside reverse transcriptase inhibitors (NNRTIs), maraviroc (MVC), and raltegravir (RAL). Rifampin is a potent enzyme inducer, leading to accelerated drug clearance and significant reduction in ARV drug exposure. Despite these interactions, some observational studies suggest that good virologic, immunologic, and clinical outcomes may be achieved with standard doses of efavirenz (EFV)[13-14] and, to a lesser extent, nevirapine (NVP)[15-16] when combined with rifampin. However, rifampin is not recommended in combination with all PIs and the NNRTIs etravirine (ETR) and rilpivirine (RPV). When rifampin is used with MVC or RAL, increased dosage of the ARV is generally recommended. Rifabutin, a weaker enzyme inducer, is an alternative to rifampin. Because rifabutin is a substrate of the CYP 450 enzyme system, its metabolism may be affected by the NNRTI or PI. Tables 18, 19a, 19b, 19d, and 19e outline the magnitude of these interactions and provide dosing recommendations when rifamycins and selected ARV drugs are used concomitantly. After determining the drugs and doses to use, clinicians should monitor patients closely to assure good control of both TB and HIV infections. Suboptimal HIV suppression or suboptimal response to TB treatment should prompt assessment of drug adherence, subtherapeutic drug levels (consider therapeutic drug monitoring [TDM]), and acquired drug resistance.

Rifapentine is a long-acting rifamycin that can be given once weekly with INH for the treatment of active or latent TB infection. Similar to rifampin and rifabutin, rifapentine is also a CYP3A4 inducer. No systematic study has been performed to assess the magnitude of the enzyme induction effect of rifapentine on the metabolism of ARV drugs and other concomitant drugs. Significant enzyme induction can result in reduced ARV drug exposure, which may compromise virologic efficacy. Rifapentine is **not recommended** for treatment of latent or active TB infection in patients receiving ART, unless given in the context of a clinical trial **(AIII)**.

Anti-Tuberculosis/Antiretroviral Drug Toxicities

ARV agents and TB drugs, particularly INH, rifamycin, and pyrazinamide, can cause drug-induced hepatitis. These first-line TB drugs should be used for treatment of active TB disease, even with coadministration of other potentially hepatotoxic drugs or when baseline liver disease is present **(AIII)**. Patients receiving potentially hepatotoxic drugs should be monitored frequently for clinical symptoms and signs of hepatitis and have laboratory monitoring for hepatotoxicity. Peripheral neuropathy can occur with administration of INH, didanosine (ddI), or stavudine (d4T) or may be a manifestation of HIV infection. All patients receiving INH also should receive supplemental pyridoxine to reduce peripheral neuropathy. Patients should be monitored closely for signs of drug-related toxicities and receive alternative ARVs to ddI or d4T.

Immune Reconstitution Inflammatory Syndrome with Tuberculosis and Antiretroviral Agents

IRIS occurs in two forms: unmasking and paradoxical. The mechanism of the syndrome is the same for both forms: restoration of immune competence by administration of ART, resulting in an exuberant host response to TB bacilli and/or antigens. Unmasking IRIS refers to the initial clinical manifestations of active TB that occurs soon after ART is started. Paradoxical IRIS refers to the worsening of TB clinical symptoms after ART is started in patients who are receiving TB treatment. Severity of IRIS ranges from mild to severe to life threatening. IRIS has been reported in 8% to more than 40% of patients starting ART after TB is diagnosed, although the incidence depends on the definition of IRIS and the intensity of monitoring.[17-18]

Predictors of IRIS include CD4 count <50 cells/mm^3; higher on-ART CD4 counts; high pre-ART and lower on-ART HIV viral loads; severity of TB disease, especially high pathogen burden; and less than 30-day interval between initiation of TB and HIV treatments.[19-22] Most IRIS in HIV/TB disease occurs within 3 months of the start of TB treatment. Delaying initiation of ART for 2 to 8 weeks may reduce the incidence and severity of IRIS. However, this possible advantage of delayed ART must be weighed against the potential benefit of earlier ART in improving immune function and preventing progression of HIV disease and mortality.

Patients with mild or moderately severe IRIS can be managed symptomatically or treated with nonsteroidal anti-inflammatory agents. Patients with more severe IRIS can be treated successfully with corticosteroids. A recent randomized, placebo-controlled trial demonstrated benefit of corticosteroids in the management of IRIS symptoms (as measured by decreasing days of hospitalization and Karnofsky performance score) without adverse consequences.[23] In the presence of IRIS, neither TB therapy nor ART should be stopped because both therapies are necessary for the long-term health of the patient **(AIII)**.

Immune Reconstitution with Antiretroviral Therapy: Conversion to Positive Tuberculin Skin Test and Interferon-Gamma Release Assay

Immune reconstitution with ART may result in unmasking LTBI (i.e., conversion of a previously negative tuberculin skin test [TST] to a positive TST or a positive interferon-gamma [IFN-γ] release assay [IGRA] for *Mycobacterium tuberculosis*-specific proteins). A positive IGRA, similar to a positive TST, is indicative of LTBI in the absence of evidence of active TB disease.[24] Because treatment for LTBI is indicated in the absence of evidence of active TB disease, clinicians should be aware of this phenomenon. Patients with a negative TST or IGRA and advanced HIV disease (i.e., CD4 count <200 cells/mm^3) should have a repeat TST or IGRA after initiation of ART and CD4 count increase to >200 cells/mm^3 **(BII)**.[25]

Caring for Patients with HIV and Tuberculosis

Close collaboration among clinicians, health care institutions, and public health programs involved in the diagnosis and treatment of HIV-infected patients with active TB disease is necessary in order to integrate care and improve medication adherence and TB treatment completion rates, reduce drug toxicities, and maximize HIV outcomes. HIV-infected patients with active TB disease should receive treatment support, including adherence counseling and DOT, corresponding to their needs **(AII)**. ART simplification or use of coformulated fixed-dose combinations also may help to improve drug adherence.

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Limitations to Treatment Safety and Efficacy

Adherence to Antiretroviral Therapy (Last updated May 1, 2014; last reviewed May 1, 2014)

Strict adherence to antiretroviral therapy (ART) is key to sustained HIV suppression, reduced risk of drug resistance, improved overall health, quality of life, and survival,[1,2] as well as decreased risk of HIV transmission.[3] Conversely, poor adherence is the major cause of therapeutic failure. Achieving adherence to ART is a critical determinant of long-term outcome in HIV infected patients. For many chronic diseases, such as diabetes or hypertension, drug regimens remain effective even after treatment is resumed following a period of interruption. In the case of HIV infection, however, loss of virologic control as a consequence of non-adherence to ART may lead to emergence of drug resistance and loss of future treatment options. Many patients initiating ART or already on therapy are able to maintain consistent levels of adherence with resultant viral suppression, CD4+ T-lymphocyte (CD4) count recovery, and improved clinical outcomes. Others, however, have poor adherence from the outset of ART and/or experience periodic lapses in adherence over the lifelong course of treatment. Identifying those with adherence-related challenges that require attention and implementing appropriate strategies to enhance adherence are essential roles for all members of the treatment team.

Recent data underscore the importance of conceptualizing treatment adherence broadly to include early engagement in care and sustained retention in care. The concept of an HIV "treatment cascade" has been used to describe the process of HIV testing, linkage to care, initiation of effective ART, adherence to treatment, and retention in care. The U.S. Centers for Disease Control and Prevention estimates that only 36% of the people living with HIV in the United States are prescribed ART and that among these individuals, only 76% have suppressed viral loads.[4] Thus, to achieve optimal clinical outcomes and to realize the potential public health benefit of treatment as prevention, attention to each step in the treatment cascade is critical.[5] Therefore, provider skill and involvement to retain patients in care and help them achieve high levels of medication adherence are crucial.

This section provides updated guidance on assessing and monitoring adherence and outlines strategies to help patients maintain high levels of adherence.

Factors Associated with Adherence Success and Failure

Adherence to ART can be influenced by a number of factors, including the patient's social situation and clinical condition; the prescribed regimen; and the patient-provider relationship.[6] It is critical that each patient receives and understands information about HIV disease including the goals of therapy (achieving and maintaining viral suppression, decreasing HIV-associated morbidity and mortality, and preventing sexual transmission of HIV), the prescribed regimen (including dosing schedule and potential side effects), the importance of strict adherence to ART, and the potential for the development of drug resistance as a consequence of suboptimal adherence. However, information alone is not sufficent to assure high levels of adherence; patients must also be positively motivated to initiate and maintain therapy.

From a patient perspective, nonadherence is often a consequence of one or more behavioral, structural, and psychosocial barriers (e.g., depression and other mental illnesses, neurocognitive impairment, low health literacy, low levels of social support, stressful life events, high levels of alcohol consumption and active substance use, homelessness, poverty, nondisclosure of HIV serostatus, denial, stigma, and inconsistent access to medications).[7-9] Furthermore, patient age may affect adherence. For example, some adolescent and young adult HIV patients, in particular, have substantial challenges in achieving levels of adherence necessary for successful therapeutic outcomes (see HIV-Infected Adolescents section).[10,11] In additon, failure to adopt practices that facilitate adherence, such as linking medication taking to daily activities or using a medication reminder system or a pill organizer, is also associated with treatment failure.[12]

Characteristics of one or more components of the prescribed regimen can affect adherence. Simple, once-daily regimens,[13] including those with low pill burden, without a food requirement, and few side effects or toxicities, are associated with higher levels of adherence.[14,15] Many currently available ARV regimens are much easier to take and better tolerated than older regimens. Studies have shown that patients taking once-daily regimens have higher rates of adherence than those taking twice-daily dosing regimens.[15] However, data to support or refute the superiority of fixed-dose combination product of 1-pill versus 3-pills (of individual drug products), once-daily regimens—as might be required for the use of some soon-to-be-available generic-based ARV regimens—are limited.

Characteristics of the clinical setting can also have important structural influences on the success or failure of medication adherence. Settings that provide comprehensive multidisciplinary care (e.g., with case managers, pharmacists, social workers, psychiatric care providers) are often more successful in supporting patients' complex needs, including their medication adherence-related needs. Further, specific settings, such as prisons and other institutional settings, may thwart or support medication adherence. Drug abuse treatment programs are often best suited to address substance use that may confound adherence and may offer services, such as directly observed therapy, that promote adherence.

Finally, a patient-provider relationship that enhances patient trust through non-judgmental and supportive care and use of motivational strategies can positively influence medication adherence.

Routine Monitoring of Adherence and Retention in Care

Although there is no gold standard for assessing adherence,[1] properly implemented validated tools and assessment strategies can prove valuable in most clinical settings. Viral load suppression is one of the most reliable indicators of adherence and can be used as positive reinforcement to encourage continuous adherence. When patients initiating ART fail to achieve viral suppression by 24 weeks of treatment, the possibility of suboptimal adherence and other factors must be assessed. Similarly, treatment failure as measured by detectable viral load during chronic care is most likely the result of non-adherence. Patient self-report, the most frequently used method for evaluating medication adherence, remains a useful tool for assessing adherence over time. However, self-reports must be properly and carefully assessed as patients may overestimate adherence. While carefully assessed patient self report of high-level adherence to ART has been associated with favorable viral load responses,[16,17] patient admission of suboptimal adherence is highly correlated with poor therapeutic response. The reliability of self report often depends on how the clinican elicits the information. It is most reliable when ascertained in a simple, nonjudgmental, routine, and structured format that normalizes less-than-perfect adherence and minimizes socially desirable or "white coat adherence" responses. Some patients may selectively adhere to components of a regimen believed to have the fewest side effects or the lowest dosing frequency or pill burden. To allow patients to more accurately disclose lapses in adherence, some experts suggest that providers inquire about the number of missed doses during a defined time period rather than directly asking "Are you taking your medicines?" Others advocate simply asking patients to rate their adherence during the last 4 weeks on a 5- or 6-point Likert scale.[18,19] Regardless of how obtained, patient self-report, in contrast to other measures of adherence, allows for immediate patient-provider discussion to identify reasons for missed doses and to explore corrective strategies.

Other measures of adherence include pharmacy records and pill counts. Pharmacy records can be valuable when medications are obtained exclusively from a single source so that refills can be traced. Pill counts are commonly used but can be altered by patients. Other methods of assessing adherence include the use of therapeutic drug monitoring and electronic measurement devices (e.g., MEMS bottle caps and dispensing systems). However, these methods are costly and are usually done primarily in research settings.

Interventions to Improve Adherence and Retention in Care

A continuum of ART adherence support services is necessary to meet individual patient needs. All health care

team members, including physicians, physician assistants, nurse practitioners, nurse midwives, nurses, pharmacists, medication managers, and social workers play integral roles in successful adherence programs.[17,20-22]

Effective adherence interventions vary in modality and duration, and by clinical setting, provider, and patient. There are many options that can be customized to suit a range of needs and settings (see Table 13). An increasing number of interventions have proven effective in improving adherence to ART. For descriptions of the interventions, see: http://www.cdc.gov/hiv/topics/research/prs/ma-good-evidence-interventions.htm.[23]

Clinicians should provide all patients with a basic level of adherence-related information and support. Before writing the first prescription(s) for patients initiating or reinitiating ART, clinicians should assess the patient's adherence readiness. Clinicians should evaluate patients' knowledge about HIV disease, treatment, and prevention and provide basic information about ART, viral load and CD4 count and the expected outcome of ART based on these parameters, the importance of strict adherence to ART, and the consequences of non-adherence. In addition, clinicians should assess patients' motivation to successfully adhere to ART and identify and support facilitating factors and address potential barriers to adherence. Finally, clinicians should be assured that patients have the necessary medication taking skills to follow the regimen as prescribed.

Given the wide array of treatment options, individualizing treatment with patient involvement in decision making is the cornerstone of treatment planning and therapeutic success. The first principle of successful treatment is to design an understandable plan to which the patient can commit.[24,25] It is important to consider the patient's daily schedule; patient tolerance of pill number, size and frequency; and any issues affecting absorption (e.g., use of acid reducing therapy and food requirements). With the patient's input, a medication choice and administration schedule should be tailored to his/her routine daily activities. If necessary, soliciting help from family members may also improve adherence. Patients who are naive to ART should understand that their first regimen usually offers the best chance for taking a simple regimen that affords long-term treatment success and prevention of drug resistance. Establishing a trusting patient-provider relationship over time and maintaining good communication will help to improve adherence and long-term outcomes. Medication taking can also be enhanced by the use of pill organizers and medication reminder aids (e.g., alarm clock, pager, calendar).

Positive reinforcement can greatly help patients maintain high levels of adherence. This technique to foster adherence includes informing patients of their low or suppressed HIV viral load levels and increases in CD4 cell counts. Motivational interviewing has also been used with some successes. Recognizing high levels of adherence with incentives and rewards can facilitate treatment success in some patients. Adherence-contingent reward incentives such as meal tickets, grocery bags, lotto tickets, and cash have been used in the treatment of HIV and other chronic diseases. The effectiveness of using cash incentives to promote HIV testing, entry to care, and adherence to ART is currently being studied in the multi-site HPTN 065 trial. Other effective interventions include nurse home visits, a five-session group intervention, pager messaging, and couples or family-based interventions. To maintain high levels of adherence in some patients, it is critically important to provide substance abuse therapy and to strengthen social support. Directly observed therapy (DOT) has been effective in providing ART to active drug users[26] but not to patients in a general clinic population.[27]

To determine whether additional adherence or retention interventions are warranted, assessments should be done at each clinical encounter and should be the responsibility of the entire health care team. Routine monitoring of HIV viral load, pharmacy records, and indicators that measure retention in care are useful to determine if more intense efforts are needed to improve adherence. Patients with a history of non-adherence to ART are at risk for poor adherence when re-starting therapy with the same or new drugs. Special attention should be given to identify and address any reason for previous poor adherence. Preferential use of ritonavir-boosted protease inhibitor-(PI/r)-based ART, which has a higher barrier to the development of resistance than

other treatment options, should be considered if poor adherence is predicted.

The critical elements of adherence go hand in hand with linkage-to-care and retention in care. A recently released guideline provides a number of strategies to improve entry and retention in care and adherence to therapy for HIV infected patients.[5] As with adherence monitoring, research advances offer many options for systematic monitoring of retention in care that may be used in accordance with local resources and standards. The options include surveillance of visit adherence, gaps in care, and the number of visits during a specified period of time.[28]

Conclusion

Adherence to ART is central to therapeutic success. Given the many available assessment strategies and interventions, the challenge for the treatment team is to select the techniques that best fit each patient and patient population, and, according to available resources, the treatment setting. In addition to maintaining high levels of medication adherence, attention to effective linkage to care, engagement in care, and retention in care is critical for successful treatment outcomes. To foster treatment success, there are interventions to support each step in the cascade of care, as well as guidance on systematic monitoring of each step in the cascade.[5]

Table 13. Strategies to Improve Adherence to Antiretroviral Therapy and Retention in Care
(page 1 of 3)

Strategies	Examples
Use a multidisciplinary team approach. Provide an accessible, trustworthy health care team.	• Nonjudgmental providers, nurses, social workers, pharmacists, and medication managers
Strengthen early linkage to care and retention in care.	• Encourage healthcare team participation in linkage to and retention in care.
Assess patient readiness to start ART.	
Evaluate patient's knowledge about HIV disease, prevention and treatment and, on the basis of the assessment, provide HIV-related information.	• Considering the patient's current knowledge base, provide information about HIV, including the natural history of the disease, HIV viral load and CD4 count and expected clinical outcomes according to these parameters, and therapeutic and prevention consequences of non-adherence.
Identify facilitators, potential barriers to adherence, and necessary medication management skills before starting ART medication.	• Assess patient's cognitive competence and impairment. • Assess behavioral and psychosocial challenges including depression, mental illnesses, levels of social support, high levels of alcohol consumption and active substance use, non-disclosure of HIV serostatus and stigma. • Identify and address language and literacy barriers. • Assess beliefs, perceptions, and expectations about taking ART (e.g., impact on health, side effects, disclosure issues, consequences of non-adherence). • Ask about medication taking skills and foreseeable challenges with adherence (e.g., past difficulty keeping appointments, adverse effects from previous medications, issues managing other chronic medications, need for medication reminders and organizers). • Assess structural issues including unstable housing, lack of income, unpredictable daily schedule, lack of prescription drug coverage, lack of continuous access to medications.
Provide needed resources.	• Provide or refer for mental health and/or substance abuse treatment. • Provide resources to obtain prescription drug coverage, stable housing, social support, and income and food security.

Table 13. Strategies to Improve Adherence to Antiretroviral Therapy and Retention in Care
(page 2 of 3)

Strategies	Examples
Involve the patient in ARV regimen selection.	• Review regimen potency, potential side effects, dosing frequency, pill burden, storage requirements, food requirements, and consequences of nonadherence. • Assess daily activities and tailor regimen to predictable and routine daily events. • Consider preferential use of PI/r-based ART if poor adherence is predicted. • Consider use of fixed-dose combination formulation. • Assess if cost/co-payment for drugs can affect access to medications and adherence.
Assess adherence at every clinic visit.	• Monitor viral load as a strong biologic measure of adherence. • Use a simple behavioral rating scale. • Employ a structured format that normalizes or assumes less-than-perfect adherence and minimizes socially desirable or "white coat adherence" responses. • Ensure that other members of the health care team also assess adherence.
Use positive reinforcement to foster adherence success.	• Inform patients of low or non-detectable levels of HIV viral load and increases in CD4 cell counts. • When needed, consider providing incentives and rewards for achieving high levels of adherence and treatment success.
Identify the type of and reasons for nonadherence.	• Failure to fill the prescription(s) • Failure to understand dosing instructions • Complexity of regimen (e.g., pill burden, size, dosing schedule, food requirements) • Pill aversion • Pill fatigue • Adverse effects • Inadequate understanding of drug resistance and its relationship to adherence • Cost-related issues • Depression, drug and alcohol use, homelessness, poverty • Stigma • Non-disclosure • Other potential barriers
Select from among available effective treatment adherence interventions.	• See http://www.cdc.gov/hiv/topics/research/prs/ma-good-evidence-interventions.htm. • Use adherence-related tools to complement education and counseling interventions (e.g., pill boxes, dose planners, reminder devices). • Use community resources to support adherence (e.g., visiting nurses, community workers, family, peer advocates). • Use patient prescription assistance programs. • Use motivational interviews.

Table 13. Strategies to Improve Adherence to Antiretroviral Therapy and Retention in Care
(page 3 of 3)

Strategies	Examples
Systematically monitor retention in care.	• Record and follow up on missed visits.
On the basis of any problems identified through systematic monitoring, consider options to enhance retention in care given resources available.	• Provide outreach for those patients who drop out of care. • Use peer or paraprofessional treatment navigators. • Employ incentives to encourage clinic attendance or recognize positive clinical outcomes resulting from good adherence. • Arrange for directly observed therapy (if feasible).

Key to Acronyms: ART = antiretroviral therapy; CD4 = CD4 T lymphocyte; PI = protease inhibitor; PI/r = ritonavir-boosted protease inhibitor

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Adverse Effects of Antiretroviral Agents (Last updated April 8, 2015; last reviewed April 8, 2015)

Adverse effects have been reported with the use of all antiretroviral (ARV) drugs and are among the most common reasons cited for switching or discontinuing therapy and for medication non-adherence.[1] Fortunately, newer ARV regimens are less toxic than regimens used in the past. Generally less than 10% of antiretroviral therapy (ART)-naive patients enrolled in randomized trials have treatment-limiting adverse events. However, because most clinical trials have a relatively short follow-up duration, the longer term complications of ART can be underestimated. In the Swiss Cohort study during a median of 6 years of follow-up, the presence of laboratory adverse events probably or certainly related to ART was associated with higher rates of mortality, which highlights the importance of monitoring for adverse events in overall patient management.[2]

Several factors may predispose individuals to adverse effects of ARV medications. For example, compared with men, women (especially ART-naive women with CD4 T lymphocyte cell counts >250 cells/mm^3) seem to have a higher propensity to develop Stevens-Johnson syndrome, rashes, and hepatotoxicity from nevirapine (NVP)[3-5] and have higher rates of lactic acidosis due to nucleoside reverse transcriptase inhibitors.[6-8] Other factors may also contribute to the development of adverse events:

- Concomitant use of medications with overlapping and additive toxicities;
- Comorbid conditions that increase the risk of or exacerbate adverse effects (e.g., alcoholism[9] or coinfection with viral hepatitis[10-12] increases the risk of hepatotoxicity);
- Drug-drug interactions that may lead to an increase in drug toxicities (e.g., interactions that result from concomitant use of statins with protease inhibitors); or
- Genetic factors that predispose patients to abacavir (ABC) hypersensitivity reaction.[13,14]

The therapeutic goals of ART are to safely achieve and maintain viral suppression and improve immune function. To accomplish these goals, the clinician must consider the toxicity potential of an ARV regimen, as well as the individual patient's underlying conditions, concomitant medications, and prior history of drug intolerances. In addition, it should be appreciated that, in general, the overall benefits of ART outweigh its risks and that some non-AIDS related conditions (e.g., anemia, cardiovascular disease, renal impairment) may be more likely in the absence of ART.[15,16]

Information on the adverse events of ARVs is outlined in several tables in the guidelines. Table 14 provides clinicians with a list of the most common and/or severe known ARV-associated adverse events for each drug class. The most common adverse effects of individual ARV agents are summarized in Appendix B, Tables 1–6.

Table 14. Antiretroviral Therapy-Associated Common and/or Severe Adverse Effects (page 1 of 5)

N/A indicates either that there are no reported cases for the particular side effect or that data for the specific ARV drug class are not available. See Appendix B for additional information listed by drug.

Adverse Effect	NRTIs	NNRTIs	PIs	INSTI	EI
Bleeding Events	N/A	N/A	Spontaneous bleeding, hematuria in hemophilia. TPV: Intracranial hemorrhage associated with CNS lesions, trauma, alcohol abuse, hypertension, coagulopathy, anti-coagulant or anti-platelet agents, vitamin E	N/A	N/A
Bone Density Effects	TDF: Associated with greater loss of BMD than other NRTIs. Osteomalacia has been reported in association with proximal renal tubulopathy.	Decreases in BMD observed after the initiation of any ART regimen.			N/A
Bone Marrow Suppression	ZDV: Anemia, neutropenia	N/A	N/A	N/A	N/A
Cardiovascular Disease	ABC and ddI: Associated with an increased risk of MI in some cohort studies. Absolute risk greatest in patients with traditional CVD risk factors.	N/A	Associated with MI and stroke in some cohorts. SQV/r, ATV/r, and LPV/r: PR prolongation. Risks include pre-existing heart disease, other medications. SQV/r: QT prolongation. Obtain ECG before administering SQV.	N/A	N/A
Cholelithiasis	N/A	N/A	ATV: Cholelithiasis and kidney stones may present concurrently. Median onset is 42 months.	N/A	N/A
Diabetes Mellitus/ Insulin Resistance	ZDV, d4T, and ddI	N/A	Reported for some (IDV, LPV/r), but not all PIs	N/A	N/A

Table 14. Antiretroviral Therapy-Associated Common and/or Severe Adverse Effects (page 2 of 5)

Adverse Effect	NRTIs	NNRTIs	PIs	INSTI	EI
Dyslipidemia	d4T > ZDV > ABC: ↑LDL and TG	EFV: ↑TG, ↑LDL, ↑HDL	All RTV-boosted PIs: ↑LDL, ↑TG, ↑HDL LPV/r = FPV/r and LPV/r > DRV/r and ATV/r: ↑TG	EVG/c/TDF/FTC: ↑TG, ↑LDL, ↑HDL	N/A
Gastrointestinal Effects	Nausea and vomiting: ddI and ZDV > other NRTIs Pancreatitis: ddI	N/A	GI intolerance (e.g., diarrhea, nausea, vomiting) Diarrhea: Common with LPV/r, more frequent than DRV/r and ATV/r	Nausea and diarrhea: EVG/c/ TDF/FTC	N/A
Hepatic Effects	Reported with most NRTIs. Steatosis most common with ZDV, d4T, or ddI. ddI: Prolonged exposure linked to non-cirrhotic portal hypertension, esophageal varices. Flares: HIV/HBV-co-infected patients may develop severe hepatic flares when TDF, 3TC, and FTC are withdrawn or when HBV resistance develops.	NVP > other NNRTIs NVP: Severe hepatotoxicity associated with skin rash or hypersensitivity. 2-week NVP dose escalation may reduce risk. Risk is greater for women with pre-NVP CD4 count >250 cells/mm^3 and men with pre-NVP CD4 count >400 cells/mm^3. NVP should **never** be used for post-exposure prophylaxis, or in patients with hepatic insufficiency (Child-Pugh B or C).	All PIs: Drug-induced hepatitis and hepatic decompensation have been reported; greatest frequency with TPV/r. IDV, ATV: Jaundice due to indirect hyperbilirubinemia TPV/r: **Contraindicated** in patients with hepatic insufficiency (Child-Pugh B or C)	N/A	MVC: Hepatotoxicity with or without rash or HSRs reported

Table 14. Antiretroviral Therapy-Associated Common and/or Severe Adverse Effects (page 3 of 5)

Adverse Effect	NRTIs	NNRTIs	PIs	INSTI	EI
Hypersensitivity Reaction Excluding rash alone or Stevens-Johnson syndrome	ABC: **Contraindicated** if HLA-B*5701 positive. Median onset 9 days; 90% of reactions occur within first 6 weeks of treatment. HSR symptoms (in order of descending frequency): fever, rash, malaise, nausea, headache, myalgia, chills, diarrhea, vomiting, abdominal pain, dyspnea, arthralgia, and respiratory symptoms. Symptoms worsen with continuation of ABC. Patients, regardless of HLA-B*5701 status, should not be re-challenged with ABC if HSR is suspected.	NVP: Hypersensitivity syndrome of hepatotoxicity and rash that may be accompanied by fever, general malaise, fatigue, myalgias, arthralgias, blisters, oral lesions, conjunctivitis, facial edema, eosinophilia, renal dysfunction, granulocytopenia, or lymphadenopathy. Risk is greater for ARV-naive women with pre-NVP CD4 count >250 cells/mm^3 and men with pre-NVP CD4 count >400 cells/mm^3. Overall, risk is higher for women than men. 2-week dose escalation of NVP reduces risk.	N/A	RAL: HSR reported when RAL given in combination with other drugs known to cause HSR. All ARVs should be stopped if HSR occurs. DTG: Reported in <1% of patients in clinical development program	MVC: Reported as part of a syndrome related to hepatotoxicity
Lactic Acidosis	Reported with NRTIs, especially d4T, ZDV, and ddI: Insidious onset with GI prodrome, weight loss, and fatigue. May rapidly progress with tachycardia, tachypnea, jaundice, weakness, mental status changes, pancreatitis, and organ failure. Mortality high if serum lactate >10 mmol/L. Women and obese patients at increased risk.	N/A	N/A	N/A	N/A

Table 14. Antiretroviral Therapy-Associated Common and/or Severe Adverse Effects (page 4 of 5)

Adverse Effect	NRTIs	NNRTIs	PIs	INSTI	EI
Lipodystrophy	Lipoatrophy: d4T > ZDV. May be more likely when NRTIs combined with EFV than with an RTV-boosted PI.	Lipohypertophy: Trunk fat increase observed with EFV-, PI-, and RAL-containing regimens; however, causal relationship has not been established.			N/A
Myopathy/ Elevated Creatine Phosphokinase	ZDV: Myopathy	N/A	N/A	RAL: ↑CPK, weakness and rhabdomyolysis	N/A
Nervous System/ Psychiatric Effects	Peripheral neuropathy: d4T > ddI and ddC (can be irreversible). d4T: Associated with rapidly progressive, ascending neuromuscular weakness resembling Guillain-Barré syndrome (rare)	EFV: Somnolence, insomnia, abnormal dreams, dizziness, impaired concentration, depression, psychosis, and suicidal ideation. Symptoms usually subside or diminish after 2–4 weeks. Bedtime dosing may reduce symptoms. Risks include psychiatric illness, concomitant use of agents with neuropsychiatric effects, and increased EFV concentrations because of genetic factors or increased absorption with food. An association between EFV and suicidal ideation, suicide, and attempted suicide (especially among younger patients and those with history of mental illness or substance abuse) was found in a retrospective analysis of comparative trials.	N/A	All INSTIs: Insomnia RAL: Depression and suicidal ideation (uncommon)	N/A
Rash	FTC: Hyperpigmentation	All NNRTIs	ATV, DRV, FPV, LPV/r, TPV	RAL, EVG/c/TDF/ FTC	MVC

Table 14. Antiretroviral Therapy-Associated Common and/or Severe Adverse Effects (page 5 of 5)

Adverse Effect	NRTIs	NNRTIs	PIs	INSTI	EI
Renal Effects/ Urolithiasis	TDF: ↑SCr, proteinuria, hypophosphatemia, urinary phosphate wasting, glycosuria, hypokalemia, non-anion gap metabolic acidosis Concurrent use with PI appears to increase risk.	N/A	ATV and LPV/r: Increased chronic kidney disease risk in a large cohort study. IDV: ↑SCr, pyuria, renal atrophy or hydronephrosis IDV, ATV: Stone, crystal formation; adequate hydration may reduce risk.	COBI (in EVG/c/ TDF/FTC) and DTG: Inhibits Cr secretion without reducing renal glomerular function.	N/A
Stevens-Johnson Syndrome/Toxic Epidermal Necrosis	ddI, ZDV: Reported cases	NVP > DLV, EFV, ETR, RPV	FPV, DRV, IDV, LPV/r, ATV: Reported cases	RAL	N/A

Key to Abbreviations: 3TC = lamivudine; ABC = abacavir; ALT = alanine aminotransferase; ARV = antiretroviral; ATV = atazanavir; ATV/r = atazanavir/ritonavir; BMD = bone mineral density; Cr = creatinine; CrCl = creatinine clearance; CNS = central nervous system; COBI or c = cobicistat; CPK = creatine phosphokinase; CVD = cardiovascular disease; d4T = stavudine; ddC = zalcitabine; ddI = didanosine; DLV = delavirdine; DRV = darunavir; DRV/r = darunavir/ritonavir; DTG = dolutegravir; ECG = electrocardiogram; EFV = efavirenz; EI = entry inhibitor; ETR = etravirine; EVG = elvitegravir; FPV = fosamprenavir; FPV/r = fosamprenavir/ritonavir; FTC = emtricitabine; GI = gastrointestinal; HBV = hepatitis B virus; HDL = high-density lipoprotein; HSR = hypersensitivity reaction; IDV = indinavir; INSTI = integrase strand transfer inhibitor; LDL = low-density lipoprotein; LPV/r = lopinavir/ritonavir; MI = myocardial infarction; MVC = maraviroc; NFV = nelfinavir; NNRTI = non-nucleoside reverse transcriptase inhibitor; NRTI = nucleoside reverse transcriptase inhibitor; NVP = nevirapine; PI = protease inhibitor; PT = prothrombin time; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; SCr = serum creatinine; SQV = saquinavir; SQV/r = saquinavir/ritonavir; TDF = tenofovir disoproxil fumarate; TG = triglyceride; TPV = tipranavir; TPV/r = tipranavir/ritonavir; ZDV = zidovudine

Switching Antiretroviral Therapy Because of Adverse Effects

Most patients do not experience treatment-limiting ART-associated toxicities; however, some patients do, and in these cases, ART must be modified. ART-associated adverse events can range from acute and potentially life threatening to chronic and insidious. Acute life-threatening events (e.g., acute hypersensitivity reaction due to ABC, lactic acidosis due to stavudine [d4T] and didanosine [ddI], liver and/or severe cutaneous toxicities due to NVP) usually require the immediate discontinuation of all ARV drugs and re-initiation of an alternative regimen without overlapping toxicity. Non-life threatening toxicities (e.g., urolithiasis with atazanavir [ATV], renal tubulopathy with tenofovir [TDF]) can usually be managed by substituting another ARV agent for the presumed causative agent without interruption of ART. Other, chronic, non-life threatening adverse events (e.g., dyslipidemia) can be addressed either by switching the potentially causative agent for another agent or by managing the adverse event with additional pharmacological or non-pharmacological interventions. Management strategies must be individualized for each patient.

