



Adherence: Successful therapy

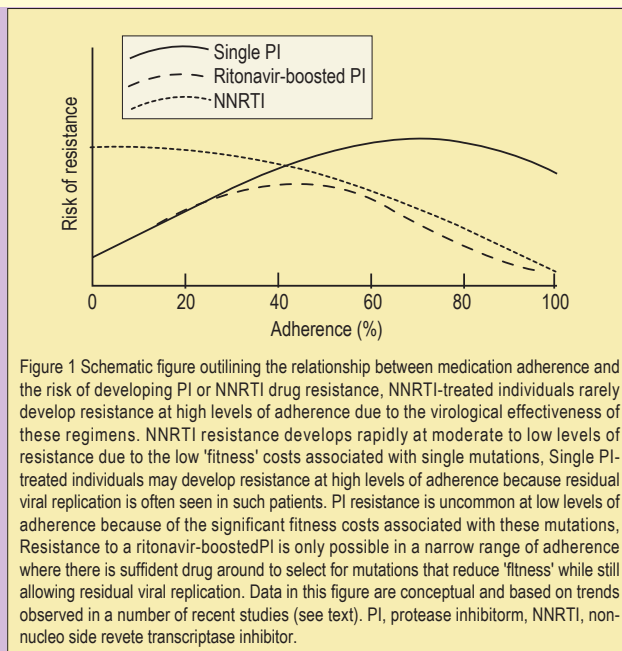
By Kimberly Scarsi

ANTIRETROVIRAL therapy offers highly effective and successful treatment for patients infected with HIV. The combination of these medications has consistently demonstrated durability over the past decade. However, the role of the patient in this success is vital. Patient adherence to the prescribed antiretroviral combination is known to improve viral suppression, slow progression to AIDS, and is considered a cornerstone in preventing the development of antiretroviral resistance.¹

Ensuring that all patients initiating an antiretroviral combination understand the importance of adherence as part of their overall programme is an important component of the care of HIV-infected patients.

Commonly quoted statistics based on data collected during the late 1990s estimate that a minimum of 95% adherence is desired to ensure a successful antiretroviral treatment.² These data were based on available antiretroviral therapies available at that time, specifically two nucleoside reverse transcriptase inhibitors (NRTIs) plus a protease inhibitor (PI), often dosed thrice daily. Over the past several years, other antiretroviral strategies have become more commonly employed, such as non-nucleoside reverse transcriptase inhibitors (NNRTIs) and boosted PIs, allowing for less frequent dosing.

Accumulating data have suggested that the level of



adherence that is required to prevent the development of drug-resistant virus is a complex relationship and may be related to the combination therapy being used. For non-boosted PI-based therapies, patients who take most of their doses of medications, approximately 70-80%, may have an increased risk of drug-resistant virus as compared to those patients who are highly adherent or very poorly adherent. Boosted PI regimens may have an overall lower risk of developing risk at any adherence level, with the greatest risk of resistance at approximately 50% adherence. Finally, NNRTI-based regimens will likely result in the development of few resistance mutations in any patient who is highly adherent, but will easily

develop resistance in the presence of any viral replication. See Figure 1 for a visual interpretation of these data from Bangsberg et al.¹

Regardless of the exact adherence required, these data still suggest that care providers and patients should be striving for as close to 100% adherence as possible to ensure therapeutic success. Because of this large commitment the patient is undertaking at the beginning of antiretroviral therapy, it is essential to ensure the patient possesses the motivation to make this therapy successful. Engaging the patient in the reasons that adherence is necessary, as well as the implications of non-adherence will help them understand their role in making antiretroviral drugs work for them.

Ensuring the patient understands the dose, frequency, timing of medications with food or at certain times of day is crucial at the initiation of therapy. Also, explaining potential side effects, and management of these side effects, will help the patient overcome the initial difficulty with starting these regimens.

Consistent reinforcement of adherence from physicians, nurses, counsellors, and pharmacists at each clinic visit will help ensure the patient understands the importance of this aspect of care. Finally, including any patient support system, friends, family, or neighbours, in the reinforcement of the importance of medication adherence will help keep the patient motivated between clinic visits and provide the much needed support for the patient throughout therapy.³

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Resistance testing for HIV disease

A very happy new year to all the friends of ATIC. We look forward to another year of working with you to help fight HIV/AIDS in Africa. This year we have some new and exciting ideas for the ATIC newsletter which we will share with you during the year. In this month's newsletter we are privileged to have an article from Dr Jonathan Schapiro on resistance testing for HIV disease. Dr Schapiro is a key opinion leader in this field and has particular interest in the interaction between resistance testing and pharmacokinetics. Dr Schapiro provides an excellent overview on the two types of resistance testing that are currently available—genotyping and phenotyping. However, both tests are very expensive and are by no means required for antiretroviral drugs to be used. Good clinical judgement

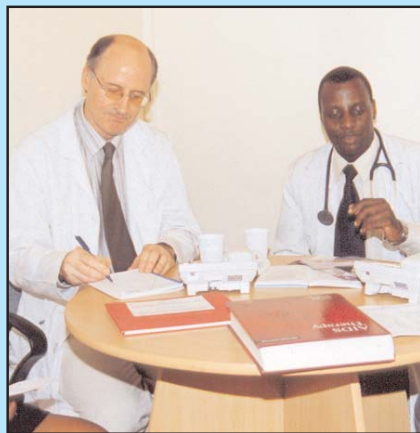
is paramount to this. These tests should be seen as an adjuvant to further improving patient care. Like any clinical investigation, these tests should be interpreted properly and used with caution considering their limitations. Resistance testing needs to be combined with proper clinical education and quickly made available worldwide. As health-care providers our job is to minimise the emergence of resistance by counselling patients on adherence and watching out for drug interactions which could inadvertently expose patients to sub-therapeutic drug levels. Even if a patient is 100% compliant, the patient will develop resistance if the doctor adds in TB therapy and forgets to adjust the dose of the antiretrovirals. It is hard to constantly watch for drug-drug interactions as these

can happen with drugs that our patients are taking for diseases other than HIV and may not even be prescribed by us. A prominent feature in the prevention of development of resistance is excellent management of the drug supply, storage and distribution and we will be doing an special ATIC newsletter dedicated to this later this year. Another article in this issue highlights the need to integrate the practice of clinical pharmacology into HIV/AIDS patient care in the choice of antiretroviral drug regimens by focusing on Tenofovir (TDF) and didanosine (DDI), the most frequently prescribed nucleoside analogues. We have also taken the opportunity to provide you with protease inhibitor (PI) and non-nucleoside reverse transcriptase inhibitor (NNRTI) charts that you can use daily.

UN calls for more effort to halt HIV

THERE is new evidence that adult HIV infection rates have decreased in certain countries and that changes in behaviour to prevent infection—such as increased use of condoms, delay of first sexual experience and fewer sexual partners—have played a key part in these declines. The new UN report also indicates, however, that overall trends in HIV transmission are still increasing, and that far greater HIV prevention efforts are needed to slow the epidemic.

Kenya, Zimbabwe and some countries in the Caribbean region all show declines in HIV prevalence over the past few years with overall adult infection rates decreasing in Kenya from a peak of 10% in the late 1990s to 7% in 2003 and evidence of drops in HIV rates among pregnant women in Zimbabwe from 26% in 2003 to 21% in 2004. In urban areas of Burkina Faso prevalence among young pregnant women declined from around 4% in 2001 to just under 2% in 2003.



Erich Kakande

Doctors discuss ways of tackling HIV

These latest findings were published in *AIDS Epidemic Update 2005*, the annual report by the Joint United Nations Programme on HIV/AIDS (UNAIDS) and the World Health Organization (WHO). The joint report focuses on HIV prevention

Several recent developments in the Caribbean region (in Bahamas, Barbados, Bermuda, Dominican Republic and Haiti) give cause for guarded optimism—with some HIV prevalence declines evident among pregnant women, signs of increased condom use among sex workers and expansion of voluntary HIV testing and counselling.

Despite decreases in the rate of infection in certain countries, the overall number of people living with HIV has continued to increase in all regions of the world except the Caribbean. There were an additional five million new infections in 2005. The number of people living with HIV globally has reached its highest level with an estimated 40.3 million people, up from an estimated 37.5 million in 2003. More than three million people died of AIDS-related illnesses in 2005; of these, more than 500,000 were children.

WHO

Efavirenz: Its use with other ARVs

Francis Kalemeera, BPharm, BSc, MPS discusses efavirenz and its use

Indications and pharmacological class ^{1,9}

Efavirenz (EFV), also called Sustiva® or Stockrin®, is a synthetic antiretroviral agent belonging to the Non Nucleoside Reverse Transcriptase Inhibitors' (NNRTI) class. It is used in combination with other antiretroviral agents for the treatment of HIV type 1 infection. Efavirenz may also be used as one of the drugs in the regimen for post exposure prophylaxis: i.e. a basic two drug regimen (2NRTI) plus efavirenz.