Switching from an effective ARV regimen to a new regimen must be done carefully and only when the potential benefits of the change outweigh the potential complications of altering treatment. The fundamental principle of regimen switching is to maintain viral suppression. When selecting a new agent or regimen, providers should be aware that resistance mutations selected for, regardless of whether previously or currently identified by genotypic resistance testing, are archived in HIV reservoirs, and even if absent from subsequent resistance test results, may reappear under selective pressure. It is critical that providers review the following before implementing any treatment switch:

- the patient's medical and complete ARV history including prior virologic responses to ART;
- resistance test results;
- viral tropism (when maraviroc [MVC] is being considered);
- HLA B*5701 status (when ABC is being considered);
- co-morbidities;
- adherence history;
- prior intolerances to any medications; and
- concomitant medications and supplements and their potential for drug interactions with ARVs.

Patient acceptance of new food or dosing requirements must also be assessed. In some cases, medication costs may also be a factor to consider before switching treatment. Signs and symptoms of ART-associated adverse events may mimic those of comorbidities, adverse effects of concomitant medications, or HIV infection itself. Therefore, concurrent with ascribing a particular clinical event to ART, alternative causes for the event should be investigated. In the case of a severe adverse event, it may be necessary to discontinue or switch ARVs pending the outcome of such an investigation. For the first few months after an ART switch, the patient should be closely monitored for any new adverse events. The patient's viral load should also be monitored to assure continued viral suppression.

Table 15 lists several major ART-associated adverse events and potential options to appropriately switch agents in an ARV regimen. The table focuses on the ARVs most commonly used in the United States and lists substitutions that are supported by ARV switch studies, findings of comparative ARV trials and observational cohort studies, or expert opinion. Switching a successful ARV regimen should be done carefully and only when the potential benefits of the change outweigh the potential complications of altering treatment.

Table 15. Antiretroviral Therapy-Associated Adverse Events That Can Be Managed with Substitution of Alternative Antiretroviral Agent (page 1 of 2)

Adverse Event	ARV Agent(s)/Drug Class		Comments
	Switch from	Switch to	
Bone Density Effects	TDF[a]	ABC[b]	Declines in BMD have been observed with the start of most ART regimens. Switching from TDF to alternative ARV agents has been shown to increase bone density, but the clinical significance of this increase remains uncertain.
Bone Marrow Suppression	ZDV	TDF or ABC[b]	ZDV has been associated with neutropenia and macrocytic anemia
Central Nervous System/ Neuropsychiatric Side Effects Dizziness, suicidal ideation, abnormal dreams, depression	EFV	Alternative NNRTI (RPV, ETR, NVP), a PI/c or PI/r, or an INSTI	In most patients, EFV-related CNS effects subside within 4 weeks after initiation of the drug. Persistent or intolerable effects should prompt substitution of EFV.
Dyslipidemia Hypertriglyceridemia (with or without elevated low-density LDL level)	RTV- or COBI-boosted regimens or EFV	RAL, DTG, RPV, NVP, or unboosted ATV[c]	Elevated TG and LDL levels are more common with LPV/r and FPV/r than with other RTV-boosted PIs. Improvements in TG and LDL levels observed with switch from LPV/r to ATV or ATV/r.[c]
Gastrointestinal Effects Nausea, diarrhea	LPV/r	ATV/c, ATV/r, DRV/c, DRV/r, RAL, DTG, EVG/c/TDF/FTC	GI intolerance is common with boosted PIs and is linked to the total dose of RTV. More GI toxicity is seen with LPV/r than with ATV/r or DRV/r. GI effects are often transient, and do not warrant substitution unless persistent and intolerable.
	Other RTV- or COBI-boosted regimens	RAL, DTG, unboosted ATV,[c] NNRTIs	In a trial of treatment-naive patients, rates of diarrhea and nausea were similar for EVG/c/TDF/FTC and ATV/r plus TDF/FTC.
Hypersensitivity Reaction	ABC	TDF	Never re-challenge with ABC following a suspected HSR, regardless of the patient's HLA B*5701 status.
	NVP, EFV, ETR, RPV	Non-NNRTI ART	Risk of HSR with NVP is higher for women and those with high CD4 cell counts.
	DTG, RAL MVC	Non-INSTI ART Suitable alternative ART	Reactions to NVP, ETR, RAL, DTG and MVC may be accompanied by elevated liver transaminases.
Insulin Resistance	LPV/r, FPV/r	NNRTI (NVP or RPV), INSTI, unboosted ATV[c]	Results of switch studies have been inconsistent. Studies in HIV-negative patients suggest a direct causal effect of LPV/r (and IDV) on insulin resistance. However, traditional risk factors may be stronger risk factors for insulin resistance than use of any PI.
Jaundice and Icterus	ATV, ATV/c, ATV/r	DRV/c, DRV/r, INSTI, or NNRTI	Increases in unconjugated bilirubin are common with ATV and generally do not require modification of therapy unless resultant symptoms are distressing to the patient.

Table 15. Antiretroviral Therapy-Associated Adverse Events That Can Be Managed with Substitution of Alternative Antiretroviral Agent (page 2 of 2)

Adverse Event	ARV Agent(s)/Drug Class		Comments
	Switch from	Switch to	
Lipoatrophy Subcutaneous fat wasting of limbs, face, buttocks	d4T, ZDV	TDF or ABC[b]	Peripheral lipoatrophy is a legacy of prior thymidine analog (d4T and ZDV) use. Switching from these ARVs prevents worsening lipoatrophy, but fat recovery is typically slow (may take years) and incomplete.
Lipohypertrophy	Accumulation of visceral, truncal, dorso-cervical, and breast fat has been observed during ART, particularly during use of older PI-based regimens (e.g., IDV), but whether ART directly causes increased fat deposits remains unclear. There is no clinical evidence that switching to another first line regimen will reverse weight or visceral fat gain.		
Rash	NNRTIs (especially NVP and EFV)	PI- or INSTI-based regimen	Mild rashes developing after initiation of NNRTIs other than NVP rarely require treatment switch. When serious rash develops due to any NNRTI, switch to another drug class.
	DRV/c, DRV/r	ATV/c, ATV/r or another drug class (e.g., INSTI)	Mild rashes following DRV/r may resolve with close follow-up only. For more severe reactions, change to an alternative boosted PI or an agent from another drug class.
Renal Effects Including proximal renal tubulopathy, elevated creatinine	TDF[a]	ABC[b]	TDF may cause tubulopathy.
	ATV/c, ATV/r, LPV/r	DTG, RAL, or NNRTI	COBI and DTG, and to a lesser extent RPV can increase SCr through inhibition of creatinine secretion. This effect does not affect glomerular filtration. However, assess for renal dysfunction if SCr increases by >0.4 mg/dL.
Stones Nephrolithiasis and cholelithiasis	ATV, ATV/c, ATV/r	DRV/c, DRV/r, INSTI, or NNRTI	Assuming that ATV/r is believed to cause the stones

[a] In patients with chronic active HBV infection, another agent active against HBV should be substituted for TDF.

[b] ABC should be used only in patients known to be HLA-B*5701 negative.

[c] TDF reduces ATV levels; therefore, unboosted ATV should not be coadministered with TDF. Long term data for unboosted ATV are unavailable.

Key to Abbreviations: ABC = abacavir; ART = antiretroviral therapy; ARV = antiretroviral; ATV = atazanavir; ATV/c = atazanavir/cobicistat; ATV/r = atazanavir/ritonavir; BMD = bone mineral density; CD4 = CD4 T lymphocyte; CNS = central nervous system; COBI or c = cobicistat; d4T = stavudine; DRV/c = darunavir/cobicistat; DRV/r = darunavir/ritonavir; DTG = dolutegravir; EFV = efavirenz; ETR = etravirine; EVG = elvitegravir; FPV/r = fosamprenavir/ritonavir; FTC = emtricitabine; GI = gastrointestinal; HBV = hepatitis B virus; HSR = hypersensitivity reaction; IDV = indinavir; INSTI = integrase strand transfer inhibitor; LDL = low-density lipoprotein; LPV/r = lopinavir/ritonavir; MVC = maraviroc; NNRTI = non-nucleoside reverse transcriptase inhibitor; NVP = nevirapine; PI = protease inhibitor; PI/c = protease inhibitor/cobicistat; PI/r = protease inhibitor/ritonavir; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; SCr = serum creatinine; TDF = tenofovir disoproxil fumarate; TG = triglycerides; ZDV = zidovudine

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Cost Considerations and Antiretroviral Therapy (Last updated May 1, 2014; last reviewed May 1, 2014)

Although antiretroviral therapy (ART) is expensive (see Table 16 below), the cost-effectiveness of ART has been demonstrated in analyses of older[1] and newer regimens,[2,3] as well as for treatment-experienced patients with drug-resistant HIV.[4] Given the recommendations for immediate initiation of lifelong treatment and the increasing number of patients taking ART, the Panel now introduces cost-related issues pertaining to medication adherence and cost-containment strategies, as discussed below.

Costs as They Relate to Adherence from a Patient Perspective

Cost sharing: Cost sharing is where the patient is responsible for some of the medication cost burden (usually accomplished via co-payments, co-insurance, or deductibles); these costs are often higher for branded medications than for generic medications. In one comprehensive review, increased patient cost sharing resulted in decreased medical adherence and more frequent drug discontinuation; for patients with chronic diseases, increased cost sharing was also associated with increased use of the medical system.[5] Conversely, co-payment reductions, such as those that might be used to incentivize prescribing of generic drugs, have been associated with improved adherence in patients with chronic diseases.[6] Whereas cost-sharing disproportionately affects low income patients, resources (e.g., the Ryan White AIDS Drug Assistance Program [ADAP]) are available to assist eligible patients with co-pays and deductibles. Given the clear association between out-of-pocket costs for patients with chronic diseases and the ability of those patients to pay for and adhere to medications, clinicians should minimize patients' out-of-pocket drug-related expenses whenever possible.

Prior authorizations: As a cost-containment strategy, some programs require that clinicians obtain prior authorizations or permission before prescribing newer or more costly treatments rather than older or less expensive drugs. Although there are data demonstrating that prior authorizations do reduce spending, several studies have also shown that prior authorizations result in fewer prescriptions filled and increased non-adherence.[7-9] Prior authorizations in HIV care specifically have been reported to cost over $40 each in provider personnel time (a hidden cost) and have substantially reduced timely access to medications.[10]

Generic ART: The impact of the availability of generic antiretroviral (ARV) drugs on selection of ART in the United States is unknown. Because U.S. patent laws currently limit the co-formulation of some generic alternatives to branded drugs, generic options may result in increased pill burden. To the extent that pill burden, rather than drug frequency, results in reduced adherence, generic ART could lead to decreased costs but at the potential expense of worsening virologic suppression rates and poorer clinical outcomes.[11,12] Furthermore, prescribing the individual, less-expensive generic components of a branded co-formulated product rather than the branded product itself could, under some insurance plans, lead to higher copays—an out-of-pocket cost increase that may reduce medication adherence.

Potential Cost Containment Strategies from a Societal Perspective

Given resource constraints, it is important to maximize the use of resources without sacrificing clinical outcomes. Evidence-based revisions to these guidelines recommend tailored laboratory monitoring for patients with long-term virologic suppression on ART as one possible way to provide overall cost savings. Data suggest that continued CD4 monitoring yields no clinical benefit for patients whose viral loads are suppressed and CD4 counts exceed 200 cells/mm^3 after 48 weeks of therapy.[13] A reduction in laboratory use from biannual to annual CD4 monitoring could save ~$10 million per year in the United States[14] (see the Laboratory Monitoring section). Although this is a small proportion of the overall costs associated with HIV care, such a strategy could reduce patients' personal expenses if they have deductibles for laboratory tests. The present and future availability of generic formulations of certain ARV drugs, despite the potential caveats of increased pill burden and reduced adherence, offers other money-saving possibilities on a much

greater scale. One analysis suggests the possibility of saving approximately $900 million nationally in the first year of switching from a branded fixed-dose combination product to a three-pill regimen containing generic efavirenz.[3]

In summary, understanding HIV and ART-related costs in the United States is complicated because of the wide variability in medical coverage, accessibility, and expenses across regions, insurance plans, and pharmacies. In an effort to retain excellent clinical outcomes in an environment of cost-containment strategies, providers should remain informed of current insurance and payment structures, ART costs (see Table 16 below for estimates of drugs' average wholesale prices), discounts among preferred pharmacies, and available generic ART options. Providers should work with patients and their case managers and social workers to understand their patients' particular pharmacy benefit plans and potential financial barriers to filling their prescriptions. Additionally, providers should familiarize themselves with ARV affordability resources (such as ADAP and pharmaceutical company patient assistance programs for patients who qualify) and refer patients to such assistance if needed.

Table 16. Monthly Average Wholesale Price[a] of Antiretroviral Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 4)

ARV Drug (Generic and Brand Names)	Strength	Dosing	Tablets/Capsules/ mLs per Month	AWP[a] (Monthly)
Nucleoside Reverse Transcriptase Inhibitors (NRTIs)				
Abacavir				
• Generic	300 mg tab	2 tabs daily	60 tabs	$602.66
• Ziagen	300 mg tab	2 tabs daily	60 tabs	$670.37
• Ziagen	20 mg/mL soln	30 mL daily	900 mL	$660.86
Didanosine Delayed-Release				
• Generic	400 mg cap	1 cap daily	30 caps	$368.72
• Videx EC	400 mg cap	1 cap daily	30 caps	$515.84
Emtricitabine				
• Emtriva	200 mg cap	1 cap daily	30 caps	$602.27
• Emtriva	10 mg/mL soln	24 mL daily	680 mL (28-day supply)	$568.88
Lamivudine				
• Generic	300 mg tab	1 tab daily	30 tabs	$429.66
• Epivir	300 mg tab	1 tab daily	30 tabs	$498.89
• Epivir	10 mg/mL soln	30 mL daily	900 mL	$498.90
Stavudine				
• Generic	40 mg cap	1 cap twice daily	60 caps	$410.70
• Zerit	40 mg cap	1 cap twice daily	60 caps	$553.12
Tenofovir				
• Viread	300 mg tab	1 tab daily	30 tabs	$1,120.04
Zidovudine				
• Generic	300 mg tab	1 tab twice daily	60 tabs	$360.97

Table 16. Monthly Average Wholesale Price[a] of Antiretroviral Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 4)

ARV Drug (Generic and Brand Names)	Strength	Dosing	Tablets/Capsules/ mLs per Month	AWP[a] (Monthly)
NRTI Combination Products				
Abacavir/Lamivudine • Epzicom	600/300 mg tab	1 tab daily	30 tabs	$1,416.35
Tenofovir Disoproxil Fumarate/ Emtricitabine • Truvada	300/200 mg tab	1 tab daily	30 tabs	$1,539.90
Zidovudine/Lamivudine • Generic	300/150 mg tab	1 tab twice daily	60 tabs	$931.61
• Combivir	300/150 mg tab	1 tab twice daily	60 tabs	$1,081.70
Abacavir Sulfate/Zidovudine/ Lamivudine • Generic	300/300/150 mg tab	1 tab twice daily	60 tabs	$1,738.46
• Trizivir	300/300/150 mg tab	1 tab twice daily	60 tabs	$1,931.64
Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTIs)				
Efavirenz • Sustiva	600 mg tab	1 tab daily	30 tabs	$1,011.97
Etravirine • Intelence	200 mg tab	1 tab twice daily	60 tabs	$1,212.29
Nevirapine • Generic	200 mg tab	1 tab twice daily	60 tabs	$650.05
• Viramune	200 mg tab	1 tab twice daily	60 tabs	$861.19
• Viramune XR (nevirapine extended release)	400 mg tab	1 tab daily	30 tabs	$798.73
Rilpivirine • Edurant	25 mg tab	1 tab daily	30 tabs	$996.43
Protease Inhibitors (PIs)				
Atazanavir • Reyataz	200 mg cap	2 caps daily	60 caps	$1,535.23
• Reyataz	300 mg cap[c]	1 cap daily	30 caps	$1,520.72
Atazanavir/Cobicistat • Evotaz	300 mg/150 mg tab	1 tab daily	30 tabs	$1,684.44
Darunavir • Prezista	600 mg tab[b]	1 tab twice daily	60 tabs	$1,509.79
• Prezista	800 mg tab[c]	1 tab daily	30 tabs	$1,509.79
• Prezista	100 mg/mL susp[b]	8 mL daily 6 mL twice daily	240 mL 360 mL	$1,006.54 $1,509.80
Darunavir/Cobicistat • Prezcobix	800 mg/150 mg tab	1 tab daily	30 tabs	$1,725.29

Table 16. Monthly Average Wholesale Price[a] of Antiretroviral Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 4)

ARV Drug (Generic and Brand Names)	Strength	Dosing	Tablets/Capsules/ mLs per Month	AWP[a] (Monthly)
Protease Inhibitors (PIs), continued				
Fosamprenavir • Lexiva	700 mg tab	2 tabs twice daily	120 tabs	$2,408.86
• Lexiva	700 mg tab	1 tab twice daily[b] or 2 tabs once daily[b]	60 tabs	$1,204.43
Lopinavir/Ritonavir • Kaletra	200 mg/50 mg tab	2 tabs twice daily or 4 tabs once daily	120 tabs	$977.22
• Kaletra	80 mg/20 mg per mL soln	5 mL twice daily	300 mL	$916.13
Nelfinavir • Viracept	625 mg tab	2 tabs twice daily	120 tabs	$1,169.22
Saquinavir • Invirase	500 mg tab[b]	2 tabs twice daily	120 tabs	$1,260.01
Tipranavir • Aptivus	250 mg cap[b]	2 caps twice daily	120 caps	$1,590.18
Integrase Strand Transfer Inhibitors (INSTIs)				
Dolutegravir • Tivicay	50 mg tab	1 tab once daily	30 tabs	$1,581.68
• Tivicay	50 mg tab	1 tab twice daily	60 tabs	$3,163.36
Elvitegravir • Vitekta	85 mg tab	1 tab daily	30 tabs	$1,352.05
• Vitekta	150 mg tab	1 tab daily	30 tabs	$1,352.05
Raltegravir • Isentress	400 mg tab	1 tab twice daily	60 tabs	$1,445.34
Fusion Inhibitor				
Enfuviritide • Fuzeon	90 mg injection kit	1 injection twice daily	60 doses (1 kit)	$3,759.43
CCR5 Antagonist				
Maraviroc • Selzentry	150 mg tab	1 tab twice daily	60 tabs	$1,455.13
• Selzentry	300 mg tab	1 tab twice daily	60 tabs	$1,455.13
• Selzentry	300 mg tab	2 tabs twice daily	120 tabs	$2,910.26
Co-Formulated Combination Products as Single Tablet Regimens				
Dolutegravir/Abacavir/Lamivudine • Triumeq	50/600/300 mg tab	1 tab daily	30 tabs	$2,648.84
Efavirenz/Tenofovir Disoproxil Fumarate/Emtricitabine • Atripla	600/300/200 mg tab	1 tab daily	30 tabs	$2,551.99
Elvitegravir/Cobicistat/Tenofovir Disoproxil Fumarate/ Emtricitabine • Stribild	150/150/300/200 mg tab	1 tab daily	30 tabs	$2,948.70

Table 16. Monthly Average Wholesale Price[a] of Antiretroviral Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 4 of 4)

ARV Drug (Generic and Brand Names)	Strength	Dosing	Tablets/Capsules/ mLs per Month	AWP[a] (Monthly)
Co-Formulated Combination Products as Single Tablet Regimens, continued				
Rilpivirine/Tenofovir Disoproxil Fumarate/Emtricitabine • Complera	25/300/200 mg tab	1 tab daily	30 tabs	$2,463.37
Pharmacokinetic Enhancers (Boosters)				
Cobicistat • Tybost	150 mg tab	1 tab daily	30 tabs	$216.00
Ritonavir - Total Daily Dose Depends On Concomitant PI (100 mg once or twice daily, or 200 mg twice daily) • Generic	100 mg tab	1 tab once daily	30 tabs	Price not yet available
• Norvir	100 mg tab	1 tab once daily	30 tabs	$308.60
	80 mg/mL soln	100 mg daily	37.5 mL (of a 240 mL bottle)	$270.04

[a] AWP = Average Wholesale Price. Note that this price may not represent the pharmacy acquisition price or the price paid by consumers. Source: http://micromedexsolutions.com. Accessed February 2015.

[b] Should be used in combination with ritonavir. Please refer to Appendix B, Table 3 for ritonavir doses.

[c] Should be used in combination with ritonavir or cobicistat. Please refer to Appendix B, Table 3 for ritonavir doses.

Key to Abbreviations: AWP = average wholesale price; cap = capsule; EC = enteric coated; soln = solution; susp = suspension; tab = tablet; XR = extended release

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Drug-Drug Interactions (Last updated April 8, 2015; last reviewed April 8, 2015)

Pharmacokinetic (PK) drug-drug interactions between antiretroviral (ARV) drugs and concomitant medications are common, and may lead to increased or decreased drug exposure. In some instances, changes in drug exposure may increase toxicities or affect therapeutic responses. When prescribing or switching one or more drugs in an ARV regimen, clinicians must consider the potential for drug-drug interactions—both those that affect ARVs and those that ARVs affect on other drugs a patient is taking. A thorough review of concomitant medications in consultation with a clinician with expertise in ARV pharmacology can help in designing a regimen that minimizes undesirable interactions. Recommendations for managing a particular drug interaction may differ depending on whether a new ARV is being initiated in a patient on a stable concomitant medication or a new concomitant medication is being initiated in a patient on a stable ARV regimen. The magnitude and significance of interactions are difficult to predict when several drugs with competing metabolic pathways are prescribed concomitantly. When prescribing interacting drugs is necessary, clinicians should be vigilant in monitoring for therapeutic efficacy and/or concentration-related toxicities.

Mechanisms of Pharmacokinetic Interactions

PK interactions may occur during absorption, metabolism, or elimination of the ARV and/or the interacting drugs. The most common mechanisms of interactions are described below and listed for each ARV drug in Table 17.

Pharmacokinetic Interactions Affecting Drug Absorption

The extent of oral absorption of drugs can be affected by the following mechanisms:

- Acid reducing agents, such as proton pump inhibitors, H2 antagonists, or antacids, can reduce the absorption of ARVs that require gastric acidity for optimal absorption (i.e., atazanavir [ATV] and rilpivirine [RPV]).
- Products that contain polyvalent cations, such as aluminum, calcium, magnesium-containing antacids, supplements, or iron products, can bind to integrase inhibitors (INSTI) and reduce absorption of these ARV agents.
- Drugs that induce or inhibit the enzyme CYP3A4 or efflux transporter p-glycoprotein in the intestines may reduce or promote the absorption of other drugs.

Pharmacokinetic Interactions Affecting Hepatic Metabolism

Two major enzyme systems are most frequently responsible for clinically significant drug interactions.

1. The cytochrome P450 enzyme system is responsible for the metabolism of many drugs, including the non-nucleoside reverse transcriptase inhibitors (NNRTI), protease inhibitors (PI), CCR5 antagonist maraviroc (MVC), and the INSTI elvitegravir (EVG). Cytochrome P450 3A4 (CYP3A4) is the most common enzyme responsible for drug metabolism, though multiple enzymes may be involved in the metabolism of a drug. ARVs and concomitant medications may be inducers, inhibitors, and/or substrates of these enzymes.
2. The uridine diphosphate (UDP)-glucuronosyltransferase (UGT) 1A1 enzyme is the primary enzyme responsible for the metabolism of the INSTIs dolutegravir (DTG) and raltegravir (RAL). Drugs that induce or inhibit the UGT enzyme can affect the PKs of these INSTIs.

Pharmacokinetic Enhancers (Boosters)

PK enhancing is a strategy used to increase exposure of an ARV by concomitantly administering a drug that inhibits the enzymes that metabolize the ARV. Currently in clinical practice, two agents are used as PK enhancers: ritonavir (RTV) and cobicistat (COBI). Both of these agents are potent inhibitors of the CYP3A4 enzyme, resulting in higher drug exposures of the coadministered ARV metabolized by this pathway.

Importantly, RTV and COBI may have different effects on other CYP or UGT metabolizing enzymes and drug transporters. Complex or unknown mechanisms of PK-based interactions preclude extrapolation of RTV drug interactions to certain COBI interactions, such as interactions with warfarin, phenytoin, voriconazole, oral contraceptives, certain HMG-CoA reductase inhibitors (or statins), and other drugs.

Other Mechanisms of Pharmacokinetic Interactions

Knowledge of drug transporters is evolving, elucidating additional drug interaction mechanisms. For example, DTG decreases the renal clearance of metformin by inhibiting organic anion transporters in renal tubular cells. Similar transporters aid hepatic, renal, and biliary clearance of drugs and may be susceptible to drug interactions. ARVs and concomitant medications may be inducers, inhibitors, and/or substrates of these drug transporters.

Tables 18–20b provide information on known or suspected drug interactions between ARV agents and commonly prescribed medications based on published PK data or information from product labels. The tables provide general guidance on drugs that should not be coadministered and recommendations for dose modifications or alternative therapy.

Table 17. Mechanisms of Antiretroviral-Associated Drug Interactions (page 1 of 2)

Pharmacokinetic interactions may occur during absorption, metabolism, or elimination of the ARV and/or the interacting drugs. This table does not include a comprehensive list of all possible mechanisms of interactions for individual ARV drugs (e.g., transporters); however, the table lists the most common mechanisms of interactions and focuses on absorption and CYP and UGT1A1 mediated interactions.

Note: Ellipses (…) indicate that there are no clinically relevant interactions by these mechanisms.

ARV Drugs by Drug Class	Mechanisms That May Affect or Be Affected by Oral Absorption of ARV Drugs			Enzymes That Metabolize or Are Induced or Inhibited by ARV Drugs				Other Mechanisms of Drug Interactions
	Increasing Gastric pH	Cationic Chelation	P-glycoprotein	CYP Substrate	CYP Inhibitor	CYP Inducer	UGT1A1	
Integrase Strand Transfer Inhibitors (INSTIs)								
Dolutegravir (DTG)	…	Concentration decreased by products containing polyvalent cations (e.g., Ca, Mg, Al, Fe, Zn)	Substrate	3A4 (small contribution)	…	…	Substrate	Inhibitor of renal transporters OCT2 and MATE
Elvitegravir (EVG)	…		…	3A4	…	…	Substrate	…
Raltegravir (RAL)	…		…	…	…	…	Substrate	…
Pharmacokinetic (PK) Enhancers (Boosters)								
Cobicistat (COBI)	…	…	Inhibitor	3A4	3A4, 2D6	…	…	…
Ritonavir (RTV)	…	…	Substrate, inhibitor	3A4, 2D6	3A4, 2D6 (lesser extent)	1A2, 2C8, 2C9, 2C19	Inducer	…
Protease Inhibitors (PIs) **Note:** When PIs are coadministered with PK enhancers (boosters), the pharmacologic properties of both agents should be considered when assessing potential drug interactions.								
Atazanavir (ATV)	Concentration decreased	…	Substrate, inducer, inhibitor	3A4	3A4, 2C8 (weak)	…	Inhibitor	…
Darunavir (DRV)	…	…	Substrate	3A4	3A4	2C9	…	…

Table 17. Mechanisms of Antiretroviral-Associated Drug Interactions (page 2 of 2)

ARV Drugs by Drug Class	Mechanisms That May Affect or be Affected by Oral Absorption of ARV Drugs			Enzymes That Metabolize or are Induced or Inhibited by ARV Drugs				Other Mechanisms of Drug Interactions
	Increasing Gastric pH	Cationic Chelation	P-glycoprotein	CYP Substrate	CYP Inhibitor	CYP Inducer	UGT1A1	
Protease Inhibitors (PIs), continued **Note:** When PIs are coadministered with PK enhancers (boosters), the pharmacologic properties of both agents should be considered when assessing potential drug interactions.								
Fosamprenavir (FPV)	Concentration decreased by H2 antagonist	…	Substrate, inhibitor	3A4	3A4	3A4 (weak)	…	…
Lopinavir (LPV)	…	…	Substrate	3A4	3A4	…	…	…
Saquinavir (SQV)	…	…	Substrate, inhibitor	3A4	3A4	…	…	…
Tipranavir (TPV)	…	…	Substrate, inducer	3A4	2D6	3A4, 1A2, 2C19	…	…
Non-nucleoside Reverse Transcriptase Inhibitors (NNRTIs)								
Efavirenz (EFV)	…	…	…	2B6 (primary), 2A6, 3A4	2C9, 2C19, 3A4	3A4, 2B6	…	…
Etravirine (ETR)	…	…	Inducer	3A4, 2C9, 2C19	2C9, 2C19	3A4	…	…
Nevirapine (NVP)	…	…	…	3A4, 2B6	…	3A4, 2B6	…	…
Rilpivirine (RPV)	Concentration decreased	…	…	3A4	…	…	…	…
Nucleoside Reverse Transcriptase Inhibitors (NRTIs)								
Abacavir (ABC)	…	…	…	…	…	…	Substrate	Alcohol dehydrogenase substrate
Emtricitabine (FTC)	…	…	…	…	…	…	…	…
Lamivudine (3TC)	…	…	…	…	…	…	…	…
Tenofovir (TDF)	…	…	Substrate	…	…	…	…	Competition of active renal tubular secretion
Zidovudine (ZDV)	…	…	…	…	…	…	…	Glucuronidation
CCR5 Antagonist								
Maraviroc (MVC)	…	…	Substrate	3A4	…	…	…	…
Fusion Inhibitor								
Enfuvirtide (T20)	…	…	…	…	…	…	…	…

Key to Abbreviations: Al = aluminium; ARV = antiretroviral; Ca = calcium; CYP = cytochrome P; Fe = iron; MATE = multidrug and toxin extrusion transporter; Mg = magnesium; OCT2 = organic cation transporter 2; UGT1A1 = uridine diphosphate glucuronosyltransferase; Zn = zinc

Table 18. Drugs That Should Not Be Used With Antiretroviral Agents (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 2)

This table only lists drugs that should not be coadministered at any dose, regardless of RTV or COBI enhancing. See Tables 19 and 20 for more detailed PK interaction data.

ARV Agents[a,b]	Cardiac Agents	Lipid-Lowering Agents	Antimyco-bacterial Agents	Antiepileptic Agents	Neurologic Agents	Herbs	HCV Agents[c]	Other Agents
ATV +/– RTV or COBI	Dronedarone Ranolazine	Lovastatin Simvastatin	Rifampin Rifapentine[d]	None	Lurasidone Midazolam[e] Pimozide Triazolam	St. John's wort	Boceprevir Simeprevir	Alfuzosin Cisapride[f] Ergot derivatives Irinotecan Salmeterol Sildenafil for PAH
DRV/c or DRV/r	Dronedarone Ranolazine	Lovastatin Simvastatin	Rifampin Rifapentine[d]	None	Lurasidone Midazolam[e] Pimozide Triazolam	St. John's wort	Boceprevir Dasabuvir Ombitasvir Paritaprevir Simeprevir	Alfuzosin Cisapride[f] Ergot derivatives Salmeterol Sildenafil for PAH
FPV +/– RTV	Dronedarone Flecainide Propafenone Ranolazine	Lovastatin Simvastatin	Rifampin Rifapentine[d]	None	Lurasidone Midazolam[e] Pimozide Triazolam	St. John's wort	Boceprevir Dasabuvir Ombitasvir Paritaprevir Simeprevir	Alfuzosin Cisapride[f] Ergot derivatives Salmeterol Sildenafil for PAH
LPV/r	Dronedarone Ranolazine	Lovastatin Simvastatin	Rifampin[g] Rifapentine[d]	None	Lurasidone Midazolam[e] Pimozide Triazolam	St. John's wort	Boceprevir Dasabuvir Ombitasvir Paritaprevir Simeprevir	Alfuzosin Cisapride[f] Ergot derivatives Salmeterol Sildenafil for PAH
SQV/r	Amiodarone Dofetilide Dronedarone Flecainide Lidocaine Propafenone Quinidine Ranolazine	Lovastatin Simvastatin	Rifampin[g] Rifapentine[d]	None	Lurasidone Midazolam[e] Pimozide Trazodone Triazolam	Garlic supple-ments St. John's wort	Boceprevir Dasabuvir Ombitasvir Paritaprevir Simeprevir	Alfuzosin Cisapride[f] Ergot derivatives Salmeterol Sildenafil for PAH
TPV/r	Amiodarone Dronedarone Flecainide Propafenone Quinidine Ranolazine	Lovastatin Simvastatin	Rifampin Rifapentine[d]	None	Lurasidone Midazolam[e] Pimozide Triazolam	St. John's wort	Boceprevir Dasabuvir Ledipasvir Ombitasvir Paritaprevir Simeprevir Sofosbuvir	Alfuzosin Cisapride[f] Ergot derivatives Salmeterol Sildenafil for PAH
EFV	None	None	Rifapentine[d]	None	None	St. John's wort	Boceprevir Dasabuvir Ombitasvir Paritaprevir Simeprevir	None
ETR	None	None	Rifampin Rifapentine[d]	Carbamazepine Phenobarbital Phenytoin	None	St John's wort	Dasabuvir Ombitasvir Paritaprevir Simeprevir	Clopidogrel
NVP	None	None	Rifapentine[d]	None	None	St. John's wort	Dasabuvir Ombitasvir Paritaprevir Simeprevir	Ketoconazole

Table 18. Drugs That Should Not Be Used With Antiretroviral Agents (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 2)

This table only lists drugs that should not be coadministered at any dose, regardless of RTV or COBI enhancing. See Tables 19 and 20 for more detailed PK interaction data.

ARV Agents[a,b]	Cardiac Agents	Lipid-Lowering Agents	Antimycobacterial Agents	Antiepileptic Agents	Neurologic Agents	Herbs	HCV Agents[c]	Other Agents
RPV	None	None	Rifampin Rifapentine[d]	Carbamazepine Oxcarbazepine Phenobarbital Phenytoin	None	St. John's wort	Dasabuvir Ombitasvir Paritaprevir	Proton pump inhibitors
MVC	None	None	Rifapentine[d]	None	None	St. John's wort	Dasabuvir Ombitasvir Paritaprevir	None
EVG/c/TDF/FTC **or** **EVG + PI/r**	Ranolazine	Lovastatin Simvastatin	Rifampin Rifapentine[d]	None	Lurasidone Pimozide Midazolam[e] Triazolam	St. John's wort	EVG/c/TDF/FTC: • Boceprevir • Dasabuvir • Ledipasvir • Ombitasvir • Paritaprevir • Simeprevir EVG + PI/r: • Refer to agents listed for the selected PI	Alfuzosin Cisapride[f] Ergot derivatives Salmeterol Sildenafil for PAH
DTG	Dofetilide	None	Rifapentine[d]	None	None	St. John's wort	None	None

[a] DLV, IDV, NFV, and RTV (as sole PI) are not included in this table. Refer to the appropriate FDA package insert for information regarding DLV-, IDV-, NFV-, and RTV (as sole PI)-related drug interactions.

[b] Certain listed drugs are contraindicated on the basis of theoretical considerations. Thus, drugs with narrow therapeutic indices and suspected metabolic involvement with CYP450 3A, 2D6, or unknown pathways are included in this table. Actual interactions may or may not occur in patients.

[c] HCV agents listed include only those that are commercially available at the publication of these guidelines.

[d] HIV-infected patients who received rifapentine as part of a treatment regimen for TB had a higher rate of TB relapse and acquired rifamycin resistance than those treated with other rifamycin-based regimens. Therefore an alternative agent to rifapentine is recommended for TB treatment.

[e] Use of oral midazolam is contraindicated. Single-dose parenteral midazolam can be used with caution and can be given in a monitored situation for procedural sedation.

[f] The manufacturer of cisapride has a limited-access protocol for patients who meet specific clinical eligibility criteria.

[g] A high rate of Grade 4 serum transaminase elevation was seen when a higher dose of RTV was added to LPV/r or SQV or when double-dose LPV/r was used with rifampin to compensate for rifampin's induction effect; therefore, these dosing strategies should not be used.

Suggested alternatives to:

- **Lovastatin, simvastatin:** Fluvastatin, pitavastatin, and pravastatin (except for pravastatin with DRV/r) have the least potential for drug-drug interactions (see Table 19a). Use atorvastatin and rosuvastatin with caution; start with the lowest possible dose and titrate based on tolerance and lipid-lowering efficacy.
- **Rifampin:** Rifabutin (with dosage adjustment, see Tables 19a and 19b)
- **Midazolam, triazolam:** temazepam, lorazepam, oxazepam

Key to Acronyms: ARV = antiretroviral; ATV = atazanavir; COBI = cobicistat; CYP = cytochrome P; DLV = delavirdine; DRV/c = darunavir/cobicistat; DRV/r = darunavir/ritonavir; DTG = dolutegravir; EFV = efavirenz; ETR = etravirine; EVG = elvitegravir; EVG/c/TDF/FTC = elvitegravir/cobicistat/tenofovir/emtricitabine; FDA = Food and Drug Administration; FPV = fosamprenavir; FTC = emtricitabine; HCV = hepatitis C virus; IDV = indinavir; LPV/r = lopinavir/ritonavir; MVC = maraviroc; NFV = nelfinavir; NVP = nevirapine; PAH = pulmonary arterial hypertension; PI = protease inhibitor; PI/r = ritonavir-boosted protease inhibitor; PK = pharmacokinetic; RPV = rilpivirine; RTV = ritonavir; SQV = saquinavir; SQV/r = saquinavir/ritonavir; TB = tuberculosis; TDF = tenofovir disoproxil fumarate; TPV/r = tipranavir/ritonavir

Table 19a. Drug Interactions Between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 14)

This table provides known or predicted information regarding PK interactions between PIs and non-ARV drugs. When information is available, interactions for specific pharmacologically-boosted (with either RTV or COBI) and unboosted PIs are listed separately. The term "All PIs" refers to both unboosted and pharmacologically-boosted PI products. For interactions between ARV agents and for dosing recommendations, refer to Tables 19c, 20a, and 20b.

Note: NFV and IDV are **not** included in this table. Please refer to the FDA product labels for NFV and IDV for information regarding drug interactions with these PIs.

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Acid Reducers			
Antacids	ATV, ATV/c, ATV/r	When given simultaneously, ↓ ATV expected	Give ATV at least 2 hours before or 1 to 2 hours after antacids or buffered medications.
	FPV	APV AUC ↓ 18%; ↔ in APV C_{min}	Give FPV simultaneously with (or at least 2 hours before or 1 hour after) antacids.
	TPV/r	TPV AUC ↓ 27%	Give TPV at least 2 hours before or 1 hour after antacids.
H2 Receptor Antagonists	ATV (unboosted)	↓ ATV	H2 receptor antagonist single dose should not exceed a dose equivalent to famotidine 20 mg and the total daily dose should not exceed a dose equivalent to famotidine 20 mg BID in ART-naive patients. Give ATV at least 2 hours before and at least 10 hours after the H2 receptor antagonist.
	ATV/c, ATV/r	↓ ATV	H2 receptor antagonist dose should not exceed a dose equivalent to famotidine 40 mg BID in ART-naive patients or 20 mg BID in ART-experienced patients. Give ATV 300 mg plus COBI 150 mg or RTV 100 mg simultaneously with and/or ≥10 hours after the dose of H2 receptor antagonist. If using TDF and H2 receptor antagonist in ART-experienced patients, use ATV 400 mg plus COBI 150 mg or RTV 100 mg.
	DRV/c, DRV/r, LPV/r	No significant effect shown or expected	No dosage adjustment necessary.
	FPV (unboosted)	APV AUC ↓ 30%; no significant change in APV C_{min}	If concomitant use is necessary, give FPV at least 2 hours before H2 receptor antagonist. Consider boosting FPV with RTV.
PPIs	ATV (unboosted)	↓ ATV	**PPIs are not recommended in patients receiving unboosted ATV.** In these patients, consider alternative acid-reducing agents, RTV or COBI boosting, or alternative PIs.
	ATV/c, ATV/r	↓ ATV	PPIs should not exceed a dose equivalent to omeprazole 20 mg daily in PI-naive patients. PPIs should be administered at least 12 hours before ATV/c or ATV/r. **PPIs are not recommended in PI-experienced patients.**
	DRV/r	omeprazole AUC ↓ 42%	No dosage adjustment necessary.
	DRV/c	No significant effect expected	No dosage adjustment necessary.
	FPV, FPV/r, LPV/r	No significant effect	No dosage adjustment necessary.
	SQV/r	SQV AUC ↑ 82%	Monitor for SQV toxicities.
	TPV/r	↓ omeprazole	May need to increase omeprazole dose.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Anticoagulants and Antiplatelets			
Apixaban	All PIs	↑ apixaban expected	**Avoid concomitant use.**
Dabigatran	All RTV-boosted PIs, ATV/c, DRV/c	↑ dabigatran possible	No dosage adjustment if CrCl > 50 mL/min. **Avoid coadministration if CrCl < 50 mL/min.**
Rivaroxaban	All PIs	↑ rivaroxaban	**Avoid concomitant use.**
Ticagrelor	All PIs	↑ ticagrelor expected	**Avoid concomitant use.**
Vorapaxar	All PIs	↑ vorapaxar expected	**Avoid concomitant use.**
Warfarin	PI/r	↓ warfarin possible	Monitor INR closely when stopping or starting PI/r and adjust warfarin dose accordingly.
	ATV/c, DRV/c	No data	Monitor INR closely when stopping or starting PI/c and adjust warfarin dose accordingly. If switching between RTV and COBI, the effect of COBI on warfarin is not expected to be equivalent to RTV's effect on warfarin.
Anticonvulsants			
Carbamazepine	ATV, FPV (unboosted)	May ↓ PI levels substantially	**Do not coadminister.** Consider alternative anticonvulsant or ATV/r, ATV/c, or FPV/r.
	ATV/c, ATV/r, DRV/c, FPV/r, LPV/r, SQV/r, TPV/r	↑ carbamazepine possible TPV/r ↑ carbamazepine AUC 26% May ↓ PI levels substantially	Consider alternative anticonvulsant or monitor levels of both drugs and assess virologic response. **Do not coadminister with LPV/r or FPV/r once daily.**
	DRV/r	carbamazepine AUC ↑ 45% DRV: no significant change	Monitor anticonvulsant level and adjust dose accordingly.
Ethosuximide	All PIs	↑ ethosuximide possible	Clinically monitor for ethosuxamide toxicities.
Lamotrigine	ATV (unboosted)	lamotrigine: no effect	No dose adjustment necessary.
	ATV/r	lamotrigine AUC ↓ 32%	A dose increase of lamotrigine may be needed; consider monitoring lamotrigine concentration or consider alternative anticonvulsant.
	LPV/r	lamotrigine AUC ↓ 50% LPV: no significant change	
	PI/r (other than ATV/r or LPV/r)	↓ lamotrigine possible	
	ATV/c, DRV/c	No data	Monitor lamotrigine concentration or consider alternative anticonvulsant.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Anticonvulsants, continued			
Phenobarbital	All PIs	May ↓ PI levels substantially	Consider alternative anticonvulsant or monitor levels of both drugs and assess virologic response. **Do not coadminister with LPV/r or FPV/r once daily, or unboosted ATV or FPV.**
Phenytoin	ATV, FPV (unboosted)	May ↓ PI levels substantially	**Do not coadminister.** Consider alternative anticonvulsant or boosting either ATV or FPV.
	ATV/r, DRV/r, SQV/r, TPV/r	↓ phenytoin possible ↓ PI possible	Consider alternative anticonvulsant or monitor levels of both drugs and assess virologic response.
	ATV/c, DRV/c	Effect on phenytoin unknown ↓ PI possible	
	FPV/r	phenytoin AUC ↓ 22% APV AUC ↑ 20%	Monitor phenytoin level and adjust dose accordingly. No change in FPV/r dose recommended.
	LPV/r	phenytoin AUC ↓ 31% LPV/r AUC ↓ 33%	Consider alternative anticonvulsant or monitor levels of both drugs and assess virologic response. **Do not coadminister with LPV/r once daily.**
Valproic Acid	LPV/r	↓ or ↔ VPA possible LPV AUC ↑ 75%	Monitor VPA levels and virologic response. Monitor for LPV-related toxicities.
Antidepressants, Anxiolytics, and Antipsychotics (Also see Sedative/Hypnotics section below.)			
Bupropion	LPV/r	bupropion AUC ↓ 57%	Titrate bupropion dose based on clinical response.
	TPV/r	bupropion AUC ↓ 46%	
Buspirone	All PIs	↑ buspirone expected	Use a low dose of buspirone with caution and titrate buspirone dose based on clinical response.
Fluvoxamine	All PIs	↑ or ↓ PI possible	Consider alternative therapeutic agent.
Other Selective Serotonin Reuptake Inhibitors (SSRIs) (e.g., citalopram, escitalopram, fluoxetine, paroxetine, sertraline)	RTV	escitalopram ↔	Titrate SSRI dose based on clinical response.
	DRV/r	paroxetine AUC ↓ 39% sertraline AUC ↓ 49%	
	FPV/r	paroxetine AUC ↓ 55%	
	ATV/r, LPV/r, SQV/r, TPV/r	No data	
	ATV/c, DRV/c	Effects unknown	Titrate SSRI dose using the lowest available initial or maintenance dose.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 4 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antidepressants, Anxiolytics, and Antipsychotics (Also see Sedative/Hypnotics section below.), continued			
Quetiapine	All PIs	↑ quetiapine expected	Starting quetiapine in a patient receiving a PI: • Start quetiapine at the lowest dose and titrate up as needed. Monitor for quetiapine effectiveness and adverse effects. Starting a PI in a patient receiving a stable dose of quetiapine: • Reduce quetiapine dose to 1/6 of the original dose. Closely monitor for quetiapine effectiveness and adverse effects.
Trazodone	All PIs except SQV/r	RTV 200 mg BID (for 2 days) ↑ trazodone AUC 240%	Use lowest dose of trazodone and monitor for CNS and cardiovascular adverse effects.
	SQV/r	↑ trazodone expected	**Contraindicated. Do not coadminister.**
Tricyclic Antidepressants Amitriptyline, Desipramine, Doxepin, Imipramine, Nortriptyline	All RTV-boosted PIs, ATV/c, DRV/c	↑ TCA expected	Use lowest possible TCA dose and titrate based on clinical assessment and/or drug levels.
Antifungals			
Fluconazole	ATV/c, ATV/r	No significant effect observed or expected	No dosage adjustment necessary.
	SQV/r	No data with RTV boosting	No dosage adjustment necessary.
	TPV/r	TPV AUC ↑ 50%	Fluconazole >200 mg daily is not recommended. If high-dose fluconazole is indicated, consider alternative ARV.
Itraconazole	All PIs	↑ itraconazole possible ↑ PI possible	Consider monitoring itraconazole level to guide dosage adjustments. Doses >200 mg/day are not recommended with RTV-boosted PIs, ATV/c, or DRV/c unless dosing is guided by itraconazole levels.
Posaconazole	ATV/c	↑ ATV possible	Monitor for adverse effects of ATV.
	ATV/r	ATV AUC ↑ 146%	
	ATV	ATV AUC ↑ 268%	
	FPV	With FPV 700 mg BID (without RTV): posaconazole AUC ↓ 23%, APV AUC similar to that with FPV 1400 mg BID With FPV 1400 mg BID: ↑ APV expected	If coadministered, monitor posaconazole concentrations.
	DRV/c, DRV/r, FPV/r, LPV/r, SQV/r, TPV/r	↑ PI possible ↑ posaconazole possible	If coadministered, consider monitoring posaconazole concentrations. Monitor for PI adverse effects.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 5 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antifungals, continued			
Voriconazole	ATV, FPV (unboosted)	↑ voriconazole possible ↑ PI possible	Monitor for toxicities.
	All RTV-boosted PIs	RTV 400 mg BID ↓ voriconazole AUC 82% RTV 100 mg BID ↓ voriconazole AUC 39%	**Do not coadminister voriconazole and RTV or COBI unless benefit outweighs risk.** If coadministered, consider monitoring voriconazole concentration and adjust dose accordingly.
	ATV/c, DRV/c	Effects unknown	
Antimalarials			
Artemether/ Lumefantrine	DRV/r	artemether AUC ↓ 16% DHA[a] AUC ↓ 18% lumefantrine AUC ↑ 2.5-fold	Clinical significance unknown. If used, monitor closely for anti-malarial efficacy and lumefantrine toxicity.
	DRV/c	↑ lumefantrine expected effect on artemether unknown	
	LPV/r	artemether AUC ↓ 40% DHA AUC ↓ 17% lumefantrine AUC ↑ 470%	
Atovaquone/ Proguanil	ATV/r, LPV/r	ATV/r ↓ atovaquone AUC 46% and ↓ proguanil AUC 41% LPV/r ↓ atovaquone AUC 74% and ↓ proguanil AUC 38%	No dosage recommendation. Consider alternative drug for malaria prophylaxis, if possible.
Mefloquine	RTV	With RTV 200 mg BID: RTV AUC ↓ 31%, C_{min} ↓ 43%; ↔ mefloquine	Use with caution. Effect on exposure of RTV-boosted PIs is unknown.
Antimycobacterials (for treatment of *Mycobacterium tuberculosis* and non-tuberculosis mycobacterial infections)			
Bedaquiline	All RTV-boosted PIs, ATV/c, DRV/c	With LPV/r: bedaquiline AUC ↑ 22%, C_{max} ↔ With other PI/r, ATV/c, or DRV/c: ↑ bedaquiline possible	Clinical significance unknown. Use with caution if benefit outweighs the risk and monitor for QTc prolongation and liver function tests.
Clarithromycin	ATV/r, ATV	clarithromycin AUC ↑ 94%	May cause QTc prolongation. Reduce clarithromycin dose by 50%. Consider alternative therapy (e.g., azithromycin).
	ATV/c, DRV/c	↑ clarithromycin expected	Consider alternative macrolide (e.g., azithromycin)
	DRV/r, FPV/r, LPV/r, SQV/r, TPV/r	DRV/r ↑ clarithromycin AUC 57% FPV/r ↑ clarithromycin possible LPV/r ↑ clarithromycin expected RTV 500 mg BID ↑ clarithromycin 77% SQV unboosted ↑ clarithromycin 45% TPV/r ↑ clarithromycin 19% clarithromycin ↑ unboosted SQV 177% clarithromycin ↑ TPV 66%	Monitor for clarithromycin-related toxicities or consider alternative macrolide (e.g., azithromycin). Reduce clarithromycin dose by 50% in patients with CrCl 30–60 mL/min. Reduce clarithromycin dose by 75% in patients with CrCl <30 mL/min.
	FPV	APV AUC ↑ 18%	No dosage adjustment necessary.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 6 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antimycobacterials (for treatment of *Mycobacterium tuberculosis* and non-tuberculosis mycobacterial infections), continued			
Rifabutin	ATV (unboosted)	↑ rifabutin AUC expected	Rifabutin 150 mg daily or 300 mg three times a week
	FPV (unboosted)	No data	Consider alternative ARV.
	ATV/c, DRV/c	↑ rifabutin expected	Rifabutin 150 mg once daily or 300 mg three times a week. Monitor for antimycobacterial activity and consider therapeutic drug monitoring. PK data reported in this table are results from healthy volunteer studies. Lower rifabutin exposure has been reported in HIV-infected patients than in the healthy study participants.
	ATV/r	Compared with rifabutin (300 mg once daily) alone, rifabutin (150 mg once daily) with ATV/r, rifabutin AUC ↑ 110% and metabolite AUC ↑ 2101%	
	DRV/r	Compared with rifabutin (300 mg once daily) alone, rifabutin (150 mg every other day) with DRV/r, rifabutin AUC ↔ and metabolite AUC ↑ 881%	
	FPV/r	Compared with rifabutin (300 mg once daily) alone, rifabutin (150 mg every other day) with FPV/r, rifabutin and metabolite AUC ↑ 64%.	
	LPV/r	Compared with rifabutin (300 mg daily) alone, rifabutin (150 mg once daily) with LPV/r, rifabutin and metabolite AUC ↑ 473%.	
	SQV/r	↑ rifabutin with unboosted SQV	
	TPV/r	rifabutin and metabolite AUC ↑ 333%	
Rifampin	All PIs	↓ PI concentration by >75%	**Do not coadminister rifampin and PIs.** Additional RTV does not overcome this interaction and increases hepatotoxicity. Additional COBI is not recommended. Consider rifabutin if a rifamycin is indicated.
Rifapentine	All PIs	↓ PI expected	**Do not coadminister.**
Cardiac Medications			
Amiodarone	SQV/r, TPV/r	↑ both amiodarone and PI possible	**Do not coadminister.**
	All PIs (except SQV/r, TPV/r)	↑ both amiodarone and PI possible	Use with caution. Monitor for amiodarone toxicity and consider ECG and amiodarone drug level monitoring.
Antiarrhythmics (e.g., dofetilide, dronedarone, flecainide, lidocaine, propafenone, quinidine)	SQV/r	↑ antiarrhythmic possible	**Do not coadminister.**
	All PIs	↑ antiarrhythmic possible	Use with caution. **Refer to Table 18 for contraindicated combinations.**

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Cardiac Medications, continued			
Beta-blockers (e.g., metoprolol, timolol)	All PIs	↑ beta-blockers possible	May need to decrease beta-blocker dose; adjust dose based on clinical response. Consider using beta-blockers that are not metabolized by CYP450 enzymes (e.g., atenolol, labetalol, nadolol, sotalol).
Bosentan	All PIs	LPV/r ↑ bosentan 48-fold (day 4) and 5-fold (day 10) ↓ ATV expected	**Do not coadminister bosentan and unboosted ATV.** In Patients on a PI (Other than Unboosted ATV) >10 Days: • Start bosentan at 62.5 mg once daily or every other day. In Patients on Bosentan who Require a PI (Other than Unboosted ATV): • Stop bosentan ≥36 hours before PI initiation and 10 days after PI initiation restart bosentan at 62.5 mg once daily or every other day. When switching between COBI and RTV: • Maintain same bosentan dose.
Calcium Channel Blockers (CCBs) (except diltiazem)	All PIs	↑ dihydropyridine possible ↑ verapamil possible	Use with caution. Titrate CCB dose and monitor closely. ECG monitoring is recommended when CCB used with ATV and SQV.
Digoxin	PI/r, ATV/c, or DRV/c	RTV (200 mg BID) ↑ digoxin AUC 29% and ↑ half-life 43% SQV/r ↑ digoxin AUC 49% DRV/r ↑ digoxin AUC 36% COBI ↑ digoxin C_{max} 41%, AUC ↔	Use with caution. Monitor digoxin levels. Digoxin dose may need to be decreased. Titrate initial digoxin dose.
Diltiazem	ATV/c, ATV/r, ATV	Unboosted ATV ↑ diltiazem AUC 125% Greater ↑ likely with ATV/c or ATV/r	Decrease diltiazem dose by 50%. ECG monitoring is recommended.
	DRV/c, DRV/r, FPV/r, FPV, LPV/r, SQV/r, TPV/r	↑ diltiazem possible	Use with caution. Adjust diltiazem according to clinical response and toxicities.
Corticosteroids			
Beclomethasone Inhaled	DRV/r	RTV 100 mg BID ↑ 17-BMP AUC 2-fold and ↑ C_{max} 1.6-fold (DRV 600 mg + RTV 100 mg) BID ↓ 17-BMP AUC 11% and ↓ C_{max} 19%	No dosage adjustment necessary. Significant interaction between beclomethasone (inhaled or intranasal) and other RTV-boosted PIs, ATV/c, or DRV/c is not expected.
Budesonide Systemic	All PIs	↓ PI levels possible ↑ glucocorticoids	Coadministration can result in adrenal insufficiency and Cushing's syndrome. **Do not coadminister unless potential benefits of systemic budesonide outweigh the risks of systemic corticosteroid adverse effects.**