Dosage and Administration ^{1,2,11}

Efavirenz should be taken on an empty stomach, preferably in the evening just before bedtime. Increased serum concentrations have been noted when efavirenz is taken with food, which may be associated with an increase in adverse effects.

1. Tablets

Adult and Adolescent over 12 years, $\geq 40\text{kg}$: 600mg once daily

2. Capsules

Adult and child over 3 years, based on weight (kg):

- 10 to $< 15\text{kg}$: 200mg once daily
- 15 to $< 20\text{kg}$: 250mg once daily
- 20 to $< 25\text{kg}$: 300mg once daily
- 25 to $< 33\text{kg}$: 350mg once daily
- 33 to $< 40\text{kg}$: 400mg once daily
- $\geq 40\text{kg}$: 600mg once daily

3. Oral Solution (30mg/ml)

Note that the bioavailability of the oral solution is lower than that of the capsules and tablets, thus the difference in the dosage schedule below.

Adult and child over 3 years, based on weight (kg):

- 10 to $< 15\text{kg}$: 270mg (= 9ml) once daily
- 15 to $< 20\text{kg}$: 300mg (=

10ml) once daily

- 20 to $< 25\text{kg}$: 360mg (= 12ml) once daily
- 25 to $< 33\text{kg}$: 450mg (= 15ml) once daily
- 33 to $< 40\text{kg}$: 510mg (= 17ml) once daily
- $\geq 40\text{kg}$: 720 mg (= 24ml) once daily

Adverse Drug Reactions ^{2,3,6}

The most frequently reported side effects associated with efavirenz in combination with other anti-HIV medications include rash and nervous system symptoms that include dizziness, insomnia or somnolence, impaired concentration and abnormal dreams. Generally symptoms are worse after the 1st and 2nd doses and improve over 2-4 weeks. Dosing of efavirenz at bedtime, as well as in a fasting state, may help to improve tolerability of the medication and should be recommended. The rash generally presents as a maculopapular skin eruption during the first two weeks after initiating therapy. In most cases, the rash resolves with continued efavirenz use; however, efavirenz should be discontinued if the rash is severe. Other reported adverse effects include nausea, vomiting, diarrhea, hepatitis, allergic reactions, abdominal pain and raised serum cholesterol.

Contraindications and Precautions ^{5,7}

Efavirenz use should be avoided during pregnancy unless the potential benefit justifies potential risk to the foetus, for example in pregnant women without other therapeutic options after the first trimester of pregnancy. The pregnancy category for efavirenz was recently changed from Category C (Risk of fetal Harm Cannot Be Ruled Out) to Category D (Positive Evidence of Fetal Risk).

Barrier methods should always be used in combination with other contraceptive

methods in patients taking efavirenz. Efavirenz is contraindicated in patients with clinically significant hypersensitivity to it and to any of the components of the formulation.

Monitoring parameters ⁷

Monitor liver enzymes (AST and ALT) and cholesterol levels in plasma. Some patients accidentally taking 600mg twice daily have reported increased nervous system symptoms. ¹⁰

Drug Interactions ⁸

Because efavirenz is an inducer of cytochrome P450 (CYP) 3A4, other compounds that are substrates of this enzyme may have decreased plasma concentrations when co-administered with efavirenz. For example, efavirenz decreases the lopinavir concentration when the two drugs are given concomitantly. Therefore, patients on efavirenz and lopinavir/ritonavir (Kaletra®) should increase the Kaletra® dose to four capsules (533/133mg) twice daily.

Additionally, in vitro efavirenz has been shown to also inhibit CYP 2C9, 2C19, and 3A4 enzymes, potentially resulting in an increase in the plasma concentration of medications metabolized by these enzymes.

Examples include: bepridil, dihydroergotamine, ergotamine, ergometrine, terfenadine, pimozone, midazolam, triazolam and cisapride. These drugs should not be administered together with efavirenz.

Dosing in renal insufficiency and hepatic impairment ⁸

The pharmacokinetics of efavirenz in renal and hepatic impairment has not been adequately investigated. Less than 1% of efavirenz is excreted unchanged in urine, thus renal impairment is unlikely to have a significant effect on efavirenz pharmacokinetics. However, efavirenz is extensively metabolized by the liver so caution should be used when using efavirenz in patients with

underlying hepatic impairment. **Storage ^{3,7}**

Efavirenz preparations should be stored at 15 - 30°C and kept out of reach of children.

Presentations ¹⁻⁴

Efavirenz is available as: capsules of 50mg, 100mg and 200mg; film coated tablets of 600mg; and an oral solution containing 30mg/ml.

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Tenofovir and Didanosine; the combination to watch

SOME of the goals of antiretroviral therapy are to achieve viral suppression and improve the immunological functions of the patient's body. The combination of drugs work together to ensure that the virus levels are reduced to undetectable levels and that there is an increase in the CD4 cells. Tenofovir (TDF) and didanosine (DDI) are among the most frequently prescribed nucleoside analogues (NA) because both are administered in a convenient fashion, show relatively high genetic barrier for resistance, have a quite acceptable safety profile, and remarkable antiviral potency. However, their co-administration has caused concern given the recent evidence of unexpected CD4 T-cell declines in patients treated with this dual NA combination despite having undetectable viral load ^{1, 2}. At the same time, several reports have highlighted an increased risk of pancreatitis and of hyperglycemia in patients treated with TDF plus DDI ³⁻⁵.

In a large multicentre study the CD4 cell outcome in patients receiving different NA combinations, including TDF plus DDI, DDI alone, TDF alone, and others was assessed. A new mechanism, by which TDF plus DDI may cause CD4+ T-cell depletion in HIV-infected individuals despite providing complete virus suppression, was proposed [6].

At 12 months, the median CD4 T-cell counts was significantly lower in patients included in the simplification on TDF + DDI when compared to those taking DDI or TDF alone. Moreover, in drug-naïve individuals, those under DDI + TDF experienced a significantly lower gain in the median CD4+ T-cell count when compared with patients in other groups, taking either DDI or TDF. This occurred in drug-naïve and simplified patients irrespective of the third agent included in the triple combination.

This study demonstrates that HIV-infected individuals receiving DDI + TDF-based combinations show CD4 T-cell declines (in both absolute number and percentages) despite complete virus suppression. This effect generally occurs after 6 months of therapy and worsens with time. It occurs earlier and is more pronounced when TDF + DDI are taken together with another NA as third agent as well as when using high

Robinah Nganwa highlights the need to integrate the practice of clinical pharmacology into HIV/AIDS patient care in the choice of antiretroviral (ARV) drug regimens. Increased collaboration between pharmacists and doctors in making decisions concerning drug therapy will maximise prescribing of ARV drugs.

DDI doses. Accordingly, high DDI plasma levels correlated with loss of CD4 T cells. Finally, CD4 T-cell declines were not seen in patients receiving any other antiretroviral regimen, including those in which either TDF or DDI were included. Given that DDI and TDF are both adenosine analogues, it is hypothesized that a synergistic effect of their metabolites might cause an imbalance in the purine pool within CD4 T lymphocytes. As these cells experience a rapid turnover in HIV infection, any impairment in cell replication might translate into loss of CD4 T cells by a mechanism which is independent of virus replication. This cytostatic effect of TDF + DDI combinations on CD4 T lymphocytes essentially resembles the T-cell immunodeficiency seen in the purine nucleoside phosphorylase (PNP) deficiency, a rare autosomal recessive genetic disorder ⁷⁻⁹. The homozygotes present as severe combined immunodeficiency, with recurrent infections and death in infancy.

Failure to clear purine metabolites and accumulation of deoxyguanosine-triphosphate (dGTP) in these children result in an inhibition of the ribonucleotide reductase enzyme, which in turn, inhibits DNA synthesis and impedes cell division. Although the PNP enzyme is found in most body tissues, it has the highest levels in lymphoid cells, which may explain why CD4 T lymphocytes are selectively targeted in HIV-infected patients receiving DDI and TDF together. It is the hypothesis that because TDF metabolites inhibit PNP ¹⁰, the use of the alternative purine pathway by DDI metabolites is compromised in HIV-infected individuals on DDI + TDF. There is a shift to production of high levels of dGTP, which results in an inhibition of the ribonucleotide reductase, and conse-

quently DNA synthesis is blocked, causing CD4 T-cell declines. The fact that CD4+ T-cell declines were generally seen after 6 months on DDI + TDF therapy suggest that some compensatory mechanisms are involved, at least in the short term, which ultimately fail as extended periods of therapy are given.