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 8 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Corticosteroids, continued			
Budesonide, Fluticasone, Mometasone Inhaled or Intranasal	All RTV- or COBI-boosted PIs	↑ glucocorticoids possible RTV 100 mg BID ↑ fluticasone AUC 350-fold and ↑ C_{max} 25-fold	Coadministration can result in adrenal insufficiency and Cushing's syndrome. **Do not coadminister unless potential benefits of inhaled or intranasal corticosteroid outweigh the risks of systemic corticosteroid adverse effects.** Consider alternative corticosteroid (e.g., beclomethasone).
Dexamethasone Systemic	All PIs	↓ PI levels possible	Use systemic dexamethasone with caution. Consider alternative corticosteroid for long-term use.
Prednisone	LPV/r	↑ prednisolone AUC 31%	Use with caution. Coadministration can result in adrenal insufficiency and Cushing's syndrome. **Do not coadminister unless potential benefits of prednisone outweigh the risks of systemic corticosteroid adverse effects.**
	All PIs	↑ prednisolone possible	
Methyl-prednisolone, Prednisolone, Triamcinolone (local injections, including intra-articular, epidural, intra-orbital)	All RTV- or COBI-boosted PIs	↑ glucocorticoids expected	**Do not coadminister.** Coadministration can result in adrenal insufficiency and Cushing's syndrome.
Hepatitis C Direct-Acting Antiviral Agents			
Boceprevir	ATV/r	ATV AUC ↓ 35%, C_{min} ↓ 49% boceprevir AUC ↔	**Do not coadminister.**
	ATV/c, DRV/c	Effects unknown	**Do not coadminister.**
	DRV/r	DRV AUC ↓ 44%, C_{min} ↓ 59% boceprevir AUC ↓ 32%, C_{min} ↓ 35%	**Do not coadminister.**
	LPV/r	LPV AUC ↓ 34%, C_{min} ↓ 43% boceprevir AUC ↓ 45%, C_{min} ↓ 57%	**Do not coadminister.**
Dasabuvir + Paritaprevir/ Ombitasvir/RTV	ATV	ATV ↔	ATV 300 mg alone, **without COBI or additional RTV**, should be given in the morning with dasabuvir + paritaprevir/ ombitasvir/RTV.
	DRV	DRV C_{min} ↓ 43% to 48%	**Do not coadminister.**
	LPV/r	paritaprevir AUC ↑ 117%	**Do not coadminister.**
	ATV/c, DRV/c, FPV, SQV, TPV	No data	**Do not coadminister.**

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 9 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Hepatitis C Direct-Acting Antiviral Agents, continued			
Ledipasvir/ Sofosbuvir	ATV/r	ATV AUC ↑ 33% ledipasvir AUC ↑ 113% sofosbuvir: no significant effect	No dosage adjustment necessary. Coadministration of ledipasvir/sofosbuvir with TDF and a PI/r results in increased exposure to TDF. The safety of the increased TDF exposure has not been established. Consider alternative HCV or ARV drugs to avoid increased TDF toxicities. If coadministration is necessary, monitor for TDF-associated adverse reactions.
	DRV/r	DRV: no significant effect expected ledipasvir/sofosbuvir: no significant effect	
	ATV/c, DRV/c, FPV, FPV/r, LPV/r, SQV/r	No significant effect expected	
	TPV/r	↓ ledipasvir and sofosbuvir expected	**Do not coadminister.**
Simeprevir	All PIs	Compared with simeprevir 150 mg alone, simeprevir 50 mg plus DRV/r 800/100 mg daily, simeprevir AUC ↑ 159% RTV 100 mg BID ↑ simeprevir AUC 618%	**Do not coadminister.**
Herbal Products			
St. John's Wort	All PIs	↓ PI expected	**Do not coadminister.**
Hormonal Contraceptives			
Hormonal Contraceptives (oral)	ATV (unboosted)	ethinyl estradiol AUC ↑ 48% norethindrone AUC ↑ 110%	Prescribe oral contraceptive that contains no more than 30 mcg of ethinyl estradiol or recommend alternative contraceptive method. Oral contraceptives containing less than 25 mcg of ethinyl estradiol or progestins other than norethindrone or norgestimate have not been studied.[c]
	ATV/r	ethinyl estradiol AUC ↓ 19% and C_{min} ↓ 37% norgestimate ↑ 85%	Oral contraceptive should contain at least 35 mcg of ethinyl estradiol. Oral contraceptives containing progestins other than norethindrone or norgestimate have not been studied.[b]
	ATV/c, DRV/c	Effects unknown	Recommend alternative or additional contraceptive method or alternative ARV drug.
	DRV/r, FPV/r, LPV/r, SQV/r, TPV/r	ethinyl estradiol AUC ↓ 37% to 48% norethindrone AUC ↓ 14% to 34% With TPV/r: norethindrone AUC ↔	Recommend alternative or additional contraceptive method or alternative ARV drug.
	FPV	With APV: ↑ ethinyl estradiol and ↑ norethindrone C_{min}; APV C_{min} ↓ 20%	Recommend alternative contraceptive method or alternative ARV drug.
Etonogestrel-releasing subdermal implant	LPV/r	etonogestrel AUC ↑ 52% and C_{min} ↑ 34%	Use standard dose.
	All other PIs	No data	Recommend alternative or additional contraceptive method or alternative ARV drug.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 10 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Hormonal Contraceptives, continued			
Transdermal ethinyl estradiol/ norelgestromin	LPV/r	LPV ↔ ethinyl estradiol AUC ↓ 45%, norelgestromin AUC ↑ 83%	Use standard dose.
	All other PIs	No data	Recommend alternative or additional contraceptive method or alternative ARV drug.
HMG-CoA Reductase Inhibitors			
Atorvastatin	ATV, ATV/c, ATV/r, DRV/c	↑ atorvastatin possible	Titrate atorvastatin dose carefully and use lowest dose necessary.
	DRV/r	DRV/r plus atorvastatin 10 mg similar to atorvastatin 40 mg administered alone	Titrate atorvastatin dose carefully and use the lowest necessary dose. Do not exceed 20 mg atorvastatin daily.
	FPV, FPV/r,	FPV +/– RTV ↑ atorvastatin AUC 130% to 153%	
	SQV/r	SQV/r ↑ atorvastatin AUC 79%	
	LPV/r	LPV/r ↑ atorvastatin AUC 488%	Use with caution and use the lowest atorvastatin dose necessary.
	TPV/r	↑ atorvastatin AUC 836%	**Do not coadminister.**
Lovastatin	All PIs	Significant ↑ lovastatin expected	**Contraindicated. Do not coadminister.**
Pitavastatin	All PIs	ATV ↑ pitavastatin AUC 31%, C_{max} ↑ 60% ATV: no significant effect DRV/r: no significant effect LPV/r ↓ pitavastatin AUC 20% LPV: no significant effect	No dose adjustment necessary.
Pravastatin	ATV/c, ATV/r	No data	Use lowest starting dose of pravastatin and monitor for efficacy and adverse effects.
	DRV/c, DRV/r	With DRV/r, pravastatin AUC • ↑ 81% following single dose of pravastatin • ↑ 23% at steady state	Use lowest possible starting dose of pravastatin with careful monitoring.
	LPV/r	pravastatin AUC ↑ 33%	No dose adjustment necessary.
	SQV/r	pravastatin AUC ↓ 47% to 50%	No dose adjustment necessary.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 11 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
HMG-CoA Reductase Inhibitors, continued			
Rosuvastatin	ATV/c, DRV/c	↑ rosuvastatin possible	Titrate rosuvastatin dose carefully and use the lowest necessary dose while monitoring for toxicities.
	ATV/r, LPV/r	ATV/r ↑ rosuvastatin AUC 3-fold and C_{max} ↑ 7-fold LPV/r ↑ rosuvastatin AUC 108% and C_{max} ↑ 366%	Titrate rosuvastatin dose carefully and use the lowest necessary dose. Do not exceed 10 mg rosuvastatin daily.
	DRV/r	rosuvastatin AUC ↑ 48% and C_{max} ↑ 139%	Titrate rosuvastatin dose carefully and use the lowest necessary dose while monitoring for toxicities.
	FPV +/- RTV	No significant effect on rosuvastatin	No dosage adjustment necessary.
	SQV/r	No data available	Titrate rosuvastatin dose carefully and use the lowest necessary dose while monitoring for toxicities.
	TPV/r	rosuvastatin AUC ↑ 26% and C_{max} ↑ 123%	No dosage adjustment necessary.
Simvastatin	All PIs	Significant ↑ simvastatin level: SQV/r 400 mg/400 mg BID ↑ simvastatin AUC 3059%	**Contraindicated. Do not coadminister.**
Immunosuppressants			
Cyclosporine **Everolimus** **Sirolimus** **Tacrolimus**	All PIs	↑ immunosuppressant expected	Initiate with an adjusted dose of immunosuppressant to account for potential increased concentrations of the immunosuppressant and monitor for toxicities. Therapeutic drug monitoring of immunosuppressant is recommended. Consult with specialist as necessary.
Narcotics and Treatment for Opioid Dependence			
Buprenorphine	ATV (unboosted)	buprenorphine AUC ↑ 93% norbuprenorphine[d] AUC ↑ 76% ↓ ATV possible	**Do not coadminister buprenorphine with unboosted ATV.**
	ATV/r	buprenorphine AUC ↑ 66% norbuprenorphine[d] AUC ↑ 105%	Monitor for sedation. Buprenorphine dose reduction may be necessary.
	ATV/c, DRV/c	Effects unknown	Titrate buprenorphine dose using the lowest initial dose. Dose adjustment of buprenorphine may be needed. Clinical monitoring is recommended.
	DRV/r	buprenorphine: no significant effect norbuprenorphine[d] AUC ↑ 46% and C_{min} ↑ 71%	No dosage adjustment necessary. Clinical monitoring is recommended.
	FPV/r	buprenorphine: no significant effect norbuprenorphine[d] AUC ↓ 15%	No dosage adjustment necessary. Clinical monitoring is recommended.
	LPV/r	No significant effect	No dosage adjustment necessary.
	TPV/r	buprenorphine: no significant effect norbuprenorphine[d] AUC, C_{max}, and C_{min} ↓ 80% TPV C_{min} ↓ 19% to 40%	Consider monitoring TPV level.

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 12 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Narcotics and Treatment for Opioid Dependence, continued			
Fentanyl	All PIs	↑ fentanyl possible	Clinical monitoring is recommended, including for potentially fatal respiratory depression.
Methadone	ATV (unboosted)	No significant effect	No dosage adjustment necessary.
	ATV/c, DRV/c	Effects unknown	Titrate methadone dose using the lowest feasible initial dose. Dose adjustment of methadone may be needed. Clinical monitoring is recommended.
	FPV (unboosted)	No data with unboosted FPV APV ↓ R-methadone[e] C_{min} 21%, AUC no significant change	Monitor and titrate methadone as clinically indicated. The interaction with FPV is presumed to be similar to that with APV.
	RTV-boosted PIs	ATV/r, DRV/r, and FPV/r ↓ R-methadone[e] AUC 16% to 18% LPV/r ↓ methadone AUC 26% to 53% SQV/r 1000/100 mg BID ↓ R-methadone[e] AUC 19% TPV/r ↓ R-methadone[e] AUC 48%	Opioid withdrawal unlikely but may occur. Dosage adjustment of methadone is not usually required, but monitor for opioid withdrawal and increase methadone dose as clinically indicated.
Oxycodone	LPV/r	oxycodone AUC ↑ 2.6-fold	Monitor for opioid-related adverse effects. Oxycodone dose reduction may be necessary.
Phosphodiesterase Type 5 (PDE5) Inhibitors			
Avanafil	All PIs except unboosted FPV	RTV (600 mg BID for 5 days) ↑ avanafil AUC 13-fold, C_{max} 2.4-fold	**Coadministration is not recommended.**
	ATV, FPV (unboosted)	No data	Avanafil dose should not exceed 50 mg once every 24 hours.
Sildenafil	All PIs	DRV/r plus sildenafil 25 mg similar to sildenafil 100 mg alone RTV 500 mg BID ↑ sildenafil AUC 1,000% SQV unboosted ↑ sildenafil AUC 210%	For Treatment of Erectile Dysfunction: • Start with sildenafil 25 mg every 48 hours and monitor for adverse effects of sildenafil. For Treatment of PAH: • **Contraindicated**

Table 19a. Drug Interactions between Protease Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 13 of 14)

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Phosphodiesterase Type 5 (PDE5) Inhibitors, continued			
Tadalafil	All PIs	RTV 200 mg BID ↑ tadalafil AUC 124% TPV/r (1st dose) ↑ tadalafil AUC 133% TPV/r steady state: no significant effect	For Treatment of Erectile Dysfunction: • Start with tadalafil 5-mg dose and do not exceed a single dose of 10 mg every 72 hours. Monitor for adverse effects of tadalafil. For Treatment of PAH *In patients on a PI >7 days:* • Start with tadalafil 20 mg once daily and increase to 40 mg once daily based on tolerability. *In patients on tadalafil who require a PI:* • Stop tadalafil ≥24 hours before PI initiation. 7 days after PI initiation restart tadalafil at 20 mg once daily, and increase to 40 mg once daily based on tolerability. *In patients switching between COBI and RTV:* • Maintain tadalafil dose. For Treatment of Benign Prostatic Hyperplasia: • Maximum recommended daily dose is 2.5 mg per day.
Vardenafil	All PIs	RTV 600 mg BID ↑ vardenafil AUC 49-fold	Start with vardenafil 2.5 mg every 72 hours and monitor for adverse effects of vardenafil.
Sedative/Hypnotics			
Alprazolam **Diazepam**	All PIs	↑ benzodiazepine possible RTV (200 mg BID for 2 days) ↑ alprazolam half-life 222% and AUC 248%	Consider alternative benzodiazepines such as lorazepam, oxazepam, or temazepam.
Lorazepam **Oxazepam** **Temazepam**	All PIs	No data	These benzodiazepines are metabolized via non-CYP450 pathways; thus, there is less interaction potential than with other benzodiazepines.
Midazolam	All PIs	↑ midazolam expected SQV/r ↑ midazolam (oral) AUC 1144% and C_{max} 327%	**Do not coadminister oral midazolam and PIs.** Parenteral midazolam can be used with caution when given as a single dose in a monitored situation for procedural sedation.
Suvorexant	All PIs	↑ suvorexant expected	**Coadministration is not recommended.**
Triazolam	All PIs	↑ triazolam expected RTV (200 mg BID) ↑ triazolam half-life 1200% and AUC 2000%	**Do not coadminister.**
Zolpidem	PI/r or ATV/c or DRV/c	↑ zolpidem possible	Initiate zolpidem at a low dose. Dose reduction may be necessary.

Concomitant Drug	PI	Effect on PI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Miscellaneous Drugs			
Colchicine	All PIs	RTV 100 mg BID ↑ colchicine AUC 296%, C_{max} 184% With all PIs with or without COBI or RTV: significant ↑ colchicine expected	For Treatment of Gout Flares: • Colchicine 0.6 mg x 1 dose, followed by 0.3 mg 1 hour later. Do not repeat dose for at least 3 days. *With FPV without RTV:* • 1.2 mg x 1 dose and no repeat dose for at least 3 days For Prophylaxis of Gout Flares: • Colchicine 0.3 mg once daily or every other day *With FPV without RTV:* • Colchicine 0.3 mg BID or 0.6 mg once daily or 0.3 mg once daily For Treatment of Familial Mediterranean Fever: • Do not exceed colchicine 0.6 mg once daily or 0.3 mg BID. *With FPV without RTV:* • Do not exceed 1.2 mg once daily or 0.6 mg BID. **Do not coadminister in patients with hepatic or renal impairment.**
Salmeterol	All PIs	↑ salmeterol possible	**Do not coadminister** because of potential increased risk of salmeterol-associated cardiovascular events.

[a] DHA is an active metabolite of artemether.

[b] The following products contain at least 35 mcg of ethinyl estradiol combined with norethindrone or norgestimate (generic formulation may also be available): Brevicon; Femcon Fe; Modicon; Norinyl 1/35; Ortho-Cyclen; Ortho-Novum 1/35, 7/7/7; Ortho Tri-Cyclen; Ovcon 35; Tri-Norinyl.

[c] The following products contain no more than 30 mcg of ethinyl estradiol combined with norethindrone or norgestimate (generic formulation may also be available): Lo Minastrin Fe; Lo Loestrin Fe; Loestrin 1/20, 1.5/30; Loestrin Fe 1/20, 1.5/30; Loestrin 24 Fe; Minastrin 24 Fe; Ortho Tri-Cyclen Lo.

[d] Norbuprenorphine is an active metabolite of buprenorphine.

[e] R-methadone is the active form of methadone.

Key to Symbols: ↑ = increase, ↓ = decrease, ↔ = no change

Key to Acronyms: 17-BMP = beclomethasone 17-monopropionate; APV = amprenavir; ART = antiretroviral therapy; ARV = antiretroviral; ATV = atazanavir; ATV/c = cobicistat-boosted atazanavir; ATV/r = ritonavir-boosted atazanavir; AUC = area under the curve; BID = twice daily; C_{max} = maximum plasma concentration; C_{min} = minimum plasma concentration; CNS = central nervous system; COBI = cobicistat; CrCl = creatinine clearance; CYP = cytochrome P; DHA = dihydroartemisinin; DRV = darunavir; DRV/c = cobicistat-boosted darunavir; DRV/r = ritonavir-boosted darunavir; ECG = electrocardiogram; FPV = fosamprenavir; FPV/r = ritonavir-boosted fosamprenavir; HCV = hepatitis C virus; INR = international normalized ratio; LPV = lopinavir; LPV/r = ritonavir-boosted lopinavir; PAH = pulmonary arterial hypertension; PI = protease inhibitor; PI/c = cobicistat-boosted protease inhibitor; PI/r = ritonavir-boosted protease inhibitor; PK = pharmacokinetic; PPI = proton pump inhibitor; QTc = QT corrected for heart rate; RTV = ritonavir; SQV = saquinavir; SQV/r = ritonavir-boosted saquinavir; TCA = tricyclic antidepressant; TDF = tenofovir disoproxil fumarate; TPV = tipranavir; TPV/r = ritonavir-boosted tipranavir; VPA = valproic acid

Note: FPV is a pro-drug of APV.

Table 19b. Drug Interactions Between Non-Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 7)

This table provides information relating to PK interactions between NNRTIs and non-ARV drugs. For interactions between ARV agents and for dosing recommendations, refer to Tables 19c, 20a and 20b.

Note: DLV is **not** included in this table. Please refer to the DLV FDA package insert for information regarding drug interactions.

Concomitant Drug Class/Name	NNRTI[a]	Effect on NNRTI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Acid Reducers			
Antacids	RPV	↓ RPV expected when given simultaneously	Give antacids at least 2 hours before or at least 4 hours after RPV.
H2 Receptor Antagonists	RPV	↓ RPV	Give H2-receptor antagonists at least 12 hours before or at least 4 hours after RPV.
PPIs	RPV	With omeprazole 20 mg daily: • RPV AUC ↓ 40%, C_{min} ↓ 33%	**Contraindicated. Do not coadminister.**
Anticoagulants/Antiplatelets			
Warfarin	EFV, NVP	↑ or ↓ warfarin possible	Monitor INR and adjust warfarin dose accordingly.
	ETR	↑ warfarin possible	Monitor INR and adjust warfarin dose accordingly.
Clopidogrel	ETR	↓ activation of clopidogrel possible	ETR may prevent metabolism of clopidogrel (inactive) to its active metabolite. Avoid coadministration, if possible.
Anticonvulsants			
Carbamazepine Phenobarbital Phenytoin	EFV	Carbamazepine plus EFV: • Carbamazepine AUC ↓ 27% • EFV AUC ↓ 36% Phenytoin plus EFV: • ↓ EFV • ↓ phenytoin possible	Monitor anticonvulsant and EFV levels or, if possible, use alternative anticonvulsant to those listed.
	ETR	↓ anticonvulsant and ETR possible	**Do not coadminister.** Consider alternative anticonvulsant.
	NVP	↓ anticonvulsant and NVP possible	Monitor anticonvulsant and NVP levels and virologic responses or consider alternative anticonvulsant.
	RPV	↓ RPV possible	**Contraindicated. Do not coadminister.** Consider alternative anticonvulsant.
Antidepressants			
Bupropion	EFV	Bupropion AUC ↓ 55%	Titrate bupropion dose based on clinical response.
Paroxetine	EFV, ETR	No significant effect	No dosage adjustment necessary.
Sertraline	EFV	Sertraline AUC ↓ 39%	Titrate sertraline dose based on clinical response.

Table 19b. Drug Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 7)

Concomitant Drug Class/Name	NNRTI[a]	Effect on NNRTI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antifungals			
Fluconazole	EFV	No significant effect	No dosage adjustment necessary.
	ETR	ETR AUC ↑ 86%	No dosage adjustment necessary. Use with caution.
	NVP	NVP AUC ↑ 110%	Increased risk of hepatotoxicity possible with this combination. Monitor NVP toxicity or use alternative ARV agent.
	RPV	↑ RPV possible	No dosage adjustment necessary. Clinically monitor for breakthrough fungal infection. (RPV 150 mg/day reduces ketoconazole exposure; no data on interaction with fluconazole.)
Itraconazole	EFV	Itraconazole and OH-itraconazole AUC, C_{max}, and C_{min} ↓ 35% to 44%	Failure to achieve therapeutic itraconazole concentrations has been reported. Avoid this combination if possible. If coadministered, closely monitor itraconazole concentration and adjust dose accordingly.
	ETR	↓ itraconazole possible ↑ ETR possible	Dose adjustments for itraconazole may be necessary. Monitor itraconazole level and antifungal response.
	NVP	↓ itraconazole possible ↑ NVP possible	Avoid combination if possible. If coadministered, monitor itraconazole concentration and adjust dose accordingly.
	RPV	↑ RPV possible	No dosage adjustment necessary. Clinically monitor for breakthrough fungal infection. (RPV 150 mg/day reduces ketoconazole exposure; no data on interaction with itraconazole.)
Posaconazole	EFV	Posaconazole AUC ↓ 50% ↔ EFV	Avoid concomitant use unless the benefit outweighs the risk. If coadministered, monitor posaconazole concentration and adjust dose accordingly.
	ETR	↑ ETR possible	No dosage adjustment necessary.
	RPV	↑ RPV possible	No dosage adjustment necessary. Clinically monitor for breakthrough fungal infection. (RPV 150 mg/day reduces ketoconazole exposure; no data on interaction with posaconazole.)
Voriconazole	EFV	Voriconazole AUC ↓ 77% EFV AUC ↑ 44%	**Contraindicated at standard doses.** Dose adjustment: • Voriconazole 400 mg BID, EFV 300 mg daily
	ETR	Voriconazole AUC ↑ 14% ETR AUC ↑ 36%	No dosage adjustment necessary; use with caution. Consider monitoring voriconazole level.
	NVP	↓ voriconazole possible ↑ NVP possible	Monitor for toxicity and antifungal response and/or voriconazole level.
	RPV	↑ RPV possible	No dosage adjustment necessary. Clinically monitor for breakthrough fungal infection. (RPV 150 mg/day reduces ketoconazole exposure; no data on interaction with voriconazole.)

Table 19b. Drug Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 7)

Concomitant Drug Class/Name	NNRTI[a]	Effect on NNRTI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antimalarials			
Artemether/ Lumefantrine	EFV	Artemether AUC ↓ 79% DHA AUC ↓ 75% Lumefantrine AUC ↓ 56%	Clinical significance of the reduced antimalarial drug concentrations unknown. If used in combination with EFV, monitor closely for anti-malarial efficacy.
	ETR	Artemether AUC ↓ 38% DHA AUC ↓ 15% Lumefantrine AUC ↓ 13% ETR AUC ↑ 10%	Clinical significance of the reduced antimalarial drug concentrations unknown. If used in combination with ETR, monitor closely for anti-malarial efficacy.
	NVP	Artemether AUC ↓ 72% DHA AUC ↓ 37% Lumefantrine: • Study results are conflicting: lumefantrine AUC ↓ 25% in one study but ↑ 55.6% in another.	Clinical significance unknown. If used, monitor closely for anti-malarial efficacy and lumefantrine toxicity.
Atovaquone/ Proguanil	EFV	Atovaquone AUC ↓ 75% Proguanil AUC ↓ 43%	No dosage recommendation. Consider alternative drug for malaria prophylaxis, if possible.
Antimycobacterials			
Bedaquiline	EFV, NVP	↔ bedaquiline AUC	No dosage adjustment necessary.
Clarithromycin	EFV	Clarithromycin AUC ↓ 39%	Monitor for effectiveness or consider alternative agent, such as azithromycin, for MAC prophylaxis and treatment.
	ETR	Clarithromycin AUC ↓ 39% ETR AUC ↑ 42%	Consider alternative agent, such as azithromycin, for MAC prophylaxis and treatment.
	NVP	Clarithromycin AUC ↓ 31%	Monitor for effectiveness or use alternative agent, such as azithromycin, for MAC prophylaxis and treatment.
	RPV	↔ clarithromycin expected ↑ RPV possible	Consider alternative macrolide, such as azithromycin, for MAC prophylaxis and treatment.
Rifabutin	EFV	Rifabutin ↓ 38%	Dose: • Rifabutin 450–600 mg/day; or • Rifabutin 600 mg 3 times/week **if** EFV is not coadministered with a PI.
	ETR	Rifabutin and metabolite AUC ↓ 17% ETR AUC ↓ 37%	**If ETR is used with an RTV-boosted PI, rifabutin should not be coadministered.** Dose: • Rifabutin 300 mg once daily **if** ETR is not coadministered with an RTV-boosted PI.
	NVP	Rifabutin AUC ↑ 17% and metabolite AUC ↑ 24% NVP C_{min} ↓ 16%	No dosage adjustment necessary. Use with caution.
	RPV	RPV AUC ↓ 46%	Increase RPV to 50 mg once daily.

Table 19b. Drug Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 4 of 7)

Concomitant Drug Class/Name	NNRTI[a]	Effect on NNRTI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antimycobacterials, continued			
Rifampin	EFV	EFV AUC ↓ 26%	Maintain EFV dose at 600 mg once daily and monitor for virologic response. Consider therapeutic drug monitoring. Some clinicians suggest EFV 800 mg dose in patients who weigh more than 60 kg.
	ETR	Significant ↓ ETR possible	**Do not coadminister.**
	NVP	NVP ↓ 20% to 58%	**Do not coadminister.**
	RPV	RPV AUC ↓ 80%	**Contraindicated. Do not coadminister.**
Rifapentine	EFV, ETR, NVP, RPV	↓ NNRTI expected	**Do not coadminister.**
Benzodiazepines			
Alprazolam	EFV, ETR, NVP, RPV	No data	Monitor for therapeutic effectiveness of alprazolam.
Diazepam	ETR	↑ diazepam possible	Decreased dose of diazepam may be necessary.
Lorazepam	EFV	Lorazepam C_{max} ↑ 16%, AUC ↔	No dosage adjustment necessary.
Midazolam	EFV	Significant ↑ midazolam expected	**Do not coadminister with oral midazolam.** Parenteral midazolam can be used with caution as a single dose and can be given in a monitored situation for procedural sedation.
Triazolam	EFV	Significant ↑ triazolam expected	**Do not coadminister.**
Cardiac Medications			
Dihydropyridine CCBs	EFV, NVP	↓ CCBs possible	Titrate CCB dose based on clinical response.
Diltiazem Verapamil	EFV	Diltiazem AUC ↓ 69% ↓ verapamil possible	Titrate diltiazem or verapamil dose based on clinical response.
	NVP	↓ diltiazem or verapamil possible	
Corticosteroids			
Dexamethasone	EFV, ETR, NVP	↓ EFV, ETR, NVP possible	Consider alternative corticosteroid for long-term use. If dexamethasone is used with NNRTI, monitor virologic response.
	RPV	Significant ↓ RPV possible	**Contraindicated with more than a single dose of dexamethasone.**
Hepatitis C Direct-Acting Antiviral Agents			
Boceprevir	EFV	EFV AUC ↑ 20% Boceprevir AUC ↓ 19%, C_{min} ↓ 44%	**Coadministration is not recommended.**
	ETR	ETR AUC ↓ 23% Boceprevir AUC, C_{max} ↑ 10%	No dosage adjustment necessary.

Table 19b. Drug Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 5 of 7)

Concomitant Drug Class/Name	NNRTI[a]	Effect on NNRTI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Hepatitis C Direct-Acting Antiviral Agents, continued			
Dasabuvir plus Paritaprevir/ Ombitasivir/RTV	EFV	No data	**Contraindicated. Do not coadminister.**
	ETR, NVP	↓ DAAs possible	**Do not coadminister.**
	RPV	RPV AUC ↑ 150% to 225%	**Do not coadminister because of potential for QT interval prolongation with higher concentrations of RPV.**
Ledipasvir/ Sofosbuvir	EFV	Ledipasvir AUC, C_{min}, C_{max} – all ↓ 34% Sofosbuvir: no significant effect	No dosage adjustment necessary.
	ETR, NVP, RPV	No significant effect expected	
Simeprevir	EFV	Simeprevir AUC ↓ 71%, C_{min} ↓ 91% ↔ EFV	**Coadministration is not recommended.**
	ETR, NVP	↓ simeprevir expected	**Coadministration is not recommended.**
	RPV	↔ simeprevir and RPV	No dosage adjustment necessary.
Herbal Products			
St. John's Wort	EFV, ETR, NVP, RPV	↓ NNRTI	**Do not coadminister.**
Hormonal Contraceptives			
Hormonal Contraceptives	EFV	Ethinyl estradiol ↔ Levonorgestrel AUC ↓ 83% Norelgestromin AUC ↓ 64% Etonogestrel (implant) AUC ↓ 63%	Use alternative or additional contraceptive methods. Norelgestromin and levonorgestrel are active metabolites of norgestimate.
	ETR	Ethinyl estradiol AUC ↑ 22% Norethindrone: no significant effect	No dosage adjustment necessary.
	NVP	Ethinyl estradiol AUC ↓ 20% Norethindrone AUC ↓ 19%	Use alternative or additional contraceptive methods.
		DMPA: no significant change	No dosage adjustment necessary.
	RPV	Ethinyl estradiol AUC ↑ 14% Norethindrone: no significant change	No dosage adjustment necessary.
Levonorgestrel For emergency contraception	EFV	Levonorgestrel AUC ↓ 58%	Effectiveness of emergency post-coital contraception may be diminished.