In the study above, the greater CD4 T-cell decline seen in patients who took DDI + TDF with a third NA is a remarkably finding. The fact that other triple NA combinations did not cause CD4 T-cell drops, including those in which TDF or DDI were provided separately, suggests that administration of additional NA's might further exacerbate the metabolic interaction between DDI and TDF within the cells.

These findings are relevant for selection of antiretroviral combinations and discourage the use of TDF and DDI in combination. The recognition of CD4 T-cell declines in patients taking these medications together adds to the other recently discussed concerns about other side effects, including a higher risk of pancreatitis, hyperglycemia, and lactic acidosis, as well as of higher risk of virological failure with selection of the K65R mutation. Therefore, when possible, the combination of TDF and DDI should be avoided.

From a public health point of view, this issue is of great concern in developing countries where patients are initiated on antiretroviral therapy at relatively lower CD4 counts. Anything that acts to decrease the already low CD4 values or that slows the increase in CD4 values should be avoided. There is therefore a need to review current policies in several countries that have put the combination of TDF + DDI on national programs.

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QUESTIONS

with

Robinah Nganwa

After diagnosing KS in an HIV patient and putting them on vincristine and bleomycin, which lab parameter should we monitor regularly? - J.G, Uganda

Because chemotherapeutic agents adversely affect bone marrow cells, a complete blood count (CBC) is necessary prior to each treatment. The effects on bone marrow are temporary and normal functioning usually returns within 4-10 days. Because mature red blood cells have a relatively long life (120 days), cell production usually resumes before symptoms of deficiency develop. White blood cells (WBC), however, have a life span of 1 to 3 days only. Those in circulation remain unaffected, but the production of new leukocytes may be slow, creating a period of increased risk for infection. WBC production usually recovers before the next treatment. If it does not, treatment is delayed until the cell count increases sufficiently.

Thrombocytopenia (below normal platelet count of 15,000 to 300,000 per milliliter) and the risk of increased bleeding usually peaks 10 to 14 days following a course of chemotherapy. Damage to these cells is not permanent.

Normal values
WBC- 2.75-7.7 x 10³ /uL
RBC count
Men: 4.7-6.6 x 10⁶ /uL
Women: 4-5.6 x 10⁶ /uL
hHaemoglobin
Men: 14.4-18.9 g/dL
Women: 10.9-16.7g/dL
Platelet count
Men: 156-358 x 10³ /uL
Women : 125-445 x 10³ /uL

ICASA: Switching therapy

THE 14th International Conference on AIDS and Sexually Transmitted Infections in Africa was held December 4 to 9 2005 at Abuja, Nigeria. The following is an overview of two presentations delivered at the conference.

Hope for a preventive vaccine for HIV

Professor Robert Gallo of the Institute for Human Virology, renowned for his work in the discovery of HIV as the cause of AIDS along with Luc Montagnier made a presentation on the history of the HIV epidemic and prospects for developing a preventive HIV vaccine.

According to Gallo, "the multiple mechanisms evolved by HIV to impair the immune response is in itself a warning against the use of "live" attenuated HIV vaccine strategies". This among other difficulties has hampered efforts at developing an effective vaccine. He presented current research which demonstrated effectiveness of cross linked Gp120-CD4 complexes in eliciting



Gallo co-discovered the HIV

antibody responses that neutralise diverse primary isolates of HIV within and across clades.

Feasibility of switching to boosted PIs in Africa

Dr Cisse Mamadou described the NOGOMA study (a prospective monocentre study) giving twelve month results of a boosted PI strategy with Indinavir (IDV)/ritonavir(r) 400mg/100mg in Bamako Mali.

The aim of this study was to assess the feasibility, efficacy and safety of switching from IDV 800mg Tid and two NRTIs to IDV/r 400/100mg Bid and the same NRTIs in HIV-1 infected patients. The feasibility of switching to a boosted protease inhibitor regimen in

Africa had been questioned due to lack of refrigerator facilities for drug storage and high local temperatures which can exceed 40 degrees Celsius in some countries. In this study, 60% of patients had access to a refrigerator; other patients used traditional methods of keeping food and water cool.

All patients had been on the previous indinavir based regimen for 12 months. Following the switch to indinavir boosted with ritonavir, there was an increase in median CD 4 count from 244 to 321 cells per microlitre and 93% versus 83% attaining a viral load less than 400 copies per ml at week 48. There was no incidence of grade >2 adverse reactions and none of the patients was lost to follow up.

There were no significant differences in results according to mode of storage of indinavir boosted with ritonavir with respect to immunologic, virologic and pharmacokinetic parameters; leading to the conclusion that boosted indinavir is a feasible option in Africa despite local conditions.

The TDF and DDI combination

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The selection of drug

By Jonathan M Schapiro, MD

HIV has a very high potential to mutate. Although this results in generation of a large amount of non-viable virus, it also allows HIV many opportunities to select for genetic changes that code for viral target proteins less susceptible to antiretroviral drugs. These are drug resistance mutations. If selective pressure is exerted by drug therapy (in other words, viruses with resistance mutations to the drug will replicate better than those without) and the virus continues to replicate (incomplete viral suppression), eventually viruses with resistance mutations will emerge and populate the host out-competing the original wild type virus.

To prevent resistance we either need to avoid selective pressure (not give drugs) or prevent replication (complete viral suppression with our drugs). If we treat with drugs and the virus is allowed to replicate, we will be selecting for resistant virus with drug resistance mutations.

Only viruses with reduced susceptibility to the drug (or drugs) will have a selective advantage and not be inhibited. If drugs are used in combination, especially if for some of the drugs multiple mutations are required for resistance; it will be hard for the virus to select a virus with all the required mutations. If a virus with only one or two relevant mutations appears, it will still be inhibited with equal efficacy and not have a selective advantage and replicate.

Thus the advantage of using drugs requiring multiple mutations for resistance, and of course, of using drugs in combination. The numbers of mutations by a drug, or a drug regi-

men, required for resistance is sometimes referred to as the "genetic barrier".

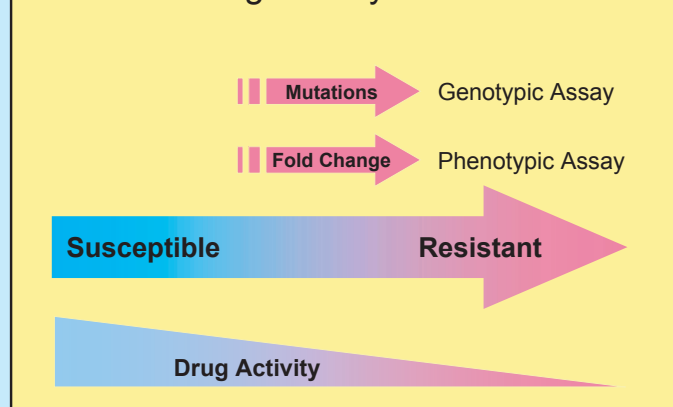
Cross-Resistance

When failing a drug the virus selects for mutations that confer resistance (or reduced susceptibility) to the drug. Commonly these mutations also effect other drugs of the same class (NRTI, NNRTI or PI) that interact with the target protein in a similar fashion. This phenomenon known as "cross-resistance" is key to the utility of drug resistance testing. If drugs selected only for mutations that affected themselves, treatment history alone would be sufficient to guide our therapeutic decisions when changing therapy in a failing patient. Understanding which mutations effect which drugs, and to what degree, is at the core of our ability to predict drug resistance. Although drugs may commonly select for a specific mutation, many other mutations or combinations of mutations may also confer resistance to the drug. Knowing all these different patterns that confer resistance to the drug is crucial for proper interpretations of resistance assays. An example might be the protease inhibitor nelfinavir. This drug commonly selects for mutations D30N or L90M that confer resistance to it, but is also strongly effected by mutation I84V selected by other PI.

Drug Resistance Assays

There are two types of assays used to determine antiretroviral drug resistance. The first is known as a genotypic assay and it examines the genetic makeup of the virus. The basis of resistance is of course the mutations in the viral genes that code for the proteins targeted by the drug. Changes in the genetic sequence result in changes in the target protein (for example

Loss of Drug Activity is Continuous



the protease enzyme's active site) and thus determining these changes allow us to assess drug resistance. Genotypic assays are performed by taking a small amount of patient blood and amplifying the viral RNA by molecular techniques (PCR). The genetic code of the relevant genes is determined (RT and protease) and drug resistance mutations are identified. An interpretation system that links specific mutations or patterns of mutations with resistance to the different drugs is then used to determine which drugs are resistant, partially resistant, or remain susceptible. Genotypic resistance assays are the most commonly used, and by far the most experience worldwide is with these assays. Multiple studies have shown their clinical utility, although they must be used wisely by clinicians understanding their limitations and proper interpretation of the assay results is crucial.

Phenotypic, or susceptibility assays are the second type of resistance assay. Here a laboratory test is performed to evaluate how resistant the specific virus is to each drug. The entire virus is not tested, only the area of the virus that determines the

Factors Required for Successful Drug Therapy



Adherence → Pharmacokinetics
Dosing schedule Toxicity Metabolism Drug interactions

RT and protease enzymes (and some surrounding genes). Here too, initially the viral RNA is amplified and then inserted into a specifically genetically engineered test virus. These assays are only performed on a large scale at a few laboratories around the world, mostly private companies. They require extremely expensive laboratory facilities and take longer and are considerably more expensive (~1,000 US Dollars for each blood sample) than genotypic tests (usually ~ 200 - 400 US Dollars). There are less data on the utility of phenotypic assays as routine clinical tools. Since they are not nearly as available

Understanding which mutations effect which drugs, and to what

resistance by HIV

Drug Resistance Assays Must Predict Clinical Resistance

Genotypic Assay

Detect which mutations are present

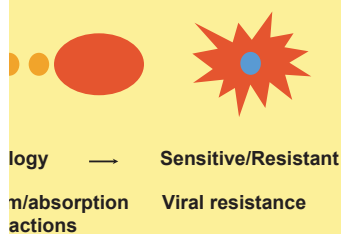
Phenotypic Assay

Test what effect mutations have on the virus in the laboratory

Clinical Resistance

Suppress viral replication in the patient

Successful Antiretroviral Therapy



as genotypic assays, take longer and are more expensive, and have never been found to have any advantages over genotyping; phenotypic assays are used worldwide much less often than genotyping which has become by far the more commonly used test. Phenotypic assays are a very important research tool and are key to understanding the resistance characteristics of new drugs. Although there is hope that perhaps these assays will have an advantage in highly drug-experienced patients, no studies thus far have shown this to be true.

Clinical Utility of Resistance Testing

Clinicians must always keep in mind that resistance assays can help us decide which drugs will likely not work against the patient's virus, or will have reduced activity, but can not decide for us which drugs are best to use. Therefore the main use of these assays is to rule out drugs, not rule them in.

Resistance assays must always be used to augment good clinical judgment and experience, never replace them. It is important to consider the many limitations of resistance assays, and to incorporate their results only in the context of the specific patient. Since drug resistance assay results may not show resistance to drugs the patient has failed in the past and is no longer receiving, it is imperative that we consider the patient's previous drug history in addition to the assay results before making treatment decisions. Let's for example consider a patient who received many years ago a protease inhibitor containing regimen. Upon failing the PI, he was switched to an NNRTI based regimen for a number of years. Now the patient is failing the NNRTI regimen and we perform a resistance assay. Since there has

been no selective pressure by a PI on the virus for years, the PI mutations that were selected in the past may no longer be detectable on the resistance assay - even though they remain present in the patient at low levels and will quickly reemerge if a PI is administered. Thus we must consider previous history, the presumed causes of failure, and the resistance assay results in order to rule out drugs properly. Of the drugs judged to still be active by these considerations, we must choose the regimen we believe will both be potent and best tolerated and convenient for the patient.

Resistance assays commonly provide three levels of interpretation for each drug. Based on the mutations present, a drug is considered as either susceptible, partially resistant, or resistant. Many alternative terms are also used (please see figure XX). "Susceptible" implies that the drug will maintain antiviral activity similar to a virus without any mutations, or have full activity. "Resistant" defines drugs with minimal to no activity, and "partially resistant" is used for drugs who will maintain significant activity, but it will be substantially less than would be expected of the drug if no mutations were present.

Comments to note

Drugs considered resistant by the assay, may still maintain some inhibitory effect on viral replication. This has been found to be true for both the NRTI and PI, but not for the NNRTI. It is thought that perhaps the mutations conferring resistance to the NRTI or PI also compromise the ability of the viral enzyme to function properly, thus reducing viral replication. Alternatively the drugs may still have some activity despite widespread resistance. Therefore clinicians often

continue to treat with NRTI and PI despite assay results showing resistance to all the drugs of the class. This often results in HIV RNA viral load levels 0.5 - 1.0 log less than would be seen without therapy and may preserve immune function, at least for some period of time.

The interpretation of resistance assay results in by no means perfect. Interpretations of both the genotypic and phenotypic assays change and are updated and improved all the time. One must realize this limitation of resistance assays and not assume perfect accuracy from the results. Interpretation of NRTI resistance is most challenging and determining which NRTI maintains activity in a patient with many mutations may not be always accurate for either of these types of assays.

Some interpretation systems, like the Stanford database, report more than three levels of resistance, dividing partial resistance into three different groups.

Summary

Resistance assays are an important tool assisting clinicians in optimizing antiretroviral drug choices. Genotypic assays have gained widespread use in countries with sufficient resources. These assays are by no means a requirement for antiretroviral drugs to be used, and good clinical judgment and experience are far more important. These assays should be seen as an adjuvant to further improving patient care. Resistance assays must always be interpreted properly, and used with caution considering their limitations. They need to be combined with proper clinician education and quickly made available worldwide.

National Hemophilia Center,
Tel Aviv, Israel

at degree, is at the core of our ability to predict drug resistance

IN BRIEF

Migrants

Both Mexicans who migrate to the United States for work as well as many Mexican migrants returning home are increasingly engaging in high-risk behaviors that put these groups at heightened vulnerability to HIV infection—especially since they are often outside the reach of conventional HIV prevention programs. Two new studies from the California–Mexico AIDS Initiative—a joint program coordinated by the Mexican Secretariat of Health and the University of California Office of the President—show rising rates of HIV infection among Mexican migrants within Mexico and in California.

HIV in China

China faces important challenges as it strives to contain a large and growing HIV/AIDS crisis that experts fear could affect more than 10 million people there by 2010. While the epidemic—which had initially centered among intravenous drug users and former plasma donors—is exploiting new opportunities for transmission to take place through heterosexual sex and sex between men.

PLWHA more

Despite decreases in the rate of infection in certain countries, the overall number of people living with HIV has continued to increase in all regions of the world except the Caribbean. There were an additional five million new infections in 2005. The number of people living with HIV globally has reached its highest level with an estimated 40.3 million people, up from an estimated 37.5 million in 2003.



A HIV patients (centre), with her attendants waits for care at a hospital

The heart of the health system

By Dr Tim Evans

HEALTH workers - the people who provide health care to those who need it - are the heart of health systems. But around the world, the health workforce is in crisis - a crisis to which no country is entirely immune. The results are evident: clinics with no health workers, hospitals that cannot recruit or keep key staff.

There is a chronic global shortage of health workers, as a result of decades of underinvestment in their education, training, salaries, working environment and management. This has led to a severe lack of key skills, rising levels of career switching and early retirement, as well as national and international migration. In sub-Saharan Africa, where all the issues mentioned above are combined with the HIV/AIDS pandemic, there are an estimated 750 000 health workers in a region that is home to 682 million people. By comparison, the ratio is ten to 15 times higher in OECD countries, whose ageing population is putting a growing



WHO's Dr Tim Evans

strain on an over-stretched workforce.

Solutions to this crisis must be worked out at local, national and international levels, and must involve governments, the United Nations, health professionals, non-governmental organizations and community leaders.

There is no single solution to such a complex problem, but ways forward do exist and must now be implemented. For example, some developed countries have put policies in place to stop active recruitment of health workers from

severely understaffed countries.

Some developing countries have revised their pay scales and introduced non-monetary incentives to retain their workforce and deploy them in rural areas. Education and training procedures have been tailored to countries' specific needs. Community health workers are helping their communities to prevent and treat key diseases. Action must be taken now for results to show in the coming years.

In 2006, World Health Day (celebrated annually on 7 April), will be devoted to the health workforce crisis. On this day around the globe, hundreds of organizations will host events to draw attention to the global health workforce crisis and celebrate the dignity and value of working for health. We invite you to join with WHO and other organizations to celebrate World Health Day 2006. Together, we can make a difference.