Table 19b. Drug Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 6 of 7)

Concomitant Drug Class/Name	NNRTI[a]	Effect on NNRTI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
HMG-CoA Reductase Inhibitors			
Atorvastatin	EFV, ETR	Atorvastatin AUC ↓ 32% to 43%	Adjust atorvastatin according to lipid responses, not to exceed the maximum recommended dose.
	RPV	Atorvastatin AUC ↔ Atorvastatin metabolites ↑	No dosage adjustment necessary.
Fluvastatin	ETR	↑ fluvastatin possible	Dose adjustments for fluvastatin may be necessary.
Lovastatin **Simvastatin**	EFV	Simvastatin AUC ↓ 68%	Adjust simvastatin dose according to lipid responses, not to exceed the maximum recommended dose. If EFV is used with a RTV-boosted PI, simvastatin and lovastatin should be avoided.
	ETR, NVP	↓ lovastatin possible ↓ simvastatin possible	Adjust lovastatin or simvastatin dose according to lipid responses, not to exceed the maximum recommended dose. If ETR or NVP is used with a RTV-boosted PI, simvastatin and lovastatin should be avoided.
Pitavastatin	EFV	Pitavastatin AUC ↓ 11%, C_{max} ↑ 20%	No dosage adjustment necessary.
	ETR, NVP, RPV	No data	No significant effect expected. No dosage adjustment necessary.
Pravastatin **Rosuvastatin**	EFV	Pravastatin AUC ↓ 44% Rosuvastatin: no data	Adjust statin dose according to lipid responses, not to exceed the maximum recommended dose.
	ETR	No significant effect expected	No dosage adjustment necessary.
Immunosuppressants			
Cyclosporine **Sirolimus** **Tacrolimus**	EFV, ETR, NVP	↓ immunosuppressant possible	Increase in immunosuppressant dose may be necessary. Therapeutic drug monitoring of immunosuppressant is recommended. Consult with specialist as necessary.
Narcotics/Treatments for Opioid Dependence			
Buprenorphine	EFV	Buprenorphine AUC ↓ 50% Norbuprenorphine[b] AUC ↓ 71%	No dosage adjustment recommended; monitor for withdrawal symptoms.
	ETR	Buprenorphine AUC ↓ 25%	No dosage adjustment necessary.
	NVP	No significant effect	No dosage adjustment necessary.
Methadone	EFV	Methadone AUC ↓ 52%	Opioid withdrawal common; increased methadone dose often necessary.
	ETR	No significant effect	No dosage adjustment necessary.
	NVP	Methadone AUC ↓ 37% to 51% NVP: no significant effect	Opioid withdrawal common; increased methadone dose often necessary.
	RPV	R-methadone[c] AUC ↓ 16%	No dosage adjustment necessary, but monitor for withdrawal symptoms.

Table 19b. Drug Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 7 of 7)

Concomitant Drug Class/Name	NNRTI[a]	Effect on NNRTI and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
PDE5 Inhibitors			
Avanafil	EFV, ETR, NVP, RPV	No data	**Coadministration is not recommended.**
Sildenafil	ETR	Sildenafil AUC ↓ 57%	May need to increase sildenafil dose based on clinical effect.
	RPV	↔ sildenafil	No dosage adjustment necessary.
Tadalafil	ETR	↓ tadalafil possible	May need to increase tadalafil dose based on clinical effect.
Vardenafil	ETR	↓ vardenafil possible	May need to increase vardenafil dose based on clinical effect.

[a] Approved dose for RPV is 25 mg once daily. Most PK interaction studies were performed using 75 to 150 mg per dose.

[b] Norbuprenorphine is an active metabolite of buprenorphine.

[c] R-methadone is the active form of methadone.

Key to Symbols: ↑ = increase, ↓ = decrease, ↔ = no change

Key to Acronyms: ARV = antiretroviral; AUC = area under the curve; BID = twice daily; CCB = calcium channel blockers; C_{max} = maximum plasma concentration; C_{min} = minimum plasma concentration; DAAs = direct-acting antivirals; DHA = dihydroartemisinin; DLV = delavirdine; DMPA = depot medroxyprogesterone acetate; EFV = efavirenz; ETR = etravirine; FDA = Food and Drug Administration; HMG-CoA = hydroxy-methylglutaryl-coenzyme A; INR = international normalized ratio; MAC = *Mycobacterium avium* complex; NNRTI = non-nucleoside reverse transcriptase inhibitor; NVP = nevirapine; OH-itraconazole = active metabolite of itraconazole; PDE5 = phosphodiesterase type 5; PI = protease inhibitor; PK = pharmacokinetic; PPI = proton pump inhibitor; RPV = rilpivirine; RTV = ritonavir

Table 19c. Drug Interactions Between Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Including Antiretroviral Agents) (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 2)

Concomitant Drug Class/Name	NRTI	Effect on NRTI and/or Concomitant Drug Concentrations	Dosage Recommendations and Clinical Comments
Non-ARV Antivirals			
Adefovir	TDF	No data	**Do not coadminister.** Serum concentrations of TDF and/or other renally eliminated drugs may be increased.
Ganciclovir **Valganciclovir**	TDF	No data	Serum concentrations of these drugs and/or TDF may be increased. Monitor for dose-related toxicities.
	ZDV	No significant effect	Potential increase in hematologic toxicities
Ledipasvir/ Sofosbuvir	TDF	• Ledipasvir ↑ TDF AUC 40% to 98% when TDF given with RPV and EFV • Further ↑ TDF possible if TDF given with PIs	No dose adjustment necessary. Monitor for TDF toxicity. The safety of increased TDF exposure when ledipasvir/sofosbuvir is coadministered with TDF and a PI/r, ATV/c, or DRV/c has not been established. Consider alternative HCV or ARV drugs to avoid increased TDF toxicities. If coadministration is necessary, monitor for TDF-associated adverse reactions. Coadministration of ledipasvir/sofosbuvir with EVG/c/TDF/FTC **is not recommended**.
Ribavirin	ddI	↑ intracellular ddI	**Contraindicated. Do not coadminister.** Fatal hepatic failure and other ddI-related toxicities have been reported with coadministration.
	ZDV	Ribavirin inhibits phosphorylation of ZDV.	Avoid coadministration if possible, or closely monitor HIV virologic response and possible hematologic toxicities.
INSTIs			
DTG	TDF	• TDF AUC ↑ 12% and C_{min} ↑ 19% • DTG ↔	No dosage adjustment necessary.
RAL	TDF	RAL AUC ↑ 49%	No dosage adjustment necessary.
Narcotics/Treatment for Opioid Dependence			
Buprenorphine	3TC, ddI, TDF, ZDV	No significant effect	No dosage adjustment necessary.
Methadone	ABC	Methadone clearance ↑ 22%	No dosage adjustment necessary.
	d4T	d4T AUC ↓ 23%	No dosage adjustment necessary.
	ZDV	ZDV AUC ↑ 29% to 43%	Monitor for ZDV-related adverse effects.
NRTIs			
ddI	d4T	No significant PK interaction	**Do not coadminister.** Additive toxicities of peripheral neuropathy, lactic acidosis, and pancreatitis seen with this combination.
	TDF	ddI-EC AUC and C_{max} ↑ 48% to 60%	**Avoid coadministration.**

Table 19c. Drug Interactions Between Nucleoside Reverse Transcriptase Inhibitors and Other Drugs (Including Antiretroviral Agents) (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 2)

Concomitant Drug Class/Name	NRTI	Effect on NRTI and/or Concomitant Drug Concentrations	Dosage Recommendations and Clinical Comments
Other			
Allopurinol	ddI	ddI AUC ↑ 113% In patients with renal impairment: • ddI AUC ↑ 312%	**Contraindicated.** Potential for increased ddI-associated toxicities.
Atovaquone	ZDV	ZDV AUC ↑ 31%	Monitor for ZDV-related adverse effects.
PIs			
ATV +/- RTV or COBI	ddI	With ddI-EC plus ATV (with food): • ddI AUC ↓ 34% • ATV no change	Administer ATV with food 2 hours before or 1 hour after ddI.
	TDF	With ATV (unboosted): • ATV AUC ↓ 25% and C_{min} ↓ 23% to 40% (higher C_{min} with RTV than without RTV) • TDF AUC ↑ 24% to 37%	**Avoid concomitant use without RTV or COBI.** Dose: • ATV 300 mg daily plus (RTV 100 mg or COBI 150 mg) daily when coadministered with TDF 300 mg daily. • If using TDF and H2 receptor antagonist in ART-experienced patients, use ATV 400 mg daily plus (RTV 100 mg or COBI 150 mg) daily. Monitor for TDF-associated toxicity.
	ZDV	With ATV (unboosted): • ZDV C_{min} ↓ 30% and AUC ↔	Clinical significance unknown.
DRV/c	TDF	Increased TDF possible	Monitor for TDF-associated toxicity.
DRV/r	TDF	TDF AUC ↑ 22% and C_{min} ↑ 37%	Clinical significance unknown. Monitor for TDF toxicity.
LPV/r	TDF	• LPV/r AUC ↓ 15% • TDF AUC ↑ 34%	Clinical significance unknown. Monitor for TDF toxicity.
TPV/r	ABC	ABC AUC ↓ 35% to 44%	Appropriate doses for this combination have not been established.
	ddI	• ddI-EC AUC ↔ and C_{min} ↓ 34% • TPV/r ↔	Separate doses by at least 2 hours.
	TDF	• TDF AUC ↔ • TPV/r AUC ↓ 9% to 18% and C_{min} ↓ 12% to 21%	No dosage adjustment necessary.
	ZDV	• ZDV AUC ↓ 35% • TPV/r AUC ↓ 31% to 43%	Appropriate doses for this combination have not been established.

Key to Symbols: ↑ = increase, ↓ = decrease, ↔ = no change

Key to Abbreviations: 3TC = lamivudine; ABC = abacavir; ART = antiretroviral therapy; ARV = antiretroviral; ATV = atazanavir; ATV/c = atazanavir/cobicistat; AUC = area under the curve; C_{max} = maximum plasma concentration; C_{min} = minimum plasma concentration; COBI = cobicistat; d4T = stavudine; ddI = didanosine; DRV/c = darunavir/cobicistat; DRV/r = darunavir/ritonavir; DTG = douletegravir; EC = enteric coated; EFV = efavirenz; EFV/c/TDF/FTC = efavirenz/cobicistat/tenofovir disoproxil fumarate/emtricitabine; HCV = hepatitis C virus; INSTI = integrase strand transfer inhibitor; LPV/r = lopinavir/ritonavir; NRTI = nucleoside reverse transcriptase inhibitor; PI = protease inhibitor; PI/r = ritonavir-boosted protease inhibitor; PK = pharmacokinetic; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; TDF = tenofovir disoproxil fumarate; TPV/r = tipranavir/ritonavir; ZDV = zidovudine

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 11)

This table provides information on known or predicted PK interactions between INSTIs and non-ARV drugs. The table includes information on interactions with EVG, an INSTI that is available in two formulations:

1. A fixed-dose combination tablet of EVG/c/TDF/FTC indicated for use as a single-tablet regimen
2. A stand-alone tablet indicated for use with a RTV-boosted PI (PI/r) and other ARVs in ARV treatment-experienced patients.

In the table, the drug interactions with EVG/c/TDF/FTC and those with EVG plus (PI/r) are presented separately. For several interactions, no dose adjustment is necessary for EVG when given with a concomitant drug; however, since EVG should always be given with a PI/r, clinicians should refer to Table 19a for recommendations on the management of drug interactions resulting from the PI/r used with EVG.

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Acid Reducers			
Aluminium, Magnesium +/- Calcium Containing Antacids Please refer to the Miscellaneous Drugs section of this table for recommendations on use with other polyvalent cation products (e.g., iron, calcium supplements, multivitamins).	DTG	DTG AUC ↓ 74% if given simultaneously with antacid; DTG AUC ↓ 26% if given 2 hours before antacid	Give DTG at least 2 hours before or at least 6 hours after antacids containing polyvalent cations.
	EVG/c/TDF/FTC	EVG AUC ↓ 40% to 50% if given simultaneously with antacid; EVG AUC ↓ 15% to 20% if given 2 hours before or after antacid; ↔ with 4-hour interval	Separate EVG/c/TDF/FTC and antacid administration by more than 2 hours.
	EVG plus (PI/r)	• EVG AUC ↓ 40% to 50% if given simultaneously with antacid; • EVG AUC ↓ 15% to 20% if antacid given 2 hours before or after EVG; ↔ with 4-hour interval	Separate EVG and antacid administration by more than 2 hours.
	RAL	Al-Mg Hydroxide Antacid: • RAL C_{min} ↓ 54% to 63% $CaCO_3$ Antacid: • RAL C_{min} ↓ 32%	**Do not coadminister RAL and Al-Mg hydroxide antacids.** Use alternative acid reducing agent. No dosing separation necessary when coadministering RAL and $CaCO_3$ antacids.
H2-Receptor Antagonists	EVG/c/TDF/FTC	No significant effect	No dosage adjustment necessary.
	EVG plus (PI/r)	↔ EVG	No dosage adjustment necessary for EVG. Refer to Table 19a for information on PI/r interactions.
PPIs	DTG	No significant effect	No dosage adjustment necessary.
	EVG/c/TDF/FTC	No significant effect	No dosage adjustment necessary.
	EVG plus (PI/r)	↔ EVG	No dosage adjustment necessary for EVG. Refer to Table 19a for information on PI/r interactions.
	RAL	RAL AUC ↑ 212% and C_{min} ↑ 46%	No dosage adjustment necessary.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Anticoagulants and Antiplatelets			
Apixaban	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ apixaban expected	**Avoid concomitant use.**
Dabigatran	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ dabigatran possible	No dosage adjustment for dabigatran if CrCl >50 mL/min. **Avoid coadministration if CrCl <50 mL/min.**
Rivaroxaban	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ rivaroxaban expected	**Avoid concomitant use.**
Ticagrelor	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ ticagrelor expected	**Avoid concomitant use.**
Vorapaxar	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ vorapaxar expected	**Avoid concomitant use.**
Warfarin	• EVG/c/TDF/FTC • EVG plus (PI/r)	No data, but warfarin levels may be affected	Monitor INR and adjust warfarin dose accordingly.
Anticonvulsants			
Carbamazepine **Oxcarbazepine** **Phenobarbital** **Phenytoin**	DTG	↓ DTG possible	Consider alternative anticonvulsant.
	EVG/c/TDF/FTC	• ↑ carbamazepine possible • ↓ EVG possible • ↓ COBI possible	Consider alternative anticonvulsant.
	EVG plus (PI/r)	↓ EVG	Consider alternative anticonvulsant.
Ethosuximide	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ ethosuximide possible	Clinically monitor for ethosuxamide toxicities.
Antidepressants/Anxiolytics/Antipsychotics Also see Sedative/Hypnotics section below.			
Bupropion	EVG/c/TDF/FTC	↑ or ↓ bupropion possible	Titrate bupropion dose based on clinical response.
	EVG plus (PI/r)	↓ bupropion possible	Titrate bupropion dose based on clinical response.
Buspirone	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ buspirone possible	Initiate buspirone at a low dose. Dose reduction may be necessary.
Fluvoxamine	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ or ↓ EVG possible	Consider alternative antidepressant or ARV.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antidepressants/Anxiolytics/Antipsychotics, continued Also see Sedative/Hypnotics section below.			
Quetiapine	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ quetiapine AUC expected.	Initiation of quetiapine in a patient receiving EVG/c/TDF/FTC: • Start quetiapine at the lowest dose and titrate up as needed. Monitor for quetiapine efficacy and adverse effects. Initiation of EVG/c/TDF/FTC in a patient receiving a stable dose of quetiapine: • Reduce quetiapine dose to 1/6 of the original dose, and closely monitor for quetiapine efficacy and adverse effects.
SSRIs Citalopram Escitalopram Fluoxetine Paroxetine Sertraline	EVG/c/TDF/FTC	↑ SSRI possible	Initiate with lowest dose of SSRI and titrate dose carefully based on antidepressant response.
	EVG plus (PI/r)	↑ or ↓ SSRI possible	Titrate SSRI dose based on clinical response.
TCAs Amitriptyline Desipramine Doxepin Imipramine Nortriptyline	EVG/c/TDF/FTC	Desipramine AUC ↑ 65%	Initiate with lowest dose of TCA and titrate dose carefully.
	EVG plus (PI/r)	↑ TCA expected	Initiate with lowest dose of TCA and titrate dose carefully based on antidepressant response and/or drug levels.
Trazodone	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ trazodone possible	Initiate with lowest dose of trazodone and titrate dose carefully.
Antifungals			
Itraconazole	EVG/c/TDF/FTC	• ↑ itraconazole expected • ↑ EVG and COBI possible	Consider monitoring itraconazole level to guide dosage adjustments. High itraconazole doses (>200 mg/day) are not recommended unless dose is guided by itraconazole levels.
	EVG plus (PI/r)	↑ EVG possible	Refer to Table 19a for PI recommendations.
Posaconazole	EVG/c/TDF/FTC	• ↑ EVG and COBI possible • ↑ posaconazole possible	If coadministered, monitor posaconazole concentrations.
	EVG plus (PI/r)	↑ EVG possible	Refer to Table 19a for PI recommendations.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 4 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antifungals, continued			
Voriconazole	EVG/c/TDF/FTC	• ↑ voriconazole expected • ↑ EVG and COBI possible	Risk/benefit ratio should be assessed to justify use of voriconazole. If administered, consider monitoring voriconazole level. Adjust dose accordingly.
	EVG plus (PI/r)	Changes in voriconazole and EVG possible	Refer to Table 19a for PI recommendations.
Antimycobacterials			
Clarithromycin	EVG/c/TDF/FTC	• ↑ clarithromycin possible • ↑ COBI possible	CrCl 50–60 mL/min: • Reduce clarithromycin dose by 50%. CrCl <50 mL/min: • EVG/c/TDF/FTC is not recommended.
Rifabutin	DTG	Rifabutin (300 mg once daily): • DTG AUC ↔ and C_{min} ↓ 30%	No dosage adjustment necessary.
	EVG/c/TDF/FTC	Rifabutin 150 mg every other day with EVG/c/TDF/FTC once daily compared to Rifabutin 300 mg once daily alone: • No significant change in rifabutin AUC • 25-O-desacetyl-rifabutin AUC ↑ 625% • EVG AUC ↓ 21% and C_{min} ↓ 67%	**Do not coadminister.**
	EVG plus (PI/r)	• ↔ EVG • ↔ rifabutin AUC • 25-O-desacetyl-rifabutin AUC ↑ 951%	Refer to Table 19a for dosing recommendations for rifabutin with PI.
	RAL	RAL AUC ↑ 19% and C_{min} ↓ 20%	No dosage adjustment necessary.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 5 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Antimycobacterials, continued			
Rifampin	DTG	Rifampin with DTG 50 mg BID compared to DTG 50 mg BID alone: • DTG AUC ↓ 54% and C_{min} ↓ 72% Rifampin with DTG 50 mg BID compared to DTG 50 mg once daily alone: • DTG AUC ↑ 33% and C_{min} ↑ 22%	Dose: • DTG 50 mg BID (instead of 50 mg once daily) for patients without suspected or documented INSTI mutation. **Alternative to rifampin should be used in patients with certain suspected or documented INSTI-associated resistance substitutions. Consider using rifabutin.**
	• EVG/c/TDF/FTC • EVG plus (PI/r)	Significant ↓ EVG and COBI expected	**Do not coadminister.**
	RAL	RAL 400 mg: • RAL AUC ↓ 40% and C_{min} ↓ 61% Compared with RAL 400 mg BID alone, Rifampin with RAL 800 mg BID: • RAL AUC ↑ 27% and C_{min} ↓ 53%	Dose: • RAL 800 mg BID Monitor closely for virologic response or consider using rifabutin as an alternative rifamycin.
Rifapentine	DTG	Significant ↓ DTG expected	**Do not coadminister.**
	• EVG/c/TDF/FTC • EVG plus (PI/r)	Significant ↓ EVG and COBI expected	**Do not coadminister.**
	RAL	RAL C_{min} ↓ 41%	**Do not coadminister.**
Cardiac Medications			
Anti-Arrhythmics Amiodarone Bepridil Digoxin Disopyramide Dronedarone Flecainide Systemic lidocaine Mexilitine Propafenone Quinidine	EVG/c/TDF/FTC	• ↑ anti-arrhythmics possible • digoxin C_{max} ↑ 41% and AUC no significant change	Use anti-arrhythmics with caution. Therapeutic drug monitoring, if available, is recommended for anti-arrhythmics.
	EVG plus (PI/r)	↑ anti-arrhythmics possible	Refer to Table 18 and 19a for use of anti-arrhythmics and PI/r

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 6 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Cardiac Medications, continued			
Bosentan	EVG/c/TDF/FTC	↑ bosentan possible	In patients on EVG/c/TDF/FTC ≥10 days: • Start bosentan at 62.5 mg once daily or every other day based on individual tolerability. In patients on bosentan who require EVG/c/TDF/FTC: • Stop bosentan ≥36 hours before EVG/c/TDF/FTC initiation. At least 10 days after initiation of EVG/c/TDF/FTC, resume bosentan at 62.5 mg once daily or every other day based on individual tolerability.
	EVG plus (PI/r)	↑ bosentan possible	Refer to Table 19a for recommendations on bosentan dosing when used with PI/r.
Beta-blockers (e.g., metoprolol, timolol)	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ beta-blockers possible	Beta-blocker dose may need to be decreased; adjust dose based on clinical response. Consider using beta-blockers that are not metabolized by CYP450 enzymes (e.g., atenolol, labetalol, nadolol, sotalol).
Dofetilide	DTG	↑ dofetilide expected	**Do not coadminister.**
CCBs	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ CCBs possible	Coadminister with caution. Titrate CCB dose and monitor for CCB efficacy and toxicities. Refer to Table 19a for diltiazem plus ATV/r and SQV/r recommendations.
Corticosteroids			
Dexamethasone (systemic)	EVG/c/TDF/FTC	↓ EVG and COBI possible	Use systemic dexamethasone with caution. Monitor virologic response to ART. Consider alternative corticosteroid.
	EVG plus (PI/r)	↓ EVG possible	
Fluticasone Inhaled/Intranasal	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ fluticasone possible	Coadministration may result in adrenal insufficiency and Cushing's syndrome. Consider alternative therapy (e.g., beclomethasone), particularly for long-term use.
Methylprednisolone, Prednisolone, Triamcinolone Local injections, including intra-articular, epidural, intra-orbital	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ glucocorticoids expected	Coadministration may result in adrenal insufficiency and Cushing's syndrome. **Do not coadminister.**

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 7 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Hepatitis C Direct Acting Antivirals			
Boceprevir	DTG	DTG AUC ↔	No dosage adjustment necessary.
	EVG/c/TDF/FTC	No data	**Do not coadminister.**
	EVG plus (PI/r)	↓ boceprevir	**Do not coadminister.**
	RAL	No significant effect	No dosage adjustment necessary.
Dasabuvir plus Ombitasvir/Paritaprevir/r	RAL	RAL AUC ↑ 134%	No dosage adjustment necessary.
	DTG	No data	**No dosing recommendations at this time.**
	• EVG plus (PI/r) • EVG/c/TDF/FTC	No data	**Do not coadminister.**
Ledipasvir/ Sofosbuvir	EVG/c/TDF/FTC	↑ TDF and ↑ ledipasvir expected	**Do not coadminister.**
	EVG plus (PI/r)	↔ EVG expected	Refer to Table 19a for PI dosing recommendations.
Simeprevir	EVG/c/TDF/FTC	↑ simeprevir expected	**Coadministration is not recommended.**
	EVG plus (PI/r)	↔ EVG expected	**Coadministration is not recommended.**
	RAL	No significant effect	No dosage adjustment necessary.
Sofosbuvir	All INSTIs	No significant effect expected	No dosage adjustment necessary.
Herbal Products			
St. John's Wort	DTG	↓ DTG possible	**Do not coadminister.**
	• EVG/c/TDF/FTC • EVG plus (PI/r)	↓ EVG and COBI possible	**Do not coadminister.**
Hormonal Contraceptives			
Hormonal Contraceptives	RAL	No clinically significant effect	No dosage adjustment necessary.
Norgestimate/Ethinyl Estradiol	DTG	No significant effect	No dosage adjustment necessary.
	EVG/c/TDF/FTC	• Norgestimate AUC, C_{max}, and C_{min} ↑ >2-fold • Ethinyl estradiol AUC ↓ 25% and C_{min} ↓ 44%	The effects of increases in progestin (norgestimate) are not fully known and can include insulin resistance, dyslipidemia, acne, and venous thrombosis. Weigh the risks and benefits of the drug, and consider alternative contraceptive method.
	EVG plus (PI/r)	↔ EVG	Refer to Table 19a for recommendations when used with PI/r.
HMG-CoA Reductase Inhibitors			
Atorvastatin	EVG/c/TDF/FTC	↑ atorvastatin possible	Titrate statin dose slowly and use the lowest dose possible.
	EVG plus (PI/r)	↔ EVG expected	Refer to Table 19a for dosing recommendations when used with PI/r.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 8 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
HMG-CoA Reductase Inhibitors, continued			
Lovastatin	• EVG/c/TDF/FTC • EVG plus (PI/r)	Significant ↑ lovastatin expected	**Contraindicated. Do not coadminister.**
Pitavastatin **Pravastatin**	EVG/c/TDF/FTC	No data	No dosage recommendation
	EVG plus (PI/r)	↔ EVG expected	Refer to Table 19a for dosing recommendations when used with PI/r.
Rosuvastatin	EVG/c/TDF/FTC	Rosuvastatin AUC ↑ 38% and C_{max} ↑ 89%	Titrate statin dose slowly and use the lowest dose possible.
	EVG plus (PI/r)	↔ EVG expected	Refer to Table 19a for dosing recommendations when used with PI/r.
Simvastatin	• EVG/c/TDF/FTC • EVG plus (PI/r)	Significant ↑ simvastatin expected	**Contraindicated. Do not coadminister.**
Immunosuppressants			
Cyclosporine **Everolimus** **Sirolimus** **Tacrolimus**	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ immunosuppressant possible	Initiate with an adjusted immunosuppressant dose to account for potential increased concentration and monitor for toxicities. Therapeutic drug monitoring of immunosuppressant is recommended. Consult with specialist as necessary.
Narcotics/Treatment for Opioid Dependence			
Buprenorphine	EVG/c/TDF/FTC	• Buprenorphine AUC ↑ 35%, C_{max} ↑ 12%, and C_{min} ↑ 66% • Norbuprenorphine AUC ↑ 42%, C_{max} ↑ 24%, and C_{min} ↑ 57%	No dosage adjustment necessary. Clinical monitoring is recommended.
	EVG plus (PI/r)	↔ EVG expected	Refer to Table 19a for dosing recommendations when used with PI/r.
	RAL	No significant effect	No dosage adjustment necessary.
Methadone	DTG	No significant effect	No dosage adjustment necessary.
	EVG/c/TDF/FTC	No significant effect	No dosage adjustment necessary.
	EVG plus (PI/r)	↓ methadone	Opioid withdrawal unlikely but may occur. Dosage adjustment of methadone is not usually required. Monitor for opioid withdrawal and increase methadone dose as clinically indicated.
	RAL	No significant effect	No dosage adjustment necessary.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 9 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Neuroleptics			
Perphenazine **Risperidone** **Thioridazine**	EVG/c/TDF/FTC	↑ neuroleptic possible	Initiate neuroleptic at a low dose. Decrease in neuroleptic dose may be necessary.
PDE5 Inhibitors			
Avanafil	• EVG/c/TDF/FTC • EVG plus (PI/r)	No data	**Coadministration is not recommended.**
Sildenafil	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ sildenafil expected	For treatment of erectile dysfunction: • Start with sildenafil 25 mg every 48 hours and monitor for adverse effects of sildenafil. For treatment of PAH: • **Contraindicated**
Tadalafil	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ tadalafil expected	For treatment of erectile dysfunction: • Start with tadalafil 5-mg dose and do not exceed a single dose of 10 mg every 72 hours. Monitor for adverse effects of tadalafil. For treatment of PAH *In patients on EVG/c/TDF/FTC >7 days:* • Start with tadalafil 20 mg once daily and increase to 40 mg once daily based on tolerability. *In patients on tadalafil who require EVG/c/TDF/FTC:* • Stop tadalafil ≥24 hours before EVG/c/TDF/FTC initiation. Seven days after EVG/c/TDF/FTC initiation restart tadalafil at 20 mg once daily, and increase to 40 mg once daily based on tolerability.
Vardenafil	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ vardenafil expected	Start with vardenafil 2.5 mg every 72 hours and monitor for adverse effects of vardenafil.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 10 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Sedative/Hypnotics			
Clonazepam **Clorazepate** **Diazepam** **Estazolam** **Flurazepam**	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ benzodiazepines possible	Dose reduction of benzodiazepine may be necessary. Initiate with low dose and clinically monitor. Consider alternative benzodiazepines to diazepam, such as lorazepam, oxazepam, or temazepam.
Midazolam **Triazolam**	DTG	With DTG 25 mg: • midazolam AUC ↔	No dosage adjustment necessary.
	• EVG/c/TDF/FTC • EVG plus (PI/r)	• ↑ midazolam expected • ↑ triazolam expected	**Do not coadminister triazolam or oral midazolam and EVG/c/TDF/FTC or (EVG plus PI).** Parenteral midazolam can be used with caution in a closely monitored setting. Consider dose reduction, especially if more than one dose is administered.
Suvorexant	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ suvorexant expected	**Coadministration is not recommended.**
Zolpidem	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ zolpidem expected	Initiate zolpidem at a low dose. Dose reduction may be necessary.
Miscellaneous Drugs			
Colchicine	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ colchicine expected	**Do not coadminister in patients with hepatic or renal impairment.** For treatment of gout flares: • Colchicine 0.6 mg for 1 dose, followed by 0.3 mg 1 hour later. Do not repeat dose for at least 3 days. For prophylaxis of gout flares: • If original dose was colchicine 0.6 mg BID, decrease to colchicine 0.3 mg once daily. If regimen was 0.6 mg once daily, decrease to 0.3 mg every other day. For treatment of Familial Mediterranean Fever: • Do not exceed colchicine 0.6 mg once daily or 0.3 mg BID.