**Assistant Director-General
Evidence and Information
for Policy, World Health
Organisation**



Protease Inhibitor Drug Interactions (1)

	APV	ATV	IDV	LPV
Analgesics				
Alfentanil	♦	♦	♦	♦
Aspirin	♦	♦	♦	♦
Buprenorphine	♦	♦	♦	♦
Dextropropoxyphene	♦	♦	♦	♦
Diamorphine	♦	♦	♦	♦
Fentanyl	♦	♦	♦	♦
Ibuprofen	♦	♦	♦	♦
Methadone	♦	♦	♦	♦
Morphine	♦	♦	♦	♦
Paracetamol	♦	♦	♦	♦
Pethidine (Meperidine)	♦	♦	♦	♦
Piroxicam	♦	♦	♦	♦
Tramadol	♦	♦	♦	♦
Antiarrhythmics				
Amiodarone	♦	♦	♦	♦
Bepiridil	♦	♦	♦	♦
Disopyramide	♦	♦	♦	♦
Flecainide	♦	♦	♦	♦
Lidocaine (Lignocaine)	♦	♦	♦	♦
Mexiletine	♦	♦	♦	♦
Propafenone	♦	♦	♦	♦
Quinidine	♦	♦	♦	♦
Antibacterials				
Azithromycin	♦	♦	♦	♦
Ciprofloxacin	♦	♦	♦	♦
Clarithromycin	♦	♦	♦	♦
Clindamycin	♦	♦	♦	♦
Dapsone	♦	♦	♦	♦
Erythromycin	♦	♦	♦	♦
Ethambutol	♦	♦	♦	♦
Isoniazid	♦	♦	♦	♦
Metronidazole	♦	♦	♦	♦
Ofloxacin	♦	♦	♦	♦
Pyrazinamide	♦	♦	♦	♦
Rifabutin	♦	♦	♦	♦
Rifampicin	♦	♦	♦	♦
Rifapentine	♦	♦	♦	♦
Streptomycin	♦	♦	♦	♦
Tetracyclines	♦	♦	♦	♦
Trimethoprim/Sulfamethoxazole	♦	♦	♦	♦
Anticonvulsants				
Carbamazepine	♦	♦	♦	♦
Clonazepam	♦	♦	♦	♦
Ethosuximide	♦	♦	♦	♦
Gabapentin	♦	♦	♦	♦
Lamotrigine	♦	♦	♦	♦
Phenobarbital	♦	♦	♦	♦
Phenytoin	♦	♦	♦	♦
Valproate	♦	♦	♦	♦
Vigabatrin	♦	♦	♦	♦
Antidepressants				
Amitriptyline	♦	♦	♦	♦
Bupropion	♦	♦	♦	♦
Citalopram	♦	♦	♦	♦
Desipramine	♦	♦	♦	♦
Doxepin	♦	♦	♦	♦
Fluoxetine	♦	♦	♦	♦
Mirtazapine	♦	♦	♦	♦
Nefazodone	♦	♦	♦	♦
Nortriptyline	♦	♦	♦	♦
Paroxetine	♦	♦	♦	♦
Sertraline	♦	♦	♦	♦
Antifungals				
Amphotericin B	♦	♦	♦	♦
Caspofungin	♦	♦	♦	♦
Fluconazole	♦	♦	♦	♦
Flucytosine	♦	♦	♦	♦
Itraconazole	♦	♦	♦	♦
Ketoconazole	♦	♦	♦	♦
Miconazole	♦	♦	♦	♦
Terbinafine	♦	♦	♦	♦
Voriconazole	♦	♦	♦	♦
Antihistamines				
Astemizole	♦	♦	♦	♦
Cetirizine	♦	♦	♦	♦
Fexofenadine	♦	♦	♦	♦
Loratadine	♦	♦	♦	♦
Terfenadine	♦	♦	♦	♦
Antimigraines				
Ergotamine & Ergot derivatives	♦	♦	♦	♦
Sumatriptan	♦	♦	♦	♦

Key to abbreviations

APV	Ampranavir/Fosampranavir (Agenerase®, Telzir®, Lexiva®)	LPV	Lopinavir (Kaletra®)
IDV	Indinavir (Crixivan®)	NFV	Nelfinavir (Viracept®)
ATV	Atazanavir (Reyataz®)	RTV	Ritonavir (Norvir®)
		SQV	Saquinavir (Invirase®, Fortovase®)

	APV	ATV	IDV	LPV
Antineoplastics				
Cyclophosphamide	♦	♦	♦	♦
Doxorubicin	♦	♦	♦	♦
Paclitaxel	♦	♦	♦	♦
Vinblastine	♦	♦	♦	♦
Vincristine	♦	♦	♦	♦
Antiplatelet and Anticoagulant				
Clopidogrel	♦	♦	♦	♦
Warfarin	♦	♦	♦	♦
Antiprototozals				
Atovaquone	♦	♦	♦	♦
Chloroquine	♦	♦	♦	♦
Halofantrine	♦	♦	♦	♦
Lumefantrine	♦	♦	♦	♦
Mefloquine	♦	♦	♦	♦
Pentamidine	♦	♦	♦	♦
Proguanil	♦	♦	♦	♦
Pyrimethamine	♦	♦	♦	♦
Antipsychotics/Neuroleptics				
Chlorpromazine	♦	♦	♦	♦
Clozapine	♦	♦	♦	♦
Haloperidol	♦	♦	♦	♦
Olanzapine	♦	♦	♦	♦
Perphenazine	♦	♦	♦	♦
Pimozide	♦	♦	♦	♦
Risperidone	♦	♦	♦	♦
Thioridazine	♦	♦	♦	♦
Antiretrovirals				
<i>Fusion Inhibitor</i>				
Enfuvirtide (T20)	♦	♦	♦	♦
<i>NNRTIs</i>				
Delavirdine	♦	♦	♦	♦
Efavirenz	♦	♦	♦	♦
Nevirapine	♦	♦	♦	♦
<i>Nucleoside/Nucleotide Analogues</i>				
Abacavir	♦	♦	♦	♦
Didanosine (ddI)	♦	♦	♦	♦
Emtricitabine (FTC)	♦	♦	♦	♦
Lamivudine (3TC)	♦	♦	♦	♦
Stavudine (d4T)	♦	♦	♦	♦
Tenofovir	♦	♦	♦	♦
Zalcitabine (ddC)	♦	♦	♦	♦
Zidovudine (AZT/ZDV)	♦	♦	♦	♦
<i>Protease Inhibitors</i>				
Ampranavir	♦	♦	♦	♦
Atazanavir	♦	♦	♦	♦
Indinavir	♦	♦	♦	♦
Lopinavir	♦	♦	♦	♦
Nelfinavir	♦	♦	♦	♦
Ritonavir	♦	♦	♦	♦
Saquinavir	♦	♦	♦	♦
Tipranavir	♦	♦	♦	♦
Antivirals				
Aciclovir	♦	♦	♦	♦
Adefovir	♦	♦	♦	♦
Cidofovir	♦	♦	♦	♦
Famciclovir	♦	♦	♦	♦
Foscarnet	♦	♦	♦	♦
Ganciclovir	♦	♦	♦	♦
Ribavirin	♦	♦	♦	♦
Valaciclovir	♦	♦	♦	♦
Anxiolytics/Hypnotics/Sedatives				
Alprazolam	♦	♦	♦	♦
Chlordiazepoxide	♦	♦	♦	♦
Clorazepate	♦	♦	♦	♦
Diazepam	♦	♦	♦	♦
Estazolam	♦	♦	♦	♦
Flurazepam	♦	♦	♦	♦
Lorazepam	♦	♦	♦	♦
Midazolam	♦	♦	♦	♦
Oxazepam	♦	♦	♦	♦
Temazepam	♦	♦	♦	♦
Triazolam	♦	♦	♦	♦
Zolpidem	♦	♦	♦	♦
Beta Blockers				
Atenolol	♦	♦	♦	♦
Bisoprolol	♦	♦	♦	♦
Carvedilol	♦	♦	♦	♦
Metoprolol	♦	♦	♦	♦
Propranolol	♦	♦	♦	♦
Bronchodilator				
Theophylline	♦	♦	♦	♦

Key to symbols

♦	These drugs should not be coadministered
□	Potential interaction – may require close monitoring, alteration of drug dosage or timing of administration
♦	No clinically significant interaction
○	There are no clear data, actual or theoretical, to indicate whether an interaction will occur

	APV	ATV	IDV	LPV
Calcium Channel Antagonists				
Amlodipine	♦	♦	♦	♦
Diltiazem	♦	♦	♦	♦
Nicardipine	♦	♦	♦	♦
Nifedipine	♦	♦	♦	♦
Nisoldipine	♦	♦	♦	♦
Verapamil	♦	♦	♦	♦
Erectile Dysfunction Agents				
Apomorphine	♦	♦	♦	♦
Sildenafil	♦	♦	♦	♦
Tadalafil	♦	♦	♦	♦
Vardenafil	♦	♦	♦	♦
Gastrointestinal Agents				
Cimetidine	♦	♦	♦	♦
Cisapride	♦	♦	♦	♦
Domperidone	♦	♦	♦	♦
Dronabinol	♦	♦	♦	♦
Famotidine	♦	♦	♦	♦
Lansoprazole	♦	♦	♦	♦
Loperamide	♦	♦	♦	♦
Metoclopramide	♦	♦	♦	♦
Ornepazole	♦	♦	♦	♦
Ondansetron	♦	♦	♦	♦
Prochlorperazine	♦	♦	♦	♦
Ranitidine	♦	♦	♦	♦
General Anaesthetics				
Enflurane	♦	♦	♦	♦
Halothane	♦	♦	♦	♦
Ketamine	♦	♦	♦	♦
Herbals/Nutraceuticals				
Echinacea	♦	♦	♦	♦
Garlic	♦	♦	♦	♦
Grapefruit juice	♦	♦	♦	♦
Milk thistle	♦	♦	♦	♦
Seville orange juice	♦	♦	♦	♦
St John's Wort	♦	♦	♦	♦
Vitamin E	♦	♦	♦	♦
Illicit/Recreational				
Alcohol	♦	♦	♦	♦
Gamma-hydroxybutyrate	♦	♦	♦	♦
Marijuana	♦	♦	♦	♦
MDMA ("Ecstasy")	♦	♦	♦	♦
Methamphetamine	♦	♦	♦	♦
Immune Modulators				
Hydroxyurea	♦	♦	♦	♦
Interferon alpha	♦	♦	♦	♦
Interleukin 2	♦	♦	♦	♦
Peginterferon alfa-2a	♦	♦	♦	♦
Immunosuppressants				
Ciclosporin	♦	♦	♦	♦
Mycophenolate	♦	♦	♦	♦
Sirolimus	♦	♦	♦	♦
Tacrolimus	♦	♦	♦	♦
Lipid Lowering Agents				
Atorvastatin	♦	♦	♦	♦
Clofibrate	♦	♦	♦	♦
Fenofibrate	♦	♦	♦	♦
Fluvastatin	♦	♦	♦	♦
Gemfibrozil	♦	♦	♦	♦
Lovastatin	♦	♦	♦	♦
Pravastatin	♦	♦	♦	♦
Rosuvastatin	♦	♦	♦	♦
Simvastatin	♦	♦	♦	♦
Oral Anti-diabetics				
Glipizide	♦	♦	♦	♦
Metformin	♦	♦	♦	♦
Rosiglitazone	♦	♦	♦	♦
Tolbutamide	♦	♦	♦	♦
Steroids				
Dexamethasone	♦	♦	♦	♦
Ethinylestradiol	♦	♦	♦	♦
Megestrol acetate	♦	♦	♦	♦
Nandrolone	♦	♦	♦	♦
Prednisolone	♦	♦	♦	♦
Progesterone/Progestogen	♦	♦	♦	♦
Stanozolol	♦	♦	♦	♦
Testosterone	♦	♦	♦	♦

Charts revised February 2005

Full information available at www.hiv-druginteractions.org
Where advice differs between countries, and/or between boosted and unboosted regimens, the charts reflect the more cautious option.

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Protease Inhibitor Drug Interactions (2)

	NFV	RTV	SQV
Analgesics			
Alfentanil	□	□	□
Aspirin	♦	♦	♦
Buprenorphine	♦	♦	♦
Dextropropoxyphene	♦	♦	♦
Diamorphine	♦	♦	♦
Fentanyl	♦	♦	♦
Ibuprofen	♦	♦	♦
Methadone	♦	♦	♦
Morphine	♦	♦	♦
Paracetamol	♦	♦	♦
Pethidine (Meperidine)	♦	♦	♦
Piroxicam	♦	♦	♦
Tramadol	♦	♦	♦
Antiarrhythmics			
Amiodarone	♦	♦	♦
Bepiridil	♦	♦	♦
Disopyramide	♦	♦	♦
Flecainide	♦	♦	♦
Lidocaine (Lignocaine)	♦	♦	♦
Mexiletine	♦	♦	♦
Propafenone	♦	♦	♦
Quinidine	♦	♦	♦
Antibacterials			
Azithromycin	♦	♦	♦
Ciprofloxacin	♦	♦	♦
Clarithromycin	♦	♦	♦
Clindamycin	♦	♦	♦
Dapsone	♦	♦	♦
Erythromycin	♦	♦	♦
Ethambutol	♦	♦	♦
Isoniazid	♦	♦	♦
Metronidazole	♦	♦	♦
Oxofloxacin	♦	♦	♦
Pyrazinamide	♦	♦	♦
Rifabutin	♦	♦	♦
Rifampicin	♦	♦	♦
Rifapentine	♦	♦	♦
Streptomycin	♦	♦	♦
Tetracyclines	♦	♦	♦
Trimethoprim/Sulfamethoxazole	♦	♦	♦
Anticonvulsants			
Carbamazepine	♦	♦	♦
Clonazepam	♦	♦	♦
Ethosuximide	♦	♦	♦
Gabapentin	♦	♦	♦
Lamotrigine	♦	♦	♦
Phenobarbital	♦	♦	♦
Phenytoin	♦	♦	♦
Valproate	♦	♦	♦
Vigabatrin	♦	♦	♦
Antidepressants			
Amitriptyline	♦	♦	♦
Bupropion	♦	♦	♦
Citalopram	♦	♦	♦
Desipramine	♦	♦	♦
Doxepin	♦	♦	♦
Fluoxetine	♦	♦	♦
Mirtazapine	♦	♦	♦
Nefazodone	♦	♦	♦
Nortriptyline	♦	♦	♦
Paroxetine	♦	♦	♦
Sertraline	♦	♦	♦
Antifungals			
Amphotericin B	♦	♦	♦
Caspofungin	♦	♦	♦
Fluconazole	♦	♦	♦
Flucytosine	♦	♦	♦
Itraconazole	♦	♦	♦
Ketoconazole	♦	♦	♦
Miconazole	♦	♦	♦
Terbinafine	♦	♦	♦
Voriconazole	♦	♦	♦
Antihistamines			
Astemizole	♦	♦	♦
Cetirizine	♦	♦	♦
Fexofenadine	♦	♦	♦
Loratadine	♦	♦	♦
Terfenadine	♦	♦	♦
Antimigraines			
Ergotamine & Ergot derivatives	♦	♦	♦
Sumatriptan	♦	♦	♦

Key to abbreviations

APV	Ampranavir/Fosamprenavir (Agenerase®, Telzir®, Lexiva®)	LPV	Lopinavir (Kaletra®)
IDV	Indinavir (Crixivan®)	NFV	Neftinavir (Viracept®)
ATV	Atazanavir (Reyataz®)	RTV	Ritonavir (Norvir®)
		SQV	Saquinavir (Invirase®, Fortovase®)

	NFV	RTV	SQV
Antineoplastics			
Cyclophosphamide	♦	♦	♦
Doxorubicin	♦	♦	♦
Paclitaxel	♦	♦	♦
Vinblastine	♦	♦	♦
Vincristine	♦	♦	♦
Anti-platelet and Anti-coagulant			
Clopidogrel	♦	♦	♦
Warfarin	♦	♦	♦
Antiprototozals			
Atovaquone	♦	♦	♦
Chloroquine	♦	♦	♦
Halofantrine	♦	♦	♦
Lumefantrine	♦	♦	♦
Mefloquine	♦	♦	♦
Pentamidine	♦	♦	♦
Proguanil	♦	♦	♦
Pyrimethamine	♦	♦	♦
Antipsychotics/Neuroleptics			
Chlorpromazine	♦	♦	♦
Clozapine	♦	♦	♦
Haloperidol	♦	♦	♦
Olanzapine	♦	♦	♦
Perphenazine	♦	♦	♦
Pimozide	♦	♦	♦
Risperidone	♦	♦	♦
Thioridazine	♦	♦	♦
Antiretrovirals			
<i>Fusion Inhibitors</i>			
Enfuvirtide (T20)	♦	♦	♦
<i>NNRTIs</i>			
Delavirdine	♦	♦	♦
Efavirenz	♦	♦	♦
Nevirapine	♦	♦	♦
<i>Nucleoside/Nucleotide Analogues</i>			
Abacavir	♦	♦	♦
Didanosine (ddI)	♦	♦	♦
Emtricitabine	♦	♦	♦
Lamivudine (3TC)	♦	♦	♦
Stavudine (d4T)	♦	♦	♦
Tenofovir	♦	♦	♦
Zalcitabine (ddC)	♦	♦	♦
Zidovudine (AZT/ZDV)	♦	♦	♦
<i>Protease Inhibitors</i>			
Ampranavir	♦	♦	♦
Atazanavir	♦	♦	♦
Indinavir	♦	♦	♦
Lopinavir	♦	♦	♦
Nelfinavir	♦	♦	♦
Ritonavir	♦	♦	♦
Saquinavir	♦	♦	♦
Tipranavir	♦	♦	♦
Antivirals			
Aciclovir	♦	♦	♦
Adefovir	♦	♦	♦
Cidofovir	♦	♦	♦
Famciclovir	♦	♦	♦
Foscarnet	♦	♦	♦
Ganciclovir	♦	♦	♦
Ribavirin	♦	♦	♦
Valaciclovir	♦	♦	♦
Anxiolytics/Hypnotics/Sedatives			
Alprazolam	♦	♦	♦
Chlordiazepoxide	♦	♦	♦
Clorazepate	♦	♦	♦
Diazepam	♦	♦	♦
Estazolam	♦	♦	♦
Flurazepam	♦	♦	♦
Lorazepam	♦	♦	♦
Midazolam	♦	♦	♦
Oxazepam	♦	♦	♦
Temazepam	♦	♦	♦
Triazolam	♦	♦	♦
Zolpidem	♦	♦	♦
Beta Blockers			
Atenolol	♦	♦	♦
Bisoprolol	♦	♦	♦
Carvedilol	♦	♦	♦
Metoprolol	♦	♦	♦
Propranolol	♦	♦	♦
Bronchodilators			
Theophylline	♦	♦	♦