Table 19d. Drug Interactions Between Integrase Strand Transfer Inhibitors and Other Drugs (Last updated April 8, 2015; last reviewed April 8, 2015) (page 11 of 11)

Concomitant Drug Class/Name	INSTI	Effect on INSTI or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Miscellaneous Drugs, continued			
Metformin	DTG	DTG 50 mg once daily plus metformin: • Metformin AUC ↑ 79%, C_{max} ↑ 66%, and C_{min} ↑ 9% DTG 50 mg BID plus metformin: • Metformin AUC ↑ 2.4 fold, C_{max} ↑ 2 fold, and C_{min} ↑ 14%	When starting metformin in patient on DTG, start at low metformin dose and titrate dose to achieve glycemic control and minimize GI symptoms. When starting/stopping DTG in patient on metformin, dose adjustment of metformin may be necessary to maintain optimal glycemic control and/or minimize GI symptoms.
Polyvalent Cation Supplements Mg, Al, Fe, Ca, Zn, including multivitamins with minerals **Note:** Please refer to the Acid Reducers section in this table for recommendations on use with Al-, Mg-, and Ca-containing antacids.	All INSTIs	• ↓ INSTI possible • DTG ↔ when administered with Ca or Fe supplement simultaneously with food	If coadministration is necessary, give INSTI at least 2 hours before or at least 6 hours after supplements containing polyvalent cations, including but not limited to the following products: cation-containing laxatives; Fe, Ca, or Mg supplements; and sucralfate. Monitor for virologic efficacy. DTG and supplements containing Ca or Fe can be taken simultaneously with food. Many oral multivitamins also contain varying amounts of polyvalent cations; the extent and significance of chelation is unknown.
Salmeterol	• EVG/c/TDF/FTC • EVG plus (PI/r)	↑ salmeterol possible	**Do not coadminister** because of potential increased risk of salmeterol-associated cardiovascular events.

Key to Acronyms: Al = aluminum; ART = antiretroviral therapy; ARV = antiretroviral; ATV/r = atazanavir/ritonavir; AUC = area under the curve; BID = twice daily; Ca = calcium; $CaCO_3$ = calcium carbonate; CCB = calcium channel blocker; C_{max} = maximum plasma concentration; C_{min} = minimum plasma concentration; COBI = cobicistat; CrCl = creatinine clearance; CYP = cytochrome P; DTG = dolutegravir; EVG = elvitegravir; EVG/c/TDF/FTC = elvitegravir/cobicistat/tenofovir disoproxil fumarate/emtricitabine; Fe = iron; GI = gastrointestinal; INR = international normalized ratio; INSTI = integrase strand transfer inhibitor; Mg = magnesium; PAH = pulmonary arterial hypertension; PI = protease inhibitor; PI/r = ritonavir-boosted protease inhibitor; PPI = proton pump inhibitor; RAL = raltegravir; SQV/r = saquanavir/ritonavir; SSRI = selective serotonin reuptake inhibitor; TCA = tricyclic anti-depressant; TDF = tenofovir disoproxil fumarate; Zn = zinc

Table 19e. Drug Interactions Between CCR5 Antagonist (Maraviroc) and Other Drugs (Including Antiretroviral Agents) (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 3)

Concomitant Drug Class/Name	CCR5 Antagonist	Effect on CCR5 Antagonist and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
Anticonvulsants			
Carbamazepine **Phenobarbital** **Phenytoin**	MVC	↓ MVC possible	If used without a strong CYP3A inhibitor, use MVC 600 mg BID or an alternative antiepileptic agent.
Antifungals			
Itraconazole	MVC	↑ MVC possible	Dose: • MVC 150 mg BID
Voriconazole	MVC	↑ MVC possible	Consider dose reduction to MVC 150 mg BID.
Antimycobacterials			
Clarithromycin	MVC	↑ MVC possible	Dose: • MVC 150 mg BID
Rifabutin	MVC	↓ MVC possible	If used without a strong CYP3A inducer or inhibitor, use MVC 300 mg BID. If used with a strong CYP3A inhibitor, use MVC 150 mg BID.
Rifampin	MVC	MVC AUC ↓ 64%	**Coadministration is not recommended.** If coadministration is necessary, use MVC 600 mg BID. If coadministered with a strong CYP3A inhibitor, use MVC 300 mg BID.
Rifapentine	MVC	↓ MVC expected	Do not coadminister.
Hepatitis C Direct Acting Antivirals			
Boceprevir	MVC	MVC AUC ↑ 202%	Dose: • MVC 150 mg BID
Dasabuvir plus Ombitasvir/ Paritaprevir/RTV	MVC	↑ MVC expected	**Do not coadminister.**
Ledipasvir/ Sofosbuvir	MVC	↔ MVC expected	Dose: • MVC 300 mg BID
Simeprevir	MVC	↔ MVC expected	Dose: • MVC 300 mg BID
Herbal Products			
St. John's Wort	MVC	↓ MVC possible	**Coadministration is not recommended.**
Hormonal Contraceptives			
Hormonal Contraceptives	MVC	No significant effect on ethinyl estradiol or levonorgestrel	Safe to use in combination

Table 19e. Drug Interactions Between CCR5 Antagonist (Maraviroc) and Other Drugs (Including Antiretroviral Agents) (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 3)

Concomitant Drug Class/Name	CCR5 Antagonist	Effect on CCR5 Antagonist and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
ARV Drugs			
INSTIs			
EVG/c/TDF/FTC	MVC	↑ MVC possible	**Do not coadminister.**
EVG + PI/r	MVC	No data	Refer to PIs listed below for dosing recommendations when MVC is used with a PI/r.
RAL	MVC	MVC AUC ↓ 21% RAL AUC ↓ 37%	Dose: • Standard
NNRTIs			
EFV	MVC	MVC AUC ↓ 45%	Dose: • MVC 600 mg BID
ETR	MVC	MVC AUC ↓ 53%	Dose: • MVC 600 mg BID in the absence of a potent CYP3A inhibitor
NVP	MVC	MVC AUC ↔	Without HIV PI: • MVC 300 mg BID With HIV PI (except TPV/r): • MVC 150 mg BID
PIs			
ATV +/- RTV or COBI	MVC	With Unboosted ATV: • MVC AUC ↑ 257% With (ATV 300 mg Plus RTV 100 mg) Once Daily: • MVC AUC ↑ 388%	Dose: • MVC 150 mg BID
DRV/r or DRV/c	MVC	With (DRV 600 mg Plus RTV 100 mg) BID: • MVC AUC ↑ 305% With (DRV 600 mg Plus RTV 100 mg) BID and ETR: • MVC AUC ↑ 210%	Dose: • MVC 150 mg BID
FPV +/- RTV	MVC	With (FPV 700 mg Plus RTV 100 mg) BID and MVC 300 mg BID: • MVC AUC ↑ 149%, C_{min} ↑ 374% With (FPV 1400 mg Plus RTV 200 mg) Once Daily and MVC 300 mg Once Daily: • MVC AUC ↑ 126%, C_{min} ↑ 80%	Dose: • MVC 150 mg BID
LPV/r	MVC	MVC AUC ↑ 295% With LPV/r and EFV: • MVC AUC ↑ 153%	Dose: • MVC 150 mg BID

Table 19e. Drug Interactions Between CCR5 Antagonist (Maraviroc) and Other Drugs (Including Antiretroviral Agents) (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 3)

Concomitant Drug Class/Name	CCR5 Antagonist	Effect on CCR5 Antagonist and/or Concomitant Drug Concentrations	Dosing Recommendations and Clinical Comments
PIs, continued			
RTV	MVC	With RTV 100 mg BID: • MVC AUC ↑ 161%	Dose: • MVC 150 mg BID
SQV/r	MVC	With (SQV 1000 mg Plus RTV 100 mg) BID: • MVC AUC ↑ 877% With (SQV 1000 mg Plus RTV 100 mg) BID and EFV: • MVC AUC ↑ 400%	Dose: • MVC 150 mg BID
TPV/r	MVC	With (TPV 500 mg Plus RTV 200 mg) BID: • MVC AUC ↔	Dose: • MVC 300 mg BID

Note: FPV is a pro-drug of APV.

Key to Symbols: ↑ = increase, ↓ = decrease, ↔ = no change

Key to Acronyms: ARV = antiretroviral; ATV = atazanavir; ATV/r = atazanavir/ritonavir; AUC = area under the curve; BID = twice daily; COBI = cobicistat; CYP = cytochrome P; DRV/c = darunavir/cobicistat; DRV/r = darunavir/ritonavir; EFV = efavirenz; ETR = etravirine; EVG = elvitegravir; FPV = fosamprenavir; FTC = emtricitabine; INSTI = integrase strand transfer inhibitor; LPV/r = lopinavir/ritonavir; MVC = maraviroc; NVP = nevirapine; PI = protease inhibitor; PK = pharmacokinetic; RAL = raltegravir; RTV = ritonavir; SQV/r = saquinavir/ritonavir; TDF = tenofovir disoproxil fumarate; TPV/r = tipranavir/ritonavir

Table 20a. Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors and Protease Inhibitors[a] (Last updated April 8, 2015; last reviewed April 8, 2015) (Page 1 of 3)

Note: DLV, IDV, and NFV are **not** included in this table. Refer to the DLV, IDV, and NFV Food and Drug Administration package inserts for information regarding drug interactions.

PIs		NNRTIs			
		EFV	**ETR**	**NVP**	**RPV[a]**
ATV Unboosted	**PK Data**	EFV: no significant change ATV AUC ↓ 74%	ETR AUC ↑ 50% and C_{min} ↑ 58% ATV AUC ↓ 17% and C_{min} ↓ 47%	↓ ATV possible	↑ RPV possible
	Dose	**Do not coadminister.**	**Do not coadminister.**	**Do not coadminister.**	Standard doses
ATV/c	**PK Data**	↓ ATV ↓ COBI	↓ ATV ↓ COBI	↓ COBI	↑ RPV possible ↔ ATV expected
	Dose	EFV standard dose In ART-Naive Patients: • ATV 400 mg plus COBI 150 mg Once Daily **Do not coadminister in ART-experienced patients.**	**Do not coadminister.**	**Do not coadminister.**	Standard doses
ATV/r	**PK Data**	(ATV 300 mg plus RTV 100 mg) Once Daily: • ATV concentrations are similar to those with unboosted ATV without EFV.	(ATV 300 mg plus RTV 100 mg) Once Daily: • ETR AUC and C_{min} both ↑ ~30% • ATV AUC ↔ and C_{min} ↓ 18%	(ATV 300 mg plus RTV 100 mg) Once Daily: • ATV AUC ↓ 42% and C_{min} ↓ 72% • NVP AUC ↑ 25%	↑ RPV possible
	Dose	EFV standard dose In ART-Naive Patients: • (ATV 400 mg plus RTV 100 mg) Once Daily **Do not coadminister in ART-experienced patients.**	ETR standard dose (ATV 300 mg plus RTV 100 mg) Once Daily	**Do not coadminister.**	Standard doses
DRV/c	**PK Data**	↓ DRV possible ↓ COBI possible	Effect on DRV unknown ↓ COBI possible	Effect on DRV unknown ↓ COBI possible	↔ DRV expected ↑ RPV possible
	Dose	**Do not coadminister.**	**Do not coadminister.**	**Do not coadminister.**	Standard doses

Table 20a. Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors, and Protease Inhibitors[a] (Last updated April 8, 2015; last reviewed April 8, 2015) (Page 2 of 3)

PIs		NNRTIs			
		EFV	ETR	NVP	RPV[a]
DRV/r	PK Data	With (DRV 300 mg plus RTV 100 mg) BID: • EFV AUC ↑ 21% • DRV AUC ↓ 13% and C_{min} ↓ 31%	ETR 100 mg BID with (DRV 600 mg plus RTV 100 mg) BID: • ETR AUC ↓ 37% and C_{min} ↓ 49% • DRV: no significant change	With (DRV 400 mg plus RTV 100 mg) BID: • NVP AUC ↑ 27% and C_{min} ↑ 47% • DRV AUC ↑ 24%[b]	RPV 150 mg Once Daily with (DRV 800 mg plus RTV 100 mg) Once Daily: • RPV AUC ↑ 130% and C_{min} ↑ 178% • DRV: no significant change
	Dose	Clinical significance unknown. Use standard doses and monitor patient closely. Consider monitoring drug levels.	Standard doses Safety and efficacy of this combination, despite reduced ETR concentration, have been established in a clinical trial.	Standard doses	Standard doses
FPV +/- RTV	PK Data	With (FPV 1400 mg plus RTV 200 mg) Once Daily: • APV C_{min} ↓ 36%	With (FPV 700 mg plus RTV 100 mg) BID: • APV AUC ↑ 69% and C_{min} ↑ 77%	With Unboosted FPV 1400 mg BID: • NVP AUC ↑ 29% • APV AUC ↓ 33% With (FPV 700 mg plus RTV 100 mg) BID: • NVP C_{min} ↑ 22%	With Boosted and Unboosted FPV: • ↑ RPV possible
	Dose	(FPV 1400 mg plus RTV 300 mg) Once Daily **or** (FPV 700 mg plus RTV 100 mg) BID EFV standard dose	**Do not coadminister with FPV +/− RTV.**	(FPV 700 mg plus RTV 100 mg) BID NVP standard dose	Standard doses
LPV/r	PK Data	With LPV/r Tablets 500/125 mg[c] BID: • LPV concentration similar to that with LPV/r 400/100 mg BID without EFV	With LPV/r Tablets: • ETR AUC ↓ 35% (comparable to the decrease with DRV/r) • LPV AUC ↓ 13%	With LPV/r Capsules: • LPV AUC ↓ 27% and C_{min} ↓ 51%	RPV 150 mg Once Daily with LPV/r Capsules: • RPV AUC ↑ 52% and C_{min} ↑ 74% • LPV no significant change
	Dose	LPV/r tablets 500/125 mg[c] BID; LPV/r oral solution 533/133 mg BID EFV standard dose	Standard doses	LPV/r tablets 500/125 mgc BID; LPV/r oral solution 533/133 mg BID NVP standard dose	Standard doses

Table 20a. Interactions between Non-Nucleoside Reverse Transcriptase Inhibitors, and Protease Inhibitors[a] (Last updated April 8, 2015; last reviewed April 8, 2015) (Page 3 of 3)

PIs		NNRTIs			
		EFV	ETR	NVP	RPV[a]
SQV Always use with RTV	**PK Data**	With SQV 1200 mg TID: • EFV AUC ↓ 12% • SQV AUC ↓ 62%	With (SQV 1000 mg plus RTV 100 mg) BID: • ETR AUC ↓ 33% and C_{min} ↓ 29% • SQV AUC ↔ ↓ ETR levels similar to reduction with DRV/r	With SQV 600 mg TID: • NVP: no significant change • SQV AUC ↓ 24%	↑ RPV possible
	Dose	(SQV 1000 mg plus RTV 100 mg) BID	(SQV 1000 mg plus RTV 100 mg) BID	Dose with SQV/r not established	Standard doses
TPV Always use with RTV	**PK Data**	With (TPV 500 mg plus RTV 100 mg) BID: • EFV no significant change • TPV AUC ↓ 31% and C_{min} ↓ 42% With (TPV 750 mg plus RTV 200 mg) BID: • EFV: no significant change • TPV: no significant change	With (TPV 500 mg plus RTV 200 mg) BID: • ETR AUC ↓ 76% and C_{min} ↓ 82% • TPV AUC ↑ 18% and C_{min} ↑ 24%	With (TPV 250 mg plus RTV 200 mg) BID or with (TPV 750 mg plus RTV 100 mg) BID: • NVP: no significant change • TPV: no data	↑ RPV possible
	Dose	Standard doses	**Do not coadminister.**	Standard doses	Standard doses

[a] Approved dose for RPV is 25 mg once daily. Most PK studies were performed using 75 mg to 150 mg RPV per dose.

[b] Based on between-study comparison.

[c] Use a combination of two LPV/r 200 mg/50 mg tablets plus one LPV/r 100 mg/25 mg tablet to make a total dose of LPV/r 500 mg/125 mg.

Key to Symbols: ↑ = increase, ↓ = decrease, ↔ = no change

Key to Acronyms: APV = amprenavir; ART = antiretroviral therapy; ATV = atazanavir; ATV/c = atazanavir/cobicistat; AUC = area under the curve; BID = twice daily; C_{max} = maximum plasma concentration; C_{min} = minimum plasma concentration; CYP = cytochrome P; DLV = delavirdine; DRV = darunavir; DRV/c = darunavir/cobicistat; DRV/r = darunavir/ritonavir; EFV = efavirenz; ETR = etravirine; FDA = Food and Drug Administration; FPV = fosamprenavir; IDV = indinavir; LPV = lopinavir; LPV/r = lopinavir/ritonavir; NFV = nelfinavir; NVP = nevirapine; PK = pharmacokinetic; RPV = rilpivirine; RTV = ritonavir; SQV = saquinavir; SQV/r = saquinavir/ritonavir; TID = three times a day; TPV = tipranavir

Table 20b. Interactions Between Integrase Strand Transfer Inhibitors and Non-Nucleoside Reverse Transcriptase Inhibitors or Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 4)

ARV Drugs by Drug Class		INSTIs			
		DTG	EVG/c/TDF/FTC	EVG (EVG must be given with a PI/r.)	RAL
NNRTIs					
EFV	**PK Data**	With DTG 50 mg once daily: • DTG AUC ↓ 57% and C_{min} ↓ 75%	↑ or ↓ EVG, COBI, EFV possible	↓ EVG expected	RAL: • AUC ↓ 36%
	Dose	In patients without INSTI resistance: • DTG 50 mg BID In patients with certain INSTI-associated resistance[a] or clinically suspected INSTI resistance: • **Consider alternative combination.**	**Do not coadminister.**	**Do not coadminister.**	Standard doses
ETR	**PK Data**	ETR 200 mg BID plus DTG 50 mg once daily: • DTG AUC ↓ 71% and C_{min} ↓ 88% ETR 200 mg BID with (DRV 600 mg plus RTV 100 mg) BID and DTG 50 mg once daily: • DTG AUC ↓ 25% and C_{min} ↓ 37% ETR 200 mg BID with (LPV 400 mg plus RTV 100 mg) BID and DTG 50 mg once daily: • DTG AUC ↑ 11% and C_{min} ↑ 28%	↑ or ↓ EVG, COBI, ETR possible	No significant interaction between EVG/r and ETR	• ETR C_{min} ↓ 17% • RAL C_{min} ↓ 34%
	Dose	**Do not coadminister ETR and DTG without concurrently administering ATV/r, DRV/r, or LPV/r.** In patients without INSTI resistance: • DTG 50 mg once daily with ETR (concurrently with ATV/r, DRV/r, or LPV/r) In patients with certain INSTI-associated resistance[a] or clinically suspected INSTI resistance: • DTG 50 mg BID with ETR (concurrently with ATV/r, DRV/r, or LPV/r)	**Do not coadminister.**	May coadminister EVG with ETR plus (ATV/r, DRV/r, or LPV/r) EVG: • Standard dose depending on the concomitant PI (see below)	Standard doses

Table 20b. Interactions Between Integrase Strand Transfer Inhibitors and Non-Nucleoside Reverse Transcriptase Inhibitors or Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 4)

ARV Drugs by Drug Class		INSTIs			
		DTG	EVG/c/TDF/FTC	EVG (EVG must be given with a PI/r.)	RAL
NNRTIs, continued					
NVP	**PK Data**	↓ DTG possible	↑ or ↓ EVG, COBI, NVP possible	↓ EVG possible	No data
	Dose	**Do not coadminister.**	**Do not coadminister.**	**Do not coadminister.**	Standard doses
RPV	**PK Data**	With DTG 50 mg once daily: • DTG AUC ↔ and C_{min} ↑ 22% • RPV AUC ↔ and C_{min} ↑ 21%	↑ or ↓ EVG, COBI, RPV possible	↑ RPV expected	• RPV ↔ • RAL C_{min} ↑ 27%
	Dose	Standard doses	**Do not coadminister.**	EVG: • Standard dose depending on the concomitant PI (see below) RPV: • Standard dose	Standard doses
PIs					
ATV/c	**PK Data**	No data	ATV/c plus EVG/c: • No data	No data	No data
	Dose	Standard doses	**Do not coadminister.**	**Do not coadminister.**	Standard doses
ATV +/- RTV	**PK Data**	Unboosted ATV plus DTG 30 mg once daily: • DTG AUC ↑ 91% and C_{min} ↑ 180% (ATV 300 mg plus RTV 100 mg) once daily plus DTG 30 mg once daily: • DTG AUC ↑ 62% and C_{min} ↑ 121%	↑ or ↓ EVG, COBI, ATV possible	EVG 85 mg with (ATV 300 mg plus RTV 100 mg) once daily: • EVG AUC ↔ and C_{min} ↑ 38% • ATV AUC and C_{min} ↔	With unboosted ATV: • RAL AUC ↑ 72% With (ATV 300 mg plus RTV 100 mg) once daily: • RAL AUC ↑ 41%
	Dose	Standard doses	**Do not coadminister.**	• EVG 85 mg once daily • (ATV 300 mg plus RTV 100 mg) once daily	Standard doses
DRV/c	**PK Data**	No data.	DRV/c plus EVG/c: • ↓ EVG possible	No data.	No data
	Dose	Standard doses	**Do not coadminister.**	**Do not coadminister.**	Standard doses

Table 20b. Interactions Between Integrase Strand Transfer Inhibitors and Non-Nucleoside Reverse Transcriptase Inhibitors or Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 4)

ARV Drugs by Drug Class		INSTIs			
		DTG	EVG/c/TDF/FTC	EVG (EVG must be given with a PI/r.)	RAL
PIs, continued					
DRV/r	**PK Data**	(DRV 600 mg plus RTV 100 mg) BID with DTG 30 mg once daily: • DTG AUC ↓ 22% and C_{min} ↓ 38%	↑ or ↓ EVG, COBI, DRV possible	EVG 125 mg once daily with (DRV 600 mg plus RTV 100 mg) BID: • EVG AUC and C_{min} ↔ • DRV AUC and C_{min} ↔	With (DRV 600 mg plus RTV 100 mg) BID: • RAL AUC ↓ 29% and C_{min} ↑ 38%
	Dose	Standard doses: • Once or twice daily dosing of DRV/r	**Do not coadminister.**	• EVG 150 mg once daily • (DRV 600 mg plus RTV 100 mg) BID	Standard doses
FPV +/- RTV	**PK Data**	With (FPV 700 mg plus RTV 100 mg) BID and DTG 50 mg once daily: • DTG AUC ↓ 35% and C_{min} ↓ 49%	↑ or ↓ EVG, COBI, FPV possible	No significant interaction with FPV and EVG	FPV: No significant effect
	Dose	In patients without INSTI resistance: • DTG 50 mg BID In patients with certain INSTI-associated resistance[a] or clinically suspected INSTI resistance: • **Consider alternative combination.**	**Do not coadminister.**	• EVG 150 mg once daily • (FPV 700 mg plus RTV 100 mg) BID	Standard doses
LPV/r	**PK Data**	With (LPV 400 mg plus RTV 100 mg) BID and DTG 30 mg once daily: • DTG: no significant effect	↑ or ↓ EVG, COBI, LPV possible RTV and COBI have similar effects on CYP3A.	EVG 125 mg once daily with (LPV 400 mg plus RTV 100 mg) BID: • EVG AUC ↑ 75% and C_{min} ↑ 138% • LPV AUC and C_{min} ↔	• ↓ RAL • ↔ LPV/r
	Dose	Standard doses: • Once or twice daily dosing of LPV/r	**Do not coadminister.**	• EVG 85 mg once daily • (LPV 400 mg plus RTV 100 mg) BID	Standard doses
SQV/r	**PK Data**	No data	↑ or ↓ EVG, COBI, SQV possible RTV and COBI have similar effects on CYP3A.	No data	No data
	Dose	Standard doses	**Do not coadminister.**	No dosage recommendation	Standard doses

Table 20b. Interactions Between Integrase Strand Transfer Inhibitors and Non-Nucleoside Reverse Transcriptase Inhibitors or Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 4 of 4)

ARV Drugs by Drug Class		INSTIs			
		DTG	EVG/c/TDF/FTC	EVG (EVG must be given with a PI/r.)	RAL
PIs, continued					
TPV/r	PK Data	With (TPV 500 mg plus RTV 200 mg) BID and DTG 50 mg once daily: • DTG AUC ↓ 59% and C_{min} ↓ 76%	↑ or ↓ EVG, COBI, TPV possible RTV and COBI have similar effects on CYP3A.	EVG 200 mg once daily with (TPV 500 mg plus RTV 200 mg) BID: • EVG AUC and C_{min} ↔ • TPV AUC and C_{min} ↔	With (TPV 500 mg plus RTV 200 mg) BID: • RAL AUC ↓ 24%
	Dose	In patients without INSTI resistance: • DTG 50 mg BID In patients with certain INSTI-associated resistancea or clinically suspected INSTI resistance: • **Consider alternative combination.**	**Do not coadminister.**	• EVG 150 mg once daily • (TPV 500 mg plus RTV 200 mg) BID	Standard doses

[a] Refer to dolutegravir product labeling for details.

Key to Symbols: ↑ = increase; ↓ = decrease; ↔ = no change

Key to Abbreviations: ARV = antiretroviral; ATV = atazanavir; ATV/c = atazanavir/cobicistat; ATV/r = atazanavir/ritonavir; AUC = area under the curve; BID = twice daily; C_{min} = minimum plasma concentration; COBI, c = cobicistat; CYP = cytochrome P; DRV = darunavir; DRV/c = darunavir/cobicistat; DRV/r = darunavir/ritonavir; DTG = dolutegravir; EFV = efavirenz; ETR = etravirine; EVG = elvitegravir; EVG/c = elvitegravir/cobicistat; EVG/c/TDF/FTC = elvitegravir/cobicistat/tenofovir disoproxil fumarate/emtricitabine; EVG/r = elvitegravir/ritonavir; FPV = fosamprenavir; INSTI = integrase strand transfer inhibitor; LPV = lopinavir; LPV/r = lopinavir/ritonavir; NNRTI = non-nucleoside reverse transcriptase inhibitor; NVP = nevirapine; PI = protease inhibitor; PI/r = ritonavir-boosted protease inhibitor; PK = pharmacokinetic; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; SQV = saquinavir; SQV/r = saquinavir/ritonavir; TPV = tipranavir; TPV/r = tipranavir/ritonavir

Preventing Secondary Transmission of HIV (Last updated March 27, 2012; last reviewed March 27, 2012)

Despite substantial advances in prevention and treatment of HIV infection in the United States, the rate of new infections has remained stable.[1-2] Although earlier prevention interventions mainly were behavioral, recent data demonstrate the strong impact of antiretroviral therapy (ART) on secondary HIV transmission. The most effective strategy to stem the spread of HIV will probably be a combination of behavioral, biological, and pharmacological interventions.[3]

Prevention Counseling

Counseling and related behavioral interventions for those living with HIV infection can reduce behaviors associated with secondary transmission of HIV. Each patient encounter offers the clinician an opportunity to reinforce HIV prevention messages, but multiple studies show that prevention counseling is frequently neglected in clinical practice.[4-5] Although delivering effective prevention interventions in a busy practice setting may be challenging, clinicians should be aware that patients often look to their providers for messages about HIV prevention. Multiple approaches to prevention counseling are available, including formal guidance from the Centers for Disease Control and Prevention (CDC) for incorporating HIV prevention into medical care settings. Such interventions have been demonstrated to be effective in changing sexual risk behavior[6-8] and can reinforce self-directed behavior change early after diagnosis.[9]

CDC has identified several prevention interventions for individuals infected with HIV that meet stringent criteria for efficacy and scientific rigor (http://www.cdc.gov/hiv/topics/research/prs/index.htm). The following three interventions have proven effective in treatment settings and can be delivered by providers as brief messages during clinic visits:

- Partnership for Health (http://effectiveinterventions.org/en/Interventions/PfH.aspx),
- Options (http://www.cdc.gov/hiv/topics/research/prs/resources/factsheets/options.htm),
- Positive Choice (http://www.cdc.gov/hiv/topics/research/prs/resources/factsheets/positive-choice.htm).

In addition, CDC's "Prevention Is Care" campaign (http://www.actagainstaids.org/provider/pic/index.html) helps providers (and members of a multidisciplinary care team) integrate simple methods to prevent transmission by HIV-infected individuals into routine care. These prevention interventions are designed to reduce the risk of secondary HIV transmission through sexual contact. The interventions are designed generally for implementation at the community or group level, but some can be adapted and administered in clinical settings by a multidisciplinary care team.

Need for Screening for High-Risk Behaviors

The primary care visit provides an opportunity to screen patients for ongoing high-risk drug and sexual behaviors for transmitting HIV infection. Routine screening and symptom-directed testing for and treatment of sexually transmitted diseases (STDs), as recommended by CDC,[10] remain essential adjuncts to prevention counseling. Genital ulcers may facilitate HIV transmission and STDs may increase HIV viral load in plasma and genital secretions.[7, 11-13] They also provide objective evidence of unprotected sexual activity, which should prompt prevention counseling.

The contribution of substance and alcohol use to HIV risk behaviors and transmission has been well established in multiple populations;[14-18] therefore, effective counseling for injection and noninjection drug users is essential to prevent HIV transmission. Identifying the substance(s) of use is important because HIV

prevalence, transmission risk, risk behaviors, transmission rates, and potential for pharmacologic intervention all vary according to the type of substance used.[19-21] Risk-reduction strategies for injection drug users (IDUs), in addition to condom use, include needle exchange and instructions on cleaning drug paraphernalia. Evidence supporting the efficacy of interventions to reduce injection drug use risk behavior also exists. Interventions include both behavioral strategies[14-15, 22] and opiate substitution treatment with methadone or buprenorphine.[23-24] No successful pharmacologic interventions have been found for cocaine and methamphetamine users; cognitive and behavioral interventions demonstrate the greatest effect on reducing the risk behaviors of these users.[25-27] Given the significant impact of cocaine and methamphetamine on sexual risk behavior, reinforcement of sexual risk-reduction strategies is important.[14-18, 28]

Antiretroviral Therapy as Prevention

ART can play an important role in preventing HIV transmission. Lower levels of plasma HIV RNA have been associated with decreases in the concentration of virus in genital secretions.[29-32] Observational studies have demonstrated the association between low serum or genital HIV RNA and a decreased rate of HIV transmission among serodiscordant heterosexual couples.[29, 33-34] Ecological studies of communities with relatively high concentrations of men who have sex with men (MSM) and IDUs suggest increased use of ART is associated with decreased community viral load and reduced rates of new HIV diagnoses.[35-37] These data suggest that the risk of HIV transmission is low when an individual's viral load is below 400 copies/mL,[35, 38] but the threshold below which transmission of the virus becomes impossible is unknown. Furthermore, to be effective at preventing transmission it is assumed that: (1) ART is capable of durably and continuously suppressing viremia; (2) adherence to an effective ARV regimen is high; and (3) there is an absence of a concomitant STD. Importantly, detection of HIV RNA in genital secretions has been documented in individuals with controlled plasma HIV RNA and data describing a differential in concentration of most ARV drugs in the blood and genital compartments exist.[30, 39] At least one case of HIV transmission from a patient with suppressed plasma viral load to a monogamous uninfected sexual partner has been reported.[40]

In the HPTN 052 trial in HIV-discordant couples, the HIV-infected partners who were ART naive and had CD4 counts between 350 and 550 cells/mm^3 were randomized to initiate or delay ART. In this study, those who initiated ART had a 96% reduction in HIV transmission to the uninfected partners.[3] Almost all of the participants were in heterosexual relationships, all participants received risk-reduction counseling, and the absolute number of transmission events was low: 1 among ART initiators and 27 among ART delayers. Over the course of the study virologic failure rates were less than 5%, a value much lower than generally seen in individuals taking ART for their own health. These low virologic failure rates suggest high levels of adherence to ART in the study, which may have been facilitated by the frequency of study follow-up (study visits were monthly) and by participants' sense of obligation to protect their uninfected partners. Therefore, caution is indicated when interpreting the extent to which ART for the HIV-infected partner protects seronegative partners in contexts where adherence and, thus, rates of continuous viral suppression, may be lower. Furthermore, for HIV-infected MSM and IDUs, biological and observational data suggest suppressive ART also should protect against transmission, but the actual extent of protection has not been established.