Key to symbols

♦	These drugs should not be coadministered
□	Potential interaction – may require close monitoring, alteration of drug dosage or timing of administration
♦	No clinically significant interaction
○	There are no clear data, actual or theoretical, to indicate whether an interaction will occur

	NFV	RTV	SQV
Calcium Channel Antagonists			
Amlodipine	♦	♦	♦
Diltiazem	♦	♦	♦
Nicardipine	♦	♦	♦
Nifedipine	♦	♦	♦
Nisoldipine	♦	♦	♦
Verapamil	♦	♦	♦
Erectile Dysfunction Agents			
Apomorphine	♦	♦	♦
Sildenafil	♦	♦	♦
Tadalafil	♦	♦	♦
Vardenafil	♦	♦	♦
Gastrointestinal Agents			
Cimetidine	♦	♦	♦
Cisapride	♦	♦	♦
Domperidone	♦	♦	♦
Dronabinol	♦	♦	♦
Famotidine	♦	♦	♦
Lansoprazole	♦	♦	♦
Loperamide	♦	♦	♦
Metoclopramide	♦	♦	♦
Omeprazole	♦	♦	♦
Ondansetron	♦	♦	♦
Prochlorperazine	♦	♦	♦
Ranitidine	♦	♦	♦
General Anaesthetics			
Enflurane	♦	♦	♦
Halothane	♦	♦	♦
Ketamine	♦	♦	♦
Herbals/Nutraceuticals			
Echinacea	♦	♦	♦
Garlic	♦	♦	♦
Grapefruit juice	♦	♦	♦
Milk thistle	♦	♦	♦
Seville orange juice	♦	♦	♦
St John's Wort	♦	♦	♦
Vitamin E	♦	♦	♦
Illicit/Recreational			
Alcohol	♦	♦	♦
Gamma-hydroxybutyrate	♦	♦	♦
Marijuana	♦	♦	♦
MDMA ("Ecstasy")	♦	♦	♦
Methamphetamine	♦	♦	♦
Immune Modulators			
Hydroxyurea	♦	♦	♦
Interferon alpha	♦	♦	♦
Interleukin 2	♦	♦	♦
Peginterferon alfa-2a	♦	♦	♦
Immunosuppressants			
Ciclosporin	♦	♦	♦
Mycophenolate	♦	♦	♦
Sirolimus	♦	♦	♦
Tacrolimus	♦	♦	♦
Lipid Lowering Agents			
Atorvastatin	♦	♦	♦
Clofibrate	♦	♦	♦
Fenofibrate	♦	♦	♦
Fluvastatin	♦	♦	♦
Gemfibrozil	♦	♦	♦
Lovastatin	♦	♦	♦
Pravastatin	♦	♦	♦
Rosuvastatin	♦	♦	♦
Simvastatin	♦	♦	♦
Oral Anti-diabetics			
Glipizide	♦	♦	♦
Metformin	♦	♦	♦
Rosiglitazone	♦	♦	♦
Tolbutamide	♦	♦	♦
Steroids			
Dexamethasone	♦	♦	♦
Ethinylestradiol	♦	♦	♦
Megestrol acetate	♦	♦	♦
Nandrolone	♦	♦	♦
Prednisolone	♦	♦	♦
Progesterone/Progestogen	♦	♦	♦
Stanozolol	♦	♦	♦
Testosterone	♦	♦	♦

Charts revised February 2005

Full information available at www.hiv-druginteractions.org
Where advice differs between countries, and/or between boosted and unboosted regimens, the charts reflect the more cautious option.

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NNRTI Drug Interactions

	DLV	EFV	NVP
Analgesics			
Alfentanil	□	□	□
Aspirin	◆	◆	◆
Buprenorphine	□	□	□
Dextropropoxyphene	□	□	□
Diamorphine	◆	◆	◆
Fentanyl	◆	◆	◆
Ibuprofen	◆	◆	◆
Methadone	◆	◆	◆
Morphine	◆	◆	◆
Paracetamol	◆	◆	◆
Pethidine (Meperidine)	◆	◆	◆
Piroxicam	◆	◆	◆
Tramadol	□	□	◆
Antiarrhythmics			
Amiodarone	□	□	□
Bepiridil	□	●	□
Disopyramide	□	□	□
Flecainide	□	□	□
Lidocaine (Lignocaine)	□	□	□
Mexiletine	□	□	□
Propafenone	□	□	□
Quinidine	□	□	□
Antibacterials			
Azithromycin	◆	◆	◆
Ciprofloxacin	◆	◆	◆
Clarithromycin	□	□	□
Clindamycin	◆	◆	◆
Dapsone	□	◆	◆
Erythromycin	◆	◆	◆
Ethambutol	◆	◆	◆
Isoniazid	◆	◆	◆
Metronidazole	◆	◆	◆
Ofloxacin	◆	◆	◆
Pyrazinamide	□	□	□
Rifabutin	◆	◆	◆
Rifampicin	●	□	□
Rifapentine	◆	◆	◆
Streptomycin	◆	◆	◆
Tetracyclines	◆	◆	◆
Trimethoprim/Sulfamethoxazole	◆	◆	◆
Anticonvulsants			
Carbamazepine	□	□	□
Clonazepam	□	□	□
Ethosuximide	□	□	□
Gabapentin	◆	◆	◆
Lamotrigine	□	□	□
Phenobarbital	□	□	□
Phenytoin	◆	◆	◆
Valproate	◆	◆	◆
Vigabatrin	◆	◆	◆
Antidepressants			
Amisulpride	◆	◆	◆
Bupropion	□	□	□
Citalopram	□	□	□
Desipramine	◆	◆	◆
Doxepin	□	◆	◆
Fluoxetine	□	◆	◆
Mirtazapine	□	□	□
Nefazodone	□	□	□
Nortriptyline	◆	◆	◆
Paroxetine	◆	◆	◆
Sertraline	□	□	□
Antifungals			
Amphotericin B	◆	◆	◆
Caspofungin	◆	◆	◆
Fluconazole	◆	◆	◆
Flucytosine	◆	◆	◆
Itraconazole	□	□	□
Ketoconazole	◆	◆	◆
Miconazole	◆	◆	◆
Terbinafine	◆	◆	◆
Voriconazole	□	●	□
Antihistamines			
Astemizole	●	●	□
Cetirizine	◆	◆	◆
Fexofenadine	◆	◆	◆
Loratadine	□	□	□
Terfenadine	●	●	□
Antimigraines			
Ergotamine & Ergot derivatives	●	●	□
Sumatriptan	◆	◆	◆

Key to abbreviations

DLV	Delavirdine (Rescriptor®)
EFV	Efavirenz (Sustiva®/Stocrin®)
NVP	Nevirapine (Viramune®)

	DLV	EFV	NVP
Antineoplastics			
Cyclophosphamide	□	□	□
Doxorubicin	◆	◆	◆
Paclitaxel	□	□	□
Vinblastine	□	□	□
Vincristine	□	□	□
Anti-platelet and Anti-coagulant			
Clopidogrel	◆	◆	◆
Warfarin	□	□	□
Antiprototozals			
Atovaquone	◆	◆	◆
Chloroquine	◆	◆	◆
Halofantrine	●	◆	◆
Lumefantrine	◆	◆	◆
Mefloquine	◆	◆	◆
Pentamidine	◆	◆	◆
Proguanil	◆	◆	◆
Pyrimethamine	◆	◆	◆
Antipsychotics/Neuroleptics			
Chlorpromazine	□	◆	◆
Clozapine	◆	◆	◆
Haloperidol	◆	◆	◆
Olanzapine	□	◆	◆
Perphenazine	◆	◆	◆
Pimozide	◆	●	◆
Risperidone	◆	◆	◆
Thioridazine	◆	◆	◆
Antiretrovirals			
<i>Fusion Inhibitors</i>			
Enfuvirtide	◆	◆	◆
<i>NNRTIs</i>			
Delavirdine	◆	□	□
Efavirenz	□	◆	◆
Nevirapine	□	◆	◆
<i>Nucleoside/Nucleotide Analogues</i>			
Abacavir	◆	◆	◆
Didanosine (ddI)	◆	◆	◆
Emtricitabine	◆	◆	◆
Lamivudine (3TC)	◆	◆	◆
Stavudine (d4T)	◆	◆	◆
Tenofovir	◆	◆	◆
Zalcitabine (ddC)	◆	◆	◆
Zidovudine (AZT/ZDV)	◆	◆	◆
<i>Protease Inhibitors</i>			
Amprenavir	□	□	□
Atazanavir	□	□	□
Indinavir	□	□	□
Lopinavir	□	□	□
Nelfinavir	□	□	□
Ritonavir	□	□	◆
Saquinavir	□	□	□
Tipranavir	□	□	□
Antivirals			
Aciclovir	◆	◆	◆
Adefovir	□	◆	◆
Cidofovir	◆	◆	◆
Famciclovir	◆	◆	◆
Foscarnet	◆	◆	◆
Ganciclovir	◆	◆	◆
Ribavirin	◆	◆	◆
Valaciclovir	◆	◆	◆
Anxiolytics/Hypnotics/Sedatives			
Alprazolam	●	□	□
Chlordiazepoxide	◆	◆	◆
Clorazepate	□	□	□
Diazepam	□	□	□
Estazolam	□	□	□
Flurazepam	◆	◆	◆
Lorazepam	◆	◆	◆
Midazolam	●	●	□
Oxazepam	◆	◆	◆
Temazepam	◆	◆	◆
Triazolam	●	●	□
Zolpidem	□	□	□
Beta Blockers			
Atenolol	◆	◆	◆
Bisoprolol	◆	◆	◆
Carvedilol	◆	◆	◆
Metoprolol	◆	◆	◆
Propranolol	◆	◆	◆
Bronchodilators			
Theophylline	◆	◆	◆

Key to symbols

●	These drugs should not be coadministered
□	Potential interaction – may require close monitoring, alteration of drug dosage or timing of administration
◆	No clinically significant interaction

	DLV	EFV	NVP
Calcium Channel Antagonists			
Amlodipine	□	□	□
Diltiazem	□	□	□
Nicardipine	□	□	□
Nifedipine	□	□	□
Nisoldipine	□	□	□
Verapamil	□	□	□
Erectile Dysfunction Agents			
Apomorphine	□	□	□
Sildenafil	□	□	□
Tadalafil	□	□	□
Vardenafil	□	□	□
Gastrointestinal Agents			
Cimetidine	□	□	◆
Cisapride	●	●	◆
Domperidone	◆	◆	◆
Dronabinol	□	□	◆
Famotidine	□	◆	◆
Lansoprazole	◆	◆	◆
Loperamide	◆	◆	◆
Metoclopramide	◆	◆	◆
Omeprazole	◆	◆	◆
Ondansetron	◆	◆	◆
Prochlorperazine	◆	◆	◆
Ranitidine	□	◆	◆
General Anaesthetics			
Enflurane	◆	◆	◆
Halothane	□	□	□
Ketamine	◆	◆	◆
Herbals/Nutraceuticals			
Echinacea	□	□	□
Garlic	◆	◆	◆
Grapefruit juice	◆	◆	◆
Milk thistle	◆	◆	◆
Seville orange juice	◆	◆	◆
St John's Wort	●	●	●
Vitamin E	◆	◆	◆
Illicit/Recreational			
Alcohol	◆	◆	◆
Gamma-hydroxybutyrate	◆	◆	◆
Marijuana	◆	◆	◆
MDMA ("Ecstasy")	□	◆	◆
Methamphetamine	□	◆	◆
Immune Modulators			
Hydroxyurea	◆	◆	◆
Interferon alpha	◆	◆	◆
Interleukin 2	◆	◆	◆
Peginterferon alfa-2a	◆	◆	◆
Immunosuppressants			
Ciclosporin	◆	□	□
Mycophenolate	◆	□	□
Sirolimus	□	□	□
Tacrolimus	□	□	□
Lipid Lowering Agents			
Atorvastatin	□	□	□
Clofibrate	◆	◆	◆
Fenofibrate	◆	◆	◆
Fluvastatin	◆	◆	◆
Gemfibrozil	◆	◆	◆
Lovastatin	◆	◆	◆
Pravastatin	◆	◆	◆
Rosuvastatin	◆	◆	◆
Simvastatin	◆	◆	◆
Oral Anti-diabetics			
Glipizide	□	□	□
Metformin	◆	◆	◆
Rosiglitazone	□	□	□
Tolbutamide	□	□	□
Steroids			
Dexamethasone	□	□	□
Ethinylestradiol	◆	◆	◆
Megestrol acetate	◆	◆	◆
Nandrolone	◆	◆	◆
Prednisolone	◆	◆	◆
Progesterone/Progestogen	□	□	□
Stanozolol	□	□	□
Testosterone	□	□	□

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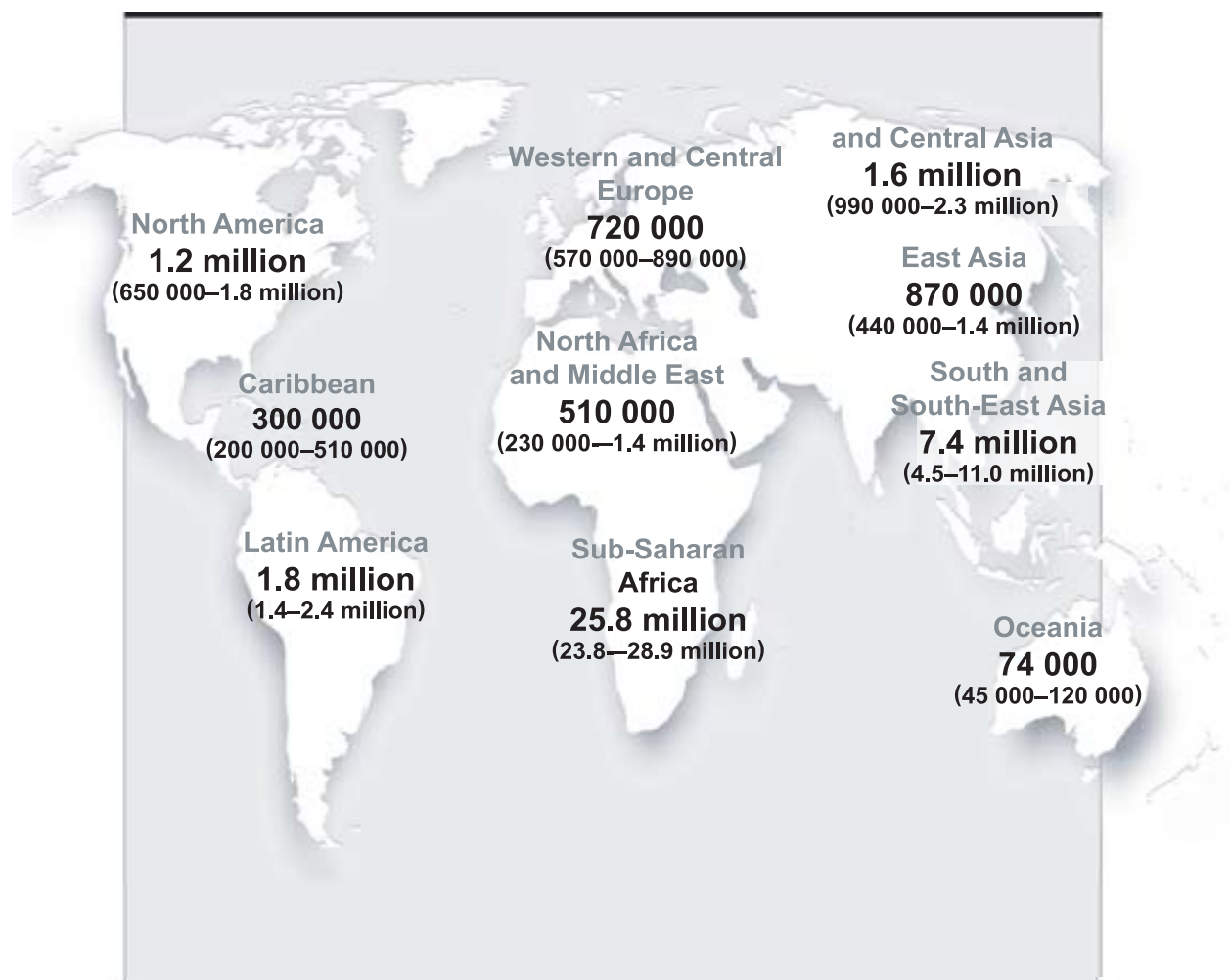
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ATIC News

Send your queries to queries@atic.idi.co.ug or call 031- 307271/307245/307258

ADULTS AND CHILDREN ESTIMATED TO BE LIVING WITH HIV IN 2005



Total: 40.3 (36.7–45.3) million