Rates of HIV risk behaviors can increase coincidently with the availability of potent combination ART, in some cases almost doubling compared with rates in the era prior to highly effective therapy.[9] A meta-analysis demonstrated that the prevalence of unprotected sex acts was increased in HIV-infected individuals who believed that receiving ART or having a suppressed viral load protected against transmitting HIV.[41] Attitudinal shifts away from safer sexual practices since the availability of potent ART underscore the role of provider-initiated HIV prevention counseling. With wider recognition that effective treatment decreases the risk of HIV transmission, it is particularly important for providers to help patients understand that a sustained viral load below the limits of detection will dramatically reduce but does not absolutely assure the absence of

HIV in the genital and blood compartments and, hence, the inability to transmit HIV to others.[41-42]

Maximal suppression of viremia not only depends on the potency of the ARV regimen used but also on the patient's adherence to prescribed therapy. Suboptimal adherence can lead to viremia that not only harms the patient but also increases his/her risk of transmitting HIV (including drug-resistant strains) via sex or needle sharing. Screening for and treating behavioral conditions that can impact adherence, such as depression and alcohol and substance use, improve overall health and reduce the risk of secondary transmission.

Summary

Consistent and effective use of ART resulting in a sustained reduction in viral load in conjunction with consistent condom usage, safer sex and drug use practices, and detection and treatment of STDs are essential tools for prevention of sexual and blood-borne transmission of HIV. Given these important considerations, medical visits provide a vital opportunity to reinforce HIV prevention messages, discuss sex- and drug-related risk behaviors, diagnose and treat intercurrent STDs, review the importance of medication adherence, and foster open communication between provider and patient.

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Conclusion (Last updated January 10, 2011; last reviewed January 10, 2011)

The Panel has carefully reviewed recent results from clinical trials in HIV therapy and considered how they inform appropriate care guidelines. The Panel appreciates that HIV care is highly complex and rapidly evolving. Guidelines are never fixed and must always be individualized. Where possible, the Panel has based recommendations on the best evidence from prospective trials with defined endpoints. When such evidence does not yet exist, the Panel attempted to reflect reasonable options in its conclusions.

HIV care requires, as always, partnerships and open communication. The provider can make recommendations most likely to lead to positive outcomes only if the patient's own point of view and social context are well known. Guidelines are only a starting point for medical decision making. They can identify some of the boundaries of high-quality care but cannot substitute for sound judgment.

As further research is conducted and reported, guidelines will be modified. The Panel anticipates continued progress in the simplicity of regimens, improved potency and barrier to resistance, and reduced toxicity. The Panel hopes the guidelines are useful and is committed to their continued adjustment and improvement.

Appendix A: Key to Acronyms (Last updated April 8, 2015; last reviewed April 8, 2015)

Drug Name Abbreviations

Abbreviation	Full Name
3TC	lamivudine
ABC	abacavir
APV	amprenavir
ATV	atazanavir
ATV/c	atazanavir/cobicistat
ATV/r	atazanavir/ritonavir
COBI or c	cobicistat
d4T	stavudine
ddC	zalcitabine
ddI	didanosine
DLV	delavirdine
DRV	darunavir
DRV/c	darunavir/cobicistat
DRV/r	darunavir/ritonavir
DTG	dolutegravir
EFV	efavirenz
EFV/c/TDF/FTC	efavirenz/cobicistat/tenofovir disoproxil fumarate/emtricitabine
ETR	etravirine
EVG	elvitegravir
EVG/c	elvitegravir/cobicistat
EVG/c/TDF/FTC	elvitegravir/cobicistat/tenofovir disoproxil fumarate/emtricitabine
EVG/r	elvitegravir/ritonavir
FPV	fosamprenavir
FPV/r	fosamprenavir/ritonavir
FTC	emtricitabine
IDV	indinavir
LPV	lopinavir
LPV/r	lopinavir/ritonavir
MVC	maraviroc
NFV	nelfinavir
NVP	nevirapine
PI/c	cobicistat-boosted protease inhibitor
PI/r	ritonavir-boosted protease inhibitor
RAL	raltegravir

RPV	rilpivirine
RTV	ritonavir
SQV	saquinavir
SQV/r	saquinavir/ritonavir
TDF	tenofovir disoproxil fumarate
TPV	tipranavir
TPV/r	tipranavir/ritonavir
ZDV	zidovudine

General Terms

Abbreviation	**Definition**
17-BMP	beclomethasone 17-monopropionate
Al	aluminum
ART	antiretroviral therapy
ARV	antiretroviral
AUC	area under the curve
AWP	average wholesale price
BID	twice daily
BMD	bone mineral density
Ca	calcium
$CaCO_3$	calcium carbonate
cap	capsule
CCB	calcium channel blockers
CD4	CD4 T lymphocyte
C_{max}	maximum plasma concentration
C_{min}	minimum plasma concentration
CNS	central nervous system
CPK	creatine phosphokinase
Cr	creatinine
CrCl	creatinine clearance
CVD	cardiovascular disease
CYP	cytochrome P
DAAs	direct-acting antivirals
DHA	dihydroartemisinin
DMPA	depot medroxyprogesterone acetate
DSMB	Data Safety Monitoring Board
EC	enteric coated
ECG	electrocardiogram
EI	entry inhibitor

FDA	Food and Drug Administration
Fe	iron
GAZT	azidothymidine glucuronide
GI	gastrointestinal
HBV	hepatitis B virus
HCV	hepatitis C virus
HDL	high-density lipoprotein
HLA	human leukocyte antigen
HMG-CoA	hydroxy-methylglutaryl-coenzyme A
HSR	hypersensitivity reaction
INR	international normalized ratio
INSTI	integrase strand transfer inhibitor
LDL	low-density lipoprotein
MAC	*Mycobacterium avium* complex
MATE	multidrug and toxin extrusion transporter
Mg	magnesium
MI	myocardial infarction
N/A	Not Applicable
NNRTI	non-nucleoside reverse transcriptase inhibitor
NRTI	nucleoside reverse transcriptase inhibitor
OCT2	organic cation transporter 2
OH-itraconazole	active metabolite of itraconazole
PAH	pulmonary arterial hypertension
PDE5	phosphodiesterase type 5
PI	protease inhibitor
PPI	proton pump inhibitor
PK	pharmacokinetic
QTc	QT corrected for heart rate
SCr	serum creatinine
soln	solution
SSRI	selective serotonin reuptake inhibitor
susp	suspension
tab	tablet
TB	tuberculosis
TCA	tricyclic anti-depressant
TG	triglyceride
TID	three times a day
UGT1A1	uridine diphosphate glucuronosyltransferase
VPA	valproic acid

WHO	World Health Organization
XR	extended release
Zn	zinc

Appendix B, Table 1. Characteristics of Nucleoside Reverse Transcriptase Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 5)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination	Serum/ Intracellular Half-Lives	Adverse Events[b]
Abacavir (ABC) *Ziagen* **Note:** Generic available in tablet formulation **Also available as a component of fixed-dose combinations.**	Ziagen: • 300 mg tablet • 20 mg/mL oral solution	Ziagen: • 300 mg BID, or • 600 mg once daily • Take without regard to meals.	Metabolized by alcohol dehydrogenase and glucuronyl transferase Renal excretion of metabolites: 82% Dosage adjustment for ABC is recommended in patients with hepatic insufficiency (see Appendix B, Table 7).	1.5 hours/ 12–26 hours	• HSRs: Patients who test positive for HLA-B*5701 are at highest risk. HLA screening should be done before initiation of ABC. • For patients with history of HSR, re-challenge is not recommended. • Symptoms of HSR may include fever, rash, nausea, vomiting, diarrhea, abdominal pain, malaise, fatigue, or respiratory symptoms such as sore throat, cough, or shortness of breath. • Some cohort studies suggest increased risk of MI with recent or current use of ABC, but this risk is not substantiated in other studies.
Trizivir (ABC/ZDV/3TC) **Note:** Generic available	Trizivir: • (ABC 300 mg plus ZDV 300 mg plus 3TC 150 mg) tablet	Trizivir: • 1 tablet BID			
Epzicom (ABC/3TC)	Epzicom: • (ABC 600 mg plus 3TC 300 mg) tablet	Epzicom: • 1 tablet once daily			
Triumeq (ABC/3TC/DTG)	Triumeq: • (ABC 600 mg plus 3TC 300 mg plus DTG 50 mg) tablet	Triumeq: • 1 tablet once daily			
Didanosine (ddI) *Videx* *Videx EC* **Note:** Generic available; dose same as Videx or Videx EC	Videx EC: • 125, 200, 250, and 400 mg capsules Videx: • 10 mg/mL oral solution	Body Weight ≥60 kg: • 400 mg once daily *With TDF:* • 250 mg once daily Body Weight <60 kg: • 250 mg once daily *With TDF:* • 200 mg once daily Take 1/2 hour before or 2 hours after a meal. **Note:** Preferred dosing with oral solution is BID (total daily dose divided into 2 doses).	Renal excretion: 50% Dosage adjustment in patients with renal insufficiency is recommended (see Appendix B, Table 7).	1.5 hours/ >20 hours	• Pancreatitis • Peripheral neuropathy • Retinal changes, optic neuritis • Lactic acidosis with hepatic steatosis with or without pancreatitis (rare but potentially life-threatening toxicity) • Nausea, vomiting • Potential association with non-cirrhotic portal hypertension; in some cases, patients presented with esophageal varices • One cohort study suggested increased risk of MI with recent or current use of ddI, but this risk is not substantiated in other studies. • Insulin resistance/diabetes mellitus

Appendix B, Table 1. Characteristics of Nucleoside Reverse Transcriptase Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 5)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination	Serum/ Intracellular Half-Lives	Adverse Events[b]
Emtricitabine (FTC) *Emtriva* **Also available as a component of fixed-dose combinations.**	Emtriva: • 200 mg hard gelatin capsule • 10 mg/mL oral solution	Emtriva *Capsule:* • 200 mg once daily *Oral Solution:* • 240 mg (24 mL) once daily Take without regard to meals.	Renal excretion: 86% Dosage adjustment in patients with renal insufficiency is recommended (see Appendix B, Table 7).	10 hours/ >20 hours	• Minimal toxicity • Hyperpigmentation/skin discoloration • Severe acute exacerbation of hepatitis may occur in HBV-coinfected patients who discontinue FTC.
Atripla (FTC/EFV/TDF)	Atripla: • (FTC 200 mg plus EFV 600 mg plus TDF 300 mg) tablet	Atripla: • 1 tablet at or before bedtime • Take on an empty stomach to reduce side effects.			
Complera (FTC/RPV/TDF)	Complera: • (FTC 200 mg plus RPV 25 mg plus TDF 300 mg) tablet	Complera: • 1 tablet once daily with a meal			
Stribild (FTC/EVG/c/ TDF)	Stribild: • (FTC 200 mg plus EVG 150 mg plus COBI 150 mg plus TDF 300 mg) tablet	Stribild: • 1 tablet once daily with food			
Truvada (FTC/TDF)	Truvada: • (FTC 200 mg plus TDF 300 mg) tablet	Truvada: • 1 tablet once daily			

Appendix B, Table 1. Characteristics of Nucleoside Reverse Transcriptase Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 5)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination	Serum/ Intracellular Half-Lives	Adverse Events[b]
Lamivudine (3TC) *Epivir* **Note:** Generic available **Also available as a component of fixed-dose combinations.**	Epivir: • 150 and 300 mg tablets • 10 mg/mL oral solution	Epivir: • 150 mg BID, or • 300 mg once daily • Take without regard to meals.	Renal excretion: 70% Dosage adjustment in patients with renal insufficiency is recommended (see Appendix B, Table 7).	5–7 hours/ 18–22 hours	• Minimal toxicity • Severe acute exacerbation of hepatitis may occur in HBV-coinfected patients who discontinue 3TC.
Combivir (3TC/ZDV) **Note:** Generic available	Combivir: • (3TC 150 mg plus ZDV 300 mg) tablet	Combivir: • 1 tablet BID			
Epzicom (3TC/ABC)	Epzicom: • (3TC 300 mg plus ABC 600 mg) tablet	Epzicom: • 1 tablet once daily			
Trizivir (3TC/ZDV/ABC) **Note:** Generic available	Trizivir: • (3TC 150 mg plus ZDV 300 mg plus ABC 300 mg) tablet	Trizivir: • 1 tablet BID			
Triumeq (3TC/ABC/DTG)	Triumeq: • (3TC 300 mg plus ABC 600 mg plus DTG 50 mg) tablet	Triumeq: • 1 tablet once daily			
Stavudine (d4T) *Zerit* **Note:** Generic available	Zerit: • 15, 20, 30, and 40 mg capsules • 1 mg/mL oral solution	Body Weight ≥60 kg: • 40 mg BID Body Weight <60 kg: • 30 mg BID Take without regard to meals. **Note:** WHO recommends 30 mg BID dosing regardless of body weight.	Renal excretion: 50% Dosage adjustment in patients with renal insufficiency is recommended (see Appendix B, Table 7).	1 hour/ 7.5 hours	• Peripheral neuropathy • Lipoatrophy • Pancreatitis • Lactic acidosis/severe hepatomegaly with hepatic steatosis (rare but potentially life-threatening toxicity) • Hyperlipidemia • Insulin resistance/diabetes mellitus • Rapidly progressive ascending neuromuscular weakness (rare)

Appendix B, Table 1. Characteristics of Nucleoside Reverse Transcriptase Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 4 of 5)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination	Serum/ Intracellular Half-Lives	Adverse Events[b]
Tenofovir Disoproxil Fumarate (TDF) *Viread* **Also available as a component of fixed-dose combinations.**	Viread: • 150, 200, 250, and 300 mg tablets • 40 mg/g oral powder	Viread: • 300 mg once daily, or • 7.5 level scoops once daily (dosing scoop dispensed with each prescription; one level scoop contains 1 g of oral powder). • Take without regard to meals. Mix oral powder with 2–4 ounces of a soft food that does not require chewing (e.g., applesauce, yogurt). **Do not mix oral powder with liquid.**	Renal excretion is primary route of elimination. Dosage adjustment in patients with renal insufficiency is recommended (see Appendix B, Table 7).	17 hours/ >60 hours	• Renal insufficiency, Fanconi syndrome, proximal renal tubulopathy • Osteomalacia, decrease in bone mineral density • Severe acute exacerbation of hepatitis may occur in HBV-coinfected patients who discontinue TDF. • Asthenia, headache, diarrhea, nausea, vomiting, and flatulence
Atripla TDF/EFV/FTC	Atripla: • (TDF 300 mg plus EFV 600 mg plus FTC 200 mg) tablet	Atripla: • 1 tablet at or before bedtime • Take on an empty stomach to reduce side effects.			
Complera TDF/RPV/FTC	Complera: • (TDF 300 mg plus RPV 25 mg plus FTC 200 mg) tablet	Complera: • 1 tablet once daily • Take with a meal			
Stribild (TDF/EVG/c/FTC)	Stribild: • (TDF 300 mg plus EVG 150 mg plus COBI 150 mg plus FTC 200 mg) tablet	Stribild: • 1 tablet once daily • Take with food.			
Truvada (TDF/FTC)	Truvada: • (TDF 300 mg plus FTC 200 mg) tablet	Truvada: • 1 tablet once daily • Take without regard to meals.			

Appendix B, Table 1. Characteristics of Nucleoside Reverse Transcriptase Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 5 of 5)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination	Serum/ Intracellular Half-Lives	Adverse Events[b]
Zidovudine (ZDV) *Retrovir* **Note:** Generic available **Also available as a component of fixed-dose combinations.**	Retrovir: • 100 mg capsule • 300 mg tablet (only available as generic) • 10 mg/mL intravenous solution • 10 mg/mL oral solution	Retrovir: • 300 mg BID, or • 200 mg TID • Take without regard to meals.	Metabolized to GAZT Renal excretion of GAZT Dosage adjustment in patients with renal insufficiency is recommended (see Appendix B, Table 7).	1.1 hours/ 7 hours	• Bone marrow suppression: macrocytic anemia or neutropenia • Nausea, vomiting, headache, insomnia, asthenia • Nail pigmentation • Lactic acidosis/severe hepatomegaly with hepatic steatosis (rare but potentially life-threatening toxicity) • Hyperlipidemia • Insulin resistance/diabetes mellitus • Lipoatrophy • Myopathy
Combivir (ZDV/3TC) **Note:** Generic available	Combivir: • (ZDV 300 mg plus 3TC 150 mg) tablet	Combivir: • 1 tablet BID • Take without regard to meals.			
Trizivir (ZDV/3TC/ABC) **Note:** Generic available	Trizivir: • (ZDV 300 mg plus 3TC 150 mg plus ABC 300 mg) tablet	Trizivir: • 1 tablet BID • Take without regard to meals.			

[a] For dosage adjustment in renal or hepatic insufficiency, see Appendix B, Table 7.

[b] Also see Table 14.

Key to Acronyms: 3TC = lamivudine; ABC = abacavir; BID = twice daily; c, COBI = cobicistat; d4T = stavudine; ddI = didanosine; DTG = dolutegravir; EC = enteric coated; EFV = efavirenz; EVG = elvitegravir; FTC = emtricitabine; GAZT = azidothymidine glucuronide; HBV = hepatitis B virus; HLA = human leukocyte antigen; HSR = hypersensitivity reaction; MI = myocardial infarction; RPV = rilpivirine; TDF = tenofovir disoproxil fumarate; TID = three times a day; WHO = World Health Organization; ZDV = zidovudine

Appendix B, Table 2. Characteristics of Non-Nucleoside Reverse Transcriptase Inhibitors (Last updated April 8, 2014; last reviewed April 8, 2015) (page 1 of 2)

Note: DLV is not included in this table. Please refer to the DLV FDA package insert for related information.

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination/ Metabolic Pathway	Serum/ Half-Life	Adverse Events[b]
Efavirenz (EFV) *Sustiva* **Also available as a component of fixed-dose combination.**	Sustiva: • 50 and 200 mg capsules • 600 mg tablet	Sustiva: • 600 mg once daily, at or before bedtime • Take on an empty stomach to reduce side effects.	Metabolized by CYPs 2B6 (primary), 3A4, and 2A6 CYP3A4 mixed inducer/inhibitor (more an inducer than an inhibitor)	40–55 hours	• Rash[c] • Neuropsychiatric symptoms[d] • Increased transaminase levels • Hyperlipidemia • False-positive results with some cannabinoid and benzodiazepine screening assays reported. • Teratogenic in non-human primates and potentially teratogenic during the first trimester of pregnancy in humans
Atripla (EFV/TDF/FTC)	Atripla: • (EFV 600 mg plus FTC 200 mg plus TDF 300 mg) tablet	Atripla: • 1 tablet once daily, at or before bedtime	CYP2C9 and 2C19 inhibitor; 2B6 inducer		
Etravirine (ETR) *Intelence*	• 25, 100, and 200 mg tablets	200 mg BID Take following a meal.	CYP3A4, 2C9, and 2C19 substrate 3A4 inducer; 2C9 and 2C19 inhibitor	41 hours	• Rash, including Stevens-Johnson syndrome[c] • HSRs, characterized by rash, constitutional findings, and sometimes organ dysfunction (including hepatic failure) have been reported. • Nausea

Nevirapine (NVP) *Viramune* or *Viramine XR*
Generic available for 200 mg tablets and oral suspension
	• 200 mg tablet
	• 400 mg XR tablet
	• 50 mg/5 mL oral suspension
		200 mg once daily for 14 days (lead-in period); thereafter, 200 mg BID, or 400 mg (Viramune XR tablet) once daily
		Take without regard to meals.
		Repeat lead-in period if therapy is discontinued for >7 days.
		In patients who develop mild-to-moderate rash without constitutional symptoms, continue lead-in period until rash resolves but not longer than 28 days total.
			CYP450 substrate, inducer of 3A4 and 2B6; 80% excreted in urine (glucuronidated metabolites, <5% unchanged); 10% in feces	25–30 hours	• Rash, including Stevens-Johnson syndrome[c]
					• Symptomatic hepatitis, including fatal hepatic necrosis, has been reported:
					  • Rash reported in approximately 50% of cases.
					  • Occurs at significantly higher frequency in ARV-naive female patients with pre-NVP CD4 counts >250 cells/mm^3 and in ARV-naive male patients with pre-NVP CD4 counts >400 cells/mm^3. NVP should not be initiated in these patients unless the benefit clearly outweighs the risk.

Appendix B, Table 2. Characteristics of Non-Nucleoside Reverse Transcriptase Inhibitors (Last updated April 8, 2014; last reviewed April 8, 2015) (page 2 of 2)

Note: DLV is not included in this table. Please refer to the DLV FDA package insert for related information.

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination/ Metabolic Pathway	Serum/ Half-Life	Adverse Events[b]
Rilpivirine (RPV) *Edurant* **Also available as a component of fixed-dose combination.**	Edurant: • 25 mg tablet	Edurant: • 25 mg once daily • Take with a meal.	CYP3A4 substrate	50 hours	• Rash[c] • Depression, insomnia, headache • Hepatotoxicity
Complera (RPV/TDF/FTC)	Complera: • (RPV 25 mg plus TDF 300 mg plus FTC 200 mg) tablet	Complera: • 1 tablet once daily • Take with a meal.			

[a] For dosage adjustment in renal or hepatic insufficiency, see Appendix B, Table 7.

[b] Also see Table 14.

[c] Rare cases of Stevens-Johnson syndrome have been reported with most NNRTIs; the highest incidence of rash was seen with NVP.

[d] Adverse events can include dizziness, somnolence, insomnia, abnormal dreams, depression, suicidality (suicide, suicide attempt or ideation), confusion, abnormal thinking, impaired concentration, amnesia, agitation, depersonalization, hallucinations, and euphoria. Approximately 50% of patients receiving EFV may experience any of these symptoms. Symptoms usually subside spontaneously after 2 to 4 weeks but may necessitate discontinuation of EFV in a small percentage of patients.

Key to Abbreviations: ARV = antiretroviral; BID = twice daily; CD4 = CD4 T lymphocyte; CYP = cytochrome P; DLV = delavirdine; EFV = efavirenz; ETR = etravirine; FDA = Food and Drug Administration; FTC = emtricitabine; HSR = hypersensitivity reaction; NNRTI = non-nucleoside reverse transcriptase inhibitor; NVP = nevirapine; RPV = rilpivirine; TDF = tenofovir disoproxil fumarate; XR = extended release

Appendix B, Table 3. Characteristics of Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 1 of 4)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination/ Metabolic Pathway	Serum Half-Life	Storage	Adverse Events[b]
Atazanavir (ATV) *Reyataz* **Also available as a component of fixed-dose combination.**	Reyataz: • 100, 150, 200, and 300 mg capsules • 50 mg single packet oral powder	In ARV-Naive Patients: • (ATV 300 mg plus RTV 100 mg) once daily; or • ATV 400 mg once daily With TDF or in ARV-Experienced Patients: • (ATV 300 mg plus RTV 100 mg) once daily With EFV in ARV-Naive Patients: • (ATV 400 mg plus RTV 100 mg) once daily Take with food. For recommendations on dosing with H2 antagonists and PPIs, refer to Table 19a.	CYP3A4 inhibitor and substrate; weak CYP2C8 inhibitor; UGT1A1 inhibitor Dosage adjustment in patients with hepatic insufficiency is recommended (see Appendix B, Table 7).	7 hours	Room temperature (up to 25° C or 77° F)	• Indirect hyperbilirubinemia • PR interval prolongation: First degree symptomatic AV block reported. Use with caution in patients with underlying conduction defects or on concomitant medications that can cause PR prolongation. • Hyperglycemia • Fat maldistribution • Cholelithiasis • Nephrolithiasis • Renal insufficiency • Serum transaminase elevations • Hyperlipidemia (especially with RTV boosting) • Skin rash • Increase in serum creatinine (with COBI)
Evotaz (ATV/c)	Evotaz: • (ATV 300 mg plus COBI 150 mg) tablet	Evotaz: • 1 tablet once daily • Take with food. With TDF: • **Not recommended** for patients with baseline CrCl< 70 mL/min (see Appendix B, Table 7 for the equation for calculating CrCl).	ATV: as above COBI: substrate of CYP3A, CYP2D6 (minor); CYP3A inhibitor			
Darunavir (DRV) *Prezista* **Also available as a component of fixed-dose combination.**	• 75, 150, 600, and 800 mg tablets • 100 mg/mL oral suspension	In ARV-Naive Patients or ARV-Experienced Patients with No DRV Mutations: • (DRV 800 mg plus RTV 100 mg) once daily In ARV-Experienced Patients with One or More DRV Resistance Mutations: • (DRV 600 mg plus RTV 100 mg) BID Unboosted DRV is **not** recommended. Take with food.	CYP3A4 inhibitor and substrate CYP2C9 inducer	15 hours (when combined with RTV)	Room temperature (up to 25° C or 77° F)	• Skin rash (10%): DRV has a sulfonamide moiety; Stevens-Johnson syndrome, toxic epidermal necrolysis, acute generalized exanthematous pustulosis, and erythrema multiforme have been reported. • Hepatotoxicity • Diarrhea, nausea • Headache • Hyperlipidemia • Serum transaminase elevation • Hyperglycemia • Fat maldistribution • Increase in serum creatinine (with COBI)
Prezcobix (DRV/c)	Prezcobix: • (DRV 800 mg plus COBI 150 mg) tablet	Prezcobix: • 1 tablet once daily • Take with food. **Not recommended** for patients with one or more DRV resistance-associated mutations. With TDF: • **Not recommended** for patients with baseline CrCl< 70 mL/min (see Appendix B, Table 7 for the equation for calculating CrCl).	DRV: As above COBI: substrate of CYP3A, CYP2D6 (minor); CYP3A inhibitor			

Appendix B, Table 3. Characteristics of Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 2 of 4)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination/ Metabolic Pathway	Serum Half-Life	Storage	Adverse Events[b]
Fosamprenavir (FPV) *Lexiva* (a prodrug of APV)	• 700 mg tablet • 50 mg/mL oral suspension	In ARV-Naive Patients: • FPV 1400 mg BID, or • (FPV 1400 mg plus RTV 100–200 mg) once daily, or • (FPV 700 mg plus RTV 100 mg) BID In PI-Experienced Patients (Once-Daily Dosing Not Recommended): • (FPV 700 mg plus RTV 100 mg) BID With EFV: • (FPV 700 mg plus RTV 100 mg) BID, or • (FPV 1400 mg plus RTV 300 mg) once daily *Tablet:* • Without RTV tablet: Take without regard to meals. • With RTV tablet: Take with meals. *Oral Suspension:* • Take without food.	APV is a CYP3A4 substrate, inhibitor, and inducer. Dosage adjustment in patients with hepatic insufficiency is recommended (see Appendix B, Table 7).	7.7 hours (APV)	Room temperature (up to 25° C or 77° F)	• Skin rash (12% to 19%): FPV has a sulfonamide moiety. • Diarrhea, nausea, vomiting • Headache • Hyperlipidemia • Serum transaminase elevation • Hyperglycemia • Fat maldistribution • Possible increased bleeding episodes in patients with hemophilia • Nephrolithiasis
Indinavir (IDV) *Crixivan*	100, 200, and 400 mg capsules	• 800 mg every 8 hours • Take 1 hour before or 2 hours after meals; may take with skim milk or a low-fat meal. With RTV: • (IDV 800 mg plus RTV 100–200 mg) BID • Take without regard to meals.	CYP3A4 inhibitor and substrate Dosage adjustment in patients with hepatic insufficiency is recommended (see Appendix B, Table 7).	1.5–2 hours	Room temperature (15° to 30° C or 59° to 86° F) Protect from moisture.	• Nephrolithiasis • GI intolerance, nausea • Hepatitis • Indirect hyperbilirubinemia • Hyperlipidemia • Headache, asthenia, blurred vision, dizziness, rash, metallic taste, thrombocytopenia, alopecia, and hemolytic anemia • Hyperglycemia • Fat maldistribution • Possible increased bleeding episodes in patients with hemophilia

Appendix B, Table 3. Characteristics of Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 3 of 4)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination/ Metabolic Pathway	Serum Half-Life	Storage	Adverse Events[b]
Lopinavir/ Ritonavir (LPV/r) *Kaletra*	Tablets: • (LPV 200 mg plus RTV 50 mg), or • (LPV 100 mg plus RTV 25 mg) Oral Solution: • Each 5 mL contains (LPV 400 mg plus RTV 100 mg). • Oral solution contains 42% alcohol.	• (LPV 400 mg plus RTV 100 mg) BID, or • (LPV 800 mg plus RTV 200 mg) once daily Once-daily dosing is not recommended for patients with ≥3 LPV-associated mutations, pregnant women, or patients receiving EFV, NVP, FPV, NFV, carbamazepine, phenytoin, or phenobarbital. With EFV or NVP (PI-Naive or PI-Experienced Patients): • LPV/r 500 mg/125 mg tablets BID (use a combination of 2 LPV/r 200 mg/50 mg tablets plus 1 LPV/r 100 mg/25 mg tablet to make a total dose of LPV/r 500 mg/125 mg), or • LPV/r 533 mg/133 mg oral solution BID *Tablet:* • Take without regard to meals. *Oral Solution:* • Take with food.	CYP3A4 inhibitor and substrate	5–6 hours	Oral tablet is stable at room temperature. Oral solution is stable at 2° to 8° C (36° to 46° F) until date on label and is stable for up to 2 months when stored at room temperature (up to 25° C or 77° F).	• GI intolerance, nausea, vomiting, diarrhea • Pancreatitis • Asthenia • Hyperlipidemia (especially hypertriglyceridemia) • Serum transaminase elevation • Hyperglycemia • Insulin resistance/diabetes mellitus • Fat maldistribution • Possible increased bleeding episodes in patients with hemophilia • PR interval prolongation • QT interval prolongation and torsades de pointes have been reported; however, causality could not be established.
Nelfinavir (NFV) *Viracept*	• 250 and 625 mg tablets • 50 mg/g oral powder	• 1250 mg BID, or • 750 mg TID Dissolve tablets in a small amount of water, mix admixture well, and consume immediately. Take with food.	CYP2C19 and 3A4 substrate—metabolized to active M8 metabolite; CYP3A4 inhibitor	3.5–5 hours	Room temperature (15° to 30° C or 59° to 86° F)	• Diarrhea • Hyperlipidemia • Hyperglycemia • Fat maldistribution • Possible increased bleeding episodes in patients with hemophilia • Serum transaminase elevation
Ritonavir (RTV) *Norvir*	• 100 mg tablet • 100 mg soft gel capsule • 80 mg/mL oral solution Oral solution contains 43% alcohol.	As Pharmacokinetic Booster (or Enhancer) for Other PIs: • 100–400 mg per day in 1 or 2 divided doses (refer to other PIs for specific dosing recommendations) *Tablet:* • Take with food. *Capsule and Oral Solution:* • To improve tolerability, take with food if possible.	CYP3A4 >2D6 substrate; potent 3A4, 2D6 inhibitor; Inducer of CYPs 1A2, 2C8, 2C9, and 2C19 and UGT1A1	3–5 hours	Tablets do not require refrigeration. Refrigerate capsules. Capsules can be left at room temperature (up to 25° C or 77° F) for up to 30 days. **Oral solution should not be refrigerated.**	• GI intolerance, nausea, vomiting, diarrhea • Paresthesia (circumoral and extremities) • Hyperlipidemia (especially hypertriglyceridemia) • Hepatitis • Asthenia • Taste perversion • Hyperglycemia • Fat maldistribution • Possible increased bleeding episodes in patients with hemophilia

Appendix B, Table 3. Characteristics of Protease Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015) (page 4 of 4)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination/ Metabolic Pathway	Serum Half-Life	Storage	Adverse Events[b]
Saquinavir (SQV) *Invirase*	• 500 mg tablet • 200 mg capsule	(SQV 1000 mg plus RTV 100 mg) BID Unboosted SQV is **not** recommended. Take with meals or within 2 hours after a meal.	CYP3A4 substrate	1–2 hours	Room temperature (15º to 30º C or 59º to 86º F)	• GI intolerance, nausea, and diarrhea • Headache • Serum transaminase elevation • Hyperlipidemia • Hyperglycemia • Fat maldistribution • Possible increased bleeding episodes in patients with hemophilia • PR interval prolongation • QT interval prolongation, torsades de pointes have been reported. Patients with pre-SQV QT interval >450 msec should not receive SQV.
Tipranavir (TPV) *Aptivus*	• 250 mg capsule • 100 mg/mL oral solution	(TPV 500 mg plus RTV 200 mg) BID Unboosted TPV is **not** recommended. With RTV Tablets: • Take with meals. With RTV Capsules or Solution: • Take without regard to meals.	CYP P450 3A4 inducer and substrate CYP2D6 inhibitor; CYP3A4, 1A2, and 2C19 inducer Net effect when combined with RTV (CYP3A4, 2D6 inhibitor)	6 hours after single dose of TPV/r	Refrigerate capsules. Capsules can be stored at room temperature (25º C or 77º F) for up to 60 days. **Oral solution should not be refrigerated or frozen** and should be used within 60 days after bottle is opened.	• Hepatotoxicity: Clinical hepatitis (including hepatic decompensation and hepatitis-associated fatalities) has been reported; monitor patients closely, especially those with underlying liver diseases. • Skin rash (3% to 21%): TPV has a sulfonamide moiety; use with caution in patients with known sulfonamide allergy. • Rare cases of fatal and nonfatal intracranial hemorrhages have been reported. Risks include brain lesion, head trauma, recent neurosurgery, coagulopathy, hypertension, alcoholism, and the use of anti-coagulant or anti-platelet agents (including vitamin E). • Hyperlipidemia • Hyperglycemia • Fat maldistribution • Possible increased bleeding episodes in patients with hemophilia

[a] For dosage adjustment in hepatic insufficiency, see Appendix B, Table 7.

[b] Also see Table 14.

Key to Acronyms: APV = amprenavir; ARV = antiretroviral; ATV = atazanavir; ATV/c = atazanavir/cobicistat; AV = atrioventricular; BID = twice daily; COBI = cobicistat; CYP = cytochrome P; DRV = darunavir; DRV/c = darunavir/cobicistat; EFV = efavirenz; FPV = fosamprenavir; GI = gastrointestinal; IDV = indinavir; LPV = lopinavir; LPV/r = lopinavir/ritonavir; msec = millisecond; NFV = nelfinavir; NVP = nevirapine; PI = protease inhibitor; PK = pharmacokinetic; PPI = proton pump inhibitor; RTV = ritonavir; SQV = saquinavir; TDF = tenofovir disoproxil fumarate; TID = three times a day; TPV = tipranavir

Appendix B, Table 4. Characteristics of Integrase Inhibitors (Last updated April 8, 2015; last reviewed April 8, 2015)

Generic Name (Abbreviation) *Trade Name*	Formulations	Dosing Recommendations[a]	Elimination/ Metabolic Pathways	Serum Half-Life	Adverse Events[b]
Dolutegravir (DTG) *Tivicay* **Also available as a component of fixed-dose combination.**	• 50 mg tablet	ARV-Naive or ARV-Experienced, INSTI-Naive Patients: • 50 mg once daily ARV-Naive or ARV-Experienced, INSTI-Naive Patients when CoAdministered with EFV, FPV/r, TPV/r, or Rifampin: • 50 mg BID INSTI-Experienced Patients with Certain INSTI Mutations (See Product Label) or with Clinically Suspected INSTI Resistance: • 50 mg BID Take without regard to meals.	UGT1A1 mediated glucuronidation Minor contribution from CYP3A4	~14 hours	• HSRs including rash, constitutional symptoms, and organ dysfunction (including liver injury) have been reported. • Insomnia • Headache
Triumeq DTG/ABC/3TC	Triumeq: • (DTG 50 mg plus 3TC 300 mg plus ABC 600 mg) tablet	Triumeq: Take 1 tablet daily without regard to meals.			
Elvitegravir (EVG) *Vitekta* **Also available as a component of fixed-dose combination.**	85 and 150 mg tablets	With Once Daily ATV/r or BID LPV/r: • 85 mg once daily with food With BID DRV/r, FPV/r, or TPV/r: • 150 mg once daily with food Unboosted EVG **is not recommended.**	CYP3A, UGT1A1/3 substrate	~9 hours	• Nausea • Diarrhea
Stribild EVG/c/FTC/TDF	Stribild: • (EVG 150 mg plus COBI 150 mg plus FTC 200 mg plus TDF 300 mg) tablet	Stribild: 1 tablet once daily with food. Not recommended for patients with baseline CrCl< 70 mL/min (see Appendix B Table 7 for the equation for calculating CrCl). **Not recommended for use with other antiretroviral drugs.**	EVG: As above COBI: CYP3A, CYP2D6 (minor); CYP3A inhibitor	~13 hours	• Nausea • Diarrhea • New onset or worsening renal impairment • Potential decrease in bone mineral density • Severe acute exacerbation of hepatitis may occur in HBV-coinfected patients who discontinue FTC and TDF.
Raltegravir (RAL) *Isentress*	• 400 mg tablet • 25 and 100 mg chewable tablets • 100 mg single packet for oral suspension	400 mg BID With Rifampin: • 800 mg BID Take without regard to meals.	UGT1A1-mediated glucuronidation	~9 hours	• Rash, including Stevens-Johnson syndrome, HSR, and toxic epidermal necrolysis • Nausea • Headache • Diarrhea • Pyrexia • CPK elevation, muscle weakness, and rhabdomyolysis • Insomnia

[a] For dosage adjustment in hepatic insufficiency, see Appendix, Table 7.

[b] Also see Table 14.

Key to Abbreviations: 3TC = lamivudine; ABC = abacavir; ARV = antiretroviral; ATV/r = atazanavir/ritonavir; BID = twice daily; c, COBI = cobicistat; CPK = creatine phosphokinase; CrCl = creatinine clearance; CYP = cytochrome P; DRV/r = darunavir/ritonavir; DTG = dolutegravir; EFV = efavirenz; EVG = elvitegravir; FPV/r = fosamprenavir/ritonavir; FTC = emtricitabine; HBV = hepatitis B virus; HSR = hypersensitivity reaction; INSTI = integrase strand transfer inhibitor; LPV/r = lopinavir/ritonavir; RAL = raltegravir; TDF = tenofovir disoproxil fumerate; TPV/r = tipranavir/ritonavir; UGT = uridine diphosphate gluconyltransferase

Appendix B, Table 5. Characteristics of Fusion Inhibitor (Last updated January 29, 2008; last reviewed April 8, 2015)

Generic Name (Abbreviation) *Trade Name*	Formulation	Dosing Recommendation	Serum Half-Life	Elimination	Storage	Adverse Events[a]
Enfuvirtide (T20) *Fuzeon*	• Injectable; supplied as lyophilized powder • Each vial contains 108 mg of T20; reconstitute with 1.1mL of sterile water for injection for delivery of approximately 90 mg/1 mL.	90 mg (1 mL) subcutaneously BID	3.8 hours	Expected to undergo catabolism to its constituent amino acids, with subsequent recycling of the amino acids in the body pool	Store at room temperature (up to 25° C or 77° F). Re-constituted solution should be refrigerated at 2° to 8° C (36° to 46° F) and used within 24 hours.	• Local injection site reactions (e.g., pain, erythema, induration, nodules and cysts, pruritus, ecchymosis) in almost 100% of patients • Increased incidence of bacterial pneumonia • HSR (<1% of patients): Symptoms may include rash, fever, nausea, vomiting, chills, rigors, hypotension, or elevated serum transaminases. Re-challenge is not recommended.

[a] Also see Table 14.

Key to Abbreviations: BID = twice daily; HSR = hypersensitivity reaction; T20 = enfuvirtide

Appendix B, Table 6. Characteristics of CCR5 Antagonist (Last updated March 27, 2012; last reviewed April 8, 2015)

Generic Name (Abbreviation)/ *Trade Name*	Formulation	Dosing Recommendations[a]	Serum Half-Life	Elimination/ Metabolic Pathway	Adverse Events[b]
Maraviroc (MVC) *Selzentry*	150 and 300 mg tablets	**150 mg BID** when given with drugs that are strong CYP3A inhibitors (with or without CYP3A inducers) including PIs (except TPV/r) **300 mg BID** when given with NRTIs, T20, TPV/r, NVP, RAL, and other drugs that are not strong CYP3A inhibitors or inducers **600 mg BID** when given with drugs that are CYP3A inducers, including EFV, ETR, etc. (without a CYP3A inhibitor) Take without regard to meals.	14–18 hours	CYP3A4 substrate	• Abdominal pain • Cough • Dizziness • Musculoskeletal symptoms • Pyrexia • Rash • Upper respiratory tract infections • Hepatotoxicity, which may be preceded by severe rash or other signs of systemic allergic reactions • Orthostatic hypotension, especially in patients with severe renal insufficiency

[a] For dosage adjustment in hepatic insufficiency, see Appendix, Table 7.

[b] Also see Table 14.

Key to Abbreviations: BID = twice daily; CYP = cytochrome P; EFV = efavirenz; ETR = etravirine; MVC = maraviroc; NRTI = nucleoside reverse transcriptase inhibitor; NVP = nevirapine; PI = protease inhibitor; RAL = raltegravir; T20 = enfuvirtide; TPV/r = tipranavir/ritonavir

Appendix B, Table 7. Antiretroviral Dosing Recommendations in Patients with Renal or Hepatic Insufficiency (Last updated May 1, 2014; last reviewed April 8, 2015) (page 1 of 6)

See the reference section at the end of this table for creatinine clearance (CrCl) calculation formulas and criteria for Child-Pugh classification.

<table>
<tr><th>ARVs
Generic Name
(Abbreviation)
Trade Name</th><th>Usual Daily Dose[a]</th><th>Dosing in Renal Insufficiency[b]</th><th>Dosing in Hepatic Impairment</th></tr>
<tr><td colspan="4">NRTIs
Stribild should not be initiated in patients with CrCl <70 mL/min. Use of the following fixed-dose combinations is not recommended in patients with CrCl <50 mL/min: Atripla, Combivir, Complera, Epzicom, Stribild, Triumeq, or Trizivir. Use of Truvada is not recommended in patients with CrCl <30 mL/min.</td></tr>
<tr><td>Abacavir
(ABC)
Ziagen</td><td>300 mg PO BID</td><td>No dosage adjustment necessary</td><td>Child-Pugh Score 5–6:
• 200 mg PO BID (use oral solution)
Child-Pugh Score >6:
• Contraindicated</td></tr>
<tr><td>Didanosine EC
(ddI)
Videx EC</td><td>Body Weight ≥60 kg:
• 400 mg PO once daily
Body Weight <60 kg:
• 250 mg PO once daily</td><td><table><tr><th colspan="3">Dose (Once Daily)</th></tr><tr><th>CrCl (mL/min)</th><th>≥60 kg</th><th><60 kg</th></tr><tr><td>30–59</td><td>200 mg</td><td>125 mg</td></tr><tr><td>10–29</td><td>125 mg</td><td>125 mg</td></tr><tr><td><10, HD[c], CAPD</td><td>125 mg</td><td>75 mg oral solution</td></tr></table></td><td>No dosage adjustment necessary.</td></tr>
<tr><td>Didanosine Oral Solution
(ddI)
Videx</td><td>Body Weight ≥60 kg:
• 200 mg PO BID, or
• 400 mg PO once daily
Body Weight <60 kg:
• 250 mg PO once daily, or
• 125 mg PO BID</td><td><table><tr><th colspan="3">Dose (Once Daily)</th></tr><tr><th>CrCl (mL/min)</th><th>≥60 kg</th><th><60 kg</th></tr><tr><td>30–59</td><td>200 mg</td><td>150 mg</td></tr><tr><td>10–29</td><td>150 mg</td><td>100 mg</td></tr><tr><td><10, HD[c], CAPD</td><td>100 mg</td><td>75 mg</td></tr></table></td><td>No dosage adjustment necessary.</td></tr>
<tr><td>Emtricitabine
(FTC)
Emtriva</td><td>200 mg oral capsule once daily
or
240 mg (24 mL) oral solution once daily</td><td><table><tr><th colspan="3">Dose</th></tr><tr><th>CrCl (mL/min)</th><th>Capsule</th><th>Solution</th></tr><tr><td>30–49</td><td>200 mg q48h</td><td>120 mg q24h</td></tr><tr><td>15–29</td><td>200 mg q72h</td><td>80 mg q24h</td></tr><tr><td><15 or on HD[c]</td><td>200 mg q96h</td><td>60 mg q24h</td></tr></table></td><td>No dosage recommendation.</td></tr>
<tr><td>Lamivudine
(3TC)
Epivir</td><td>300 mg PO once daily
or
150 mg PO BID</td><td><table><tr><th>CrCl (mL/min)</th><th>Dose</th></tr><tr><td>30–49</td><td>150 mg q24h</td></tr><tr><td>15–29</td><td>1 x 150 mg, then 100 mg q24h</td></tr><tr><td>5–14</td><td>1 x 150 mg, then 50 mg q24h</td></tr><tr><td><5 or on HD[c]</td><td>1 x 50 mg, then 25 mg q24h</td></tr></table></td><td>No dosage adjustment necessary.</td></tr>
</table>

Appendix B, Table 7. Antiretroviral Dosing Recommendations in Patients with Renal or Hepatic Insufficiency (Last updated May 1, 2014; last reviewed April 8, 2015) (page 2 of 6)

ARVs Generic Name (Abbreviation) *Trade Name*	Usual Daily Dose[a]	Dosing in Renal Insufficiency[b]	Dosing in Hepatic Impairment
NRTIs, continued			
Stavudine (d4T) *Zerit*	Body Weight ≥60 kg: • 40 mg PO BID Body Weight <60 kg: • 30 mg PO BID	**Dose** **CrCl (mL/min)** / **≥60 kg** / **<60 kg** 26–50 / 20 mg q12h / 15 mg q12h 10–25 or on HD[c] / 20 mg q24h / 15 mg q24h	No dosage recommendation.
Tenofovir Disoproxil Fumarate (TDF) *Viread*	300 mg PO once daily	**CrCl (mL/min)** / **Dose** 30–49 / 300 mg q48h 10–29 / 300 mg twice weekly (every 72–96 hours) <10 and not on HD / No recommendation On HD[c] / 300 mg q7d	No dosage adjustment necessary.
Emtricitabine (FTC) plus **Tenofovir Disoproxil Fumarate** (TDF) *Truvada*	1 tablet PO once daily	**CrCl (mL/min)** / **Dose** 30–49 / 1 tablet q48h <30 or on HD / Not recommended	No dosage recommendation.
Zidovudine (AZT, ZDV) *Retrovir*	300 mg PO BID	**CrCl (mL/min)** / **Dose** <15 or on HD[c] / 100 mg TID or 300 mg once daily	No dosage recommendation.
NNRTIs			
Delavirdine (DLV) *Rescriptor*	400 mg PO TID	No dosage adjustment necessary.	No dosage recommendation; use with caution in patients with hepatic impairment.
Efavirenz (EFV) *Sustiva*	600 mg PO once daily, at or before bedtime	No dosage adjustment necessary.	No dosage recommendation; use with caution in patients with hepatic impairment.
Efavirenz (EFV) plus **Tenofovir Disoproxil Fumarate** (TDF) plus **Emtricitabine** (FTC) *Atripla*	1 tablet PO once daily	Not recommended for use in patients with CrCl <50 mL/min. Instead use the individual drugs of the fixed-dose combination and adjust TDF and FTC doses according to CrCl level.	

Appendix B, Table 7. Antiretroviral Dosing Recommendations in Patients with Renal or Hepatic Insufficiency (Last updated May 1, 2014; last reviewed April 8, 2015) (page 3 of 6)

ARVs Generic Name (Abbreviation) *Trade Name*	Usual Daily Dose[a]	Dosing in Renal Insufficiency[b]	Dosing in Hepatic Impairment
NNRTIs, continued			
Etravirine (ETR) *Intelence*	200 mg PO BID	No dosage adjustment necessary.	Child-Pugh Class A or B: • No dosage adjustment Child-Pugh Class C: • No dosage recommendation
Nevirapine (NVP) *Viramune* or *Viramune XR*	200 mg PO BID or 400 mg PO once daily (using Viramune XR formulation)	Patients on HD: • Limited data; no dosage recommendation.	Child-Pugh Class A: • No dosage adjustment Child-Pugh Class B or C: • Contraindicated
Rilpivirine (RPV) *Edurant*	25 mg PO once daily	No dosage adjustment necessary.	Child-Pugh Class A or B: • No dosage adjustment Child-Pugh Class C: • No dosage recommendation
Rilpivirine (RPV) plus **Tenofovir Disoproxil Fumarate** (TDF) plus **Emtricitabine** (FTC) *Complera*	1 tablet PO once daily	Not recommended for use in patients with CrCl <50 mL/min. Instead use the individual drugs of the fixed-dose combination and adjust TDF and FTC doses levels according to CrCl level.	Child-Pugh Class A or B: • No dosage adjustment Child-Pugh Class C: • No dosage recommendation
PIs			
Atazanavir (ATV) *Reyataz*	400 mg PO once daily or (ATV 300 mg plus RTV 100 mg) PO once daily	No dosage adjustment for patients with renal dysfunction who do not require HD. ARV-Naive Patients on HD: • (ATV 300 mg plus RTV 100 mg) once daily ARV-Experienced Patients on HD: • ATV or ATV/r not recommended	Child-Pugh Class B: • 300 mg once daily Child-Pugh Class C: • Not recommended RTV boosting is **not** recommended in patients with hepatic impairment (Child-Pugh Class B or C).
Atazanavir (ATV) plus **Cobicistat** (COBI) *Evotaz*	1 tablet PO once daily	If Used with TDF: • Not recommended for use in patients with CrCl <70 mL/min. If Not Used with TDF: • No dosage adjustment for patients with renal dysfunction who do not require HD.	No dosage recommendation; not recommended in patients with hepatic impairment.

Appendix B, Table 7. Antiretroviral Dosing Recommendations in Patients with Renal or Hepatic Insufficiency (Last updated May 1, 2014; last reviewed April 8, 2015) (page 4 of 6)

ARVs Generic Name (Abbreviation) *Trade Name*	Usual Daily Dose[a]	Dosing in Renal Insufficiency[b]	Dosing in Hepatic Impairment
PIs, continued			
Darunavir (DRV) *Prezista*	ARV-Naive Patients and ARV-Experienced Patients with No DRV Resistance Mutations: • (DRV 800 mg plus RTV 100 mg) PO once daily ARV-Experienced Patients with at Least One DRV Resistance Mutation: • (DRV 600 mg plus RTV 100 mg) PO BID	No dosage adjustment necessary.	Mild-to-Moderate Hepatic Impairment: • No dosage adjustment Severe Hepatic Impairment: • Not recommended
Darunavir (DRV) plus **Cobicistat** (COBI) *Prezcobix*	1 tablet PO once daily (only recommended for patients without DRV-associated resistance mutations)	If Used with TDF: • Not recommended for use in patients with CrCl <70 mL/min. If Not Used with TDF: • No dosage adjustment necessary.	Child-Pugh Class A or B: • No dosage adjustment Child-Pugh Class C: • Not recommended
Fosamprenavir (FPV) *Lexiva*	1400 mg PO BID or (FPV 1400 mg plus RTV 100–200 mg) PO once daily or (FPV 700 mg plus RTV 100 mg) PO BID	No dosage adjustment necessary.	PI-Naive Patients Only: *Child-Pugh Score 5–9:* • 700 mg BID *Child-Pugh Score 10–15:* • 350 mg BID PI-Naive or PI-Experienced Patients: *Child-Pugh Score 5–6:* • (700 mg BID plus RTV 100 mg) once daily *Child-Pugh Score 7–9:* • (450 mg BID plus RTV 100 mg) once daily *Child-Pugh Score 10–15:* • (300 mg BID plus RTV 100 mg) once daily
Indinavir (IDV) *Crixivan*	800 mg PO q8h	No dosage adjustment necessary.	Mild-to-Moderate Hepatic Insufficiency Because of Cirrhosis: • 600 mg q8h

Appendix B, Table 7. Antiretroviral Dosing Recommendations in Patients with Renal or Hepatic Insufficiency (Last updated May 1, 2014; last reviewed April 8, 2015) (page 5 of 6)

ARVs Generic Name (Abbreviation) *Trade Name*	Usual Daily Dose[a]	Dosing in Renal Insufficiency[b]	Dosing in Hepatic Impairment
PIs, continued			
Lopinavir/ritonavir (LPV/r) *Kaletra*	(LPV 400 mg plus RTV 100 mg) PO BID or (LPV 800 mg plus RTV 200 mg) PO once daily	Avoid once-daily dosing in patients on HD.	No dosage recommendation; use with caution in patients with hepatic impairment.
Nelfinavir (NFV) *Viracept*	1250 mg PO BID	No dosage adjustment necessary.	Mild hepatic impairment: • No dosage adjustment Moderate-to-severe hepatic impairment: • Do not use.
Ritonavir (RTV) *Norvir*	As a PI-Boosting Agent: • 100–400 mg per day	No dosage adjustment necessary.	Refer to recommendations for the primary PI.
Saquinavir (SQV) *Invirase*	(SQV 1000 mg plus RTV 100 mg) PO BID	No dosage adjustment necessary.	Mild-to-Moderate Hepatic Impairment: • Use with caution. Severe Hepatic Impairment: • Contraindicated
Tipranavir (TPV) *Aptivus*	(TPV 500 mg plus RTV 200 mg) PO BID	No dosage adjustment necessary.	Child-Pugh Class A: • Use with caution Child-Pugh Class B or C: • Contraindicated
INSTIs			
Dolutegravir (DTG) *Tivicay*	50 mg once daily or 50 mg BID	No dosage adjustment necessary.	Child-Pugh Class A or B: • No dosage adjustment Child-Pugh Class C: • Not recommended
Elvitegravir (EVG) *Vitekta*	85 mg or 150 mg[a] once daily	No dosage adjustment necessary.	Child-Pugh Class A or B: • No dosage adjustment Child-Pugh Class C: • Not recommended

Appendix B, Table 7. Antiretroviral Dosing Recommendations in Patients with Renal or Hepatic Insufficiency (Last updated May 1, 2014; last reviewed April 8, 2015) (page 6 of 6)

ARVs Generic Name (Abbreviation) *Trade Name*	Usual Daily Dose[a]	Dosing in Renal Insufficiency[b]	Dosing in Hepatic Impairment
INSTIs, continued			
Elvitegravir (EVG) plus **Cobicistat** (COBI) plus **Tenofovir Disoproxil Fumarate** (TDF) plus **Emtricitabine** (FTC) *Stribild*	1 tablet once daily	EVG/c/TDF/FTC **should not be initiated** in patients with CrCl <70 mL/min. Discontinue EVG/c/TDF/FTC if CrCl declines to <50 mL/min while patient is on therapy.	Mild-to-Moderate Hepatic Insufficiency: • No dosage adjustment necessary Severe Hepatic Insufficiency: • Not recommended
Raltegravir (RAL) *Isentress*	400 mg BID	No dosage adjustment necessary.	Mild-to-Moderate Hepatic Insufficiency: • No dosage adjustment necessary Severe Hepatic Insufficiency: • No recommendation
Fusion Inhibitor			
Enfuvirtide (T20) *Fuzeon*	90 mg subcutaneous BID	No dosage adjustment necessary.	No dosage adjustment necessary
CCR5 Antagonist			
Maraviroc (MVC) *Selzentry*	The recommended dose differs based on concomitant medications and potential for drug-drug interactions. See Appendix B, Table 6 for detailed dosing information.	CrCl <30 mL/min or on HD *Without Potent CYP3A Inhibitors or Inducers:* • 300 mg BID; reduce to 150 mg BID if postural hypotension occurs *With Potent CYP3A Inducers or Inhibitors:* • Not recommended	No dosage recommendations. Concentrations will likely be increased in patients with hepatic impairment.

[a] Refer to Appendix B, Tables 1–6 for additional dosing information

[b] Including with chronic ambulatory peritoneal dialysis and hemodialysis

[c] On dialysis days, take dose after HD session

Key to Abbreviations: 3TC = lamivudine; ABC = abacavir; ARV = antiretroviral; ATV = atazanavir; AZT = zidovudine; BID = twice daily; CAPD = chronic ambulatory peritoneal dialysis; COBI, c = cobicistat; CrCl = creatinine clearance; CYP = cytochrome P; d4T = stavudine; ddI = didanosine; DLV = delavirdine; DRV = darunavir; EC = enteric coated; DTG = dolutegravir; EFV = efavirenz; ETR = etravirine; EVG= elvitegravir; FPV = fosamprenavir; FTC = emtricitabine; HD = hemodialysis; IDV = indinavir; LPV/r = lopinavir/ritonavir; MVC = maraviroc; NFV = nelfinavir; NNRTI = non-nucleoside reverse transcriptase inhibitor; NRTI = nucleoside reverse transcriptase inhibitor; NVP = nevirapine; PI = protease inhibitor; PO = orally; q(n)d = every (n) days; q(n)h = every (n) hours; RAL = raltegravir; RPV = rilpivirine; RTV = ritonavir; SQV = saquinavir; T20 = enfuvirtide; TDF = tenofovir disoproxil fumarate; TID = three times daily; TPV = tipranavir; XR = extended release; ZVD = zidovudine

Creatinine Clearance Calculation	
Male: $\frac{(140 - \text{age in years}) \times (\text{weight in kg})}{72 \times (\text{serum creatinine})}$	Female: $\frac{(140 - \text{age in years}) \times (\text{weight in kg}) \times (0.85)}{72 \times (\text{serum creatinine})}$

Child-Pugh Score			
Component	**Points Scored**		
	1	**2**	**3**
Encephalopathy[a]	None	Grade 1–2	Grade 3–4
Ascites	None	Mild or controlled by diuretics	Moderate or refractory despite diuretics
Albumin	>3.5 g/dL	2.8–3.5 g/dL	<2.8 g/dL
Total bilirubin or	<2 mg/dL (<34 µmol/L)	2–3 mg/dL (34 µmol/L to 50 µmol/L)	>3 mg/dL (>50 µmol/L)
Modified total bilirubin[b]	<4 mg/dL	4–7 mg/dL	>7 mg/dL
Prothrombin time (seconds prolonged) or	<4	4–6	>6
International normalized ratio (INR)	<1.7	1.7–2.3	>2.3

[a] Encephalopathy Grades

Grade 1: Mild confusion, anxiety, restlessness, fine tremor, slowed coordination

Grade 2: Drowsiness, disorientation, asterixis

Grade 3: Somnolent but rousable, marked confusion, incomprehensible speech, incontinence, hyperventilation

Grade 4: Coma, decerebrate posturing, flaccidity

[b] Modified total bilirubin used for patients who have Gilbert's syndrome or who are taking indinavir or atazanavir

Child-Pugh Classification	Total Child-Pugh Score[c]
Class A	5–6 points
Class B	7–9 points
Class C	>9 points

[c] Sum of points for each component