



information series for hiv-positive people

hiv drug resistance



acknowledgments

**This edition edited by
Michael Carter**

Produced by NAM

Sixth edition 2006

NAM is a charity that publishes information for people affected by HIV and those working with them. We believe information helps people to make decisions about, and be in control of, their lives, health and treatment options.

Awards:

The 2001 edition of this booklet was highly commended in the BMA Medical Book Awards 2002.

Thanks for the assistance of:

David Cornforth
Mortimer Market Centre, London

Professor Janet Darbyshire
Medical Research Council Clinical Trials Unit, London

Professor Frances Gotch
Department of Immunology,
Chelsea and Westminster
Hospital, London

Dr Margaret Johnson
Royal Free Hospital, London

Dr Deenan Pillay
Antiviral Susceptibility Reference
Unit, Birmingham

Professor Jonathan Weber
Imperial College of Science,
Technology and Medicine, London

Dr Mike Youle
Royal Free Hospital, London

Funders:

NAM is grateful to the funders of this booklet series:

Department of Health, NHS
South West London HIV & GUM
Commissioning Consortium and
the Derek Butler Trust.

hiv drug resistance

If you're HIV-positive and you're taking, or thinking about starting treatment for HIV, you'll need to know about drug resistance. Resistance is an important reason why anti-HIV drugs can stop working. By learning about resistance and what can reduce the risk of it developing, you will increase your chances of getting the most out of your HIV treatment.

This booklet has been written to help you decide what questions to ask your doctor about any course of treatment you might be considering. We don't intend for it to replace discussion with your doctor about your treatment.



contents

What is resistance?

1

Reducing the risk of resistance

3

- Suppress viral load
- Take care when changing to new drugs
- Switch early
- Take your HIV treatment as prescribed

Cross-resistance

9

Infection with drug resistant HIV

10

Resistance tests

12

- Using and interpreting resistance tests
- Which test to use

Summary

16

Glossary

17

1 What is resistance?

HIV reproduces itself very quickly, making billions of new viruses every day. Because the virus often makes mistakes when copying itself, each new generation differs slightly to the one before. These tiny structural differences are called mutations.

Some mutations occur in the parts of HIV which are targeted by anti-HIV drugs. This can result in strains of HIV that have reduced sensitivity to the drugs. These HIV strains are called drug-resistant.

Drug-resistant HIV strains vary – some may be highly resistant to anti-HIV drugs while others may be less so. When an anti-HIV drug is started, HIV that is fully

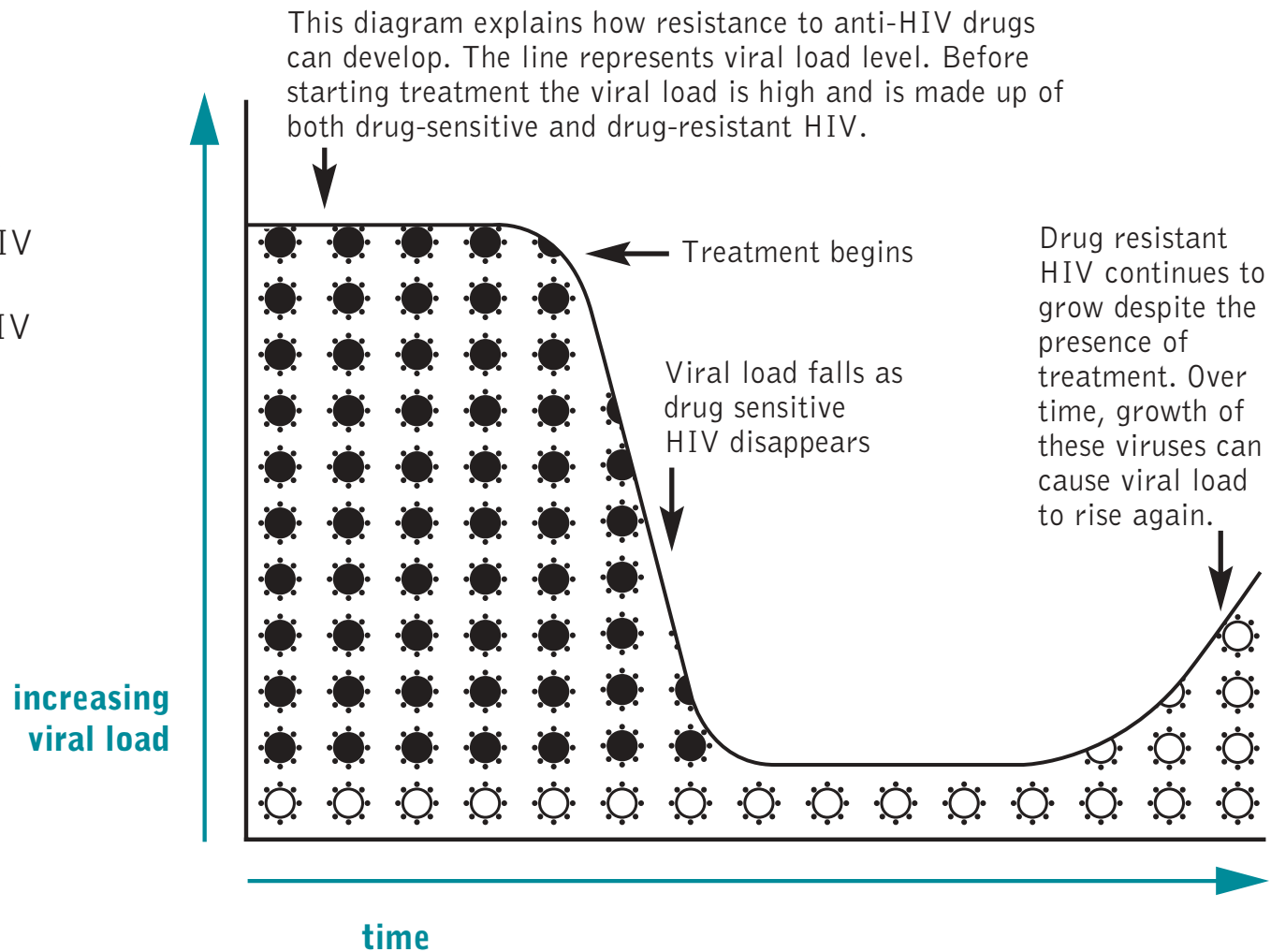
susceptible to that drug disappears rapidly, leaving behind drug resistant viruses. These viruses continue to reproduce themselves despite the drug's presence. Diagram 1 on page 2 shows how this works.

Resistance is an important reason why anti-HIV treatment can fail. Viral load, which should drop when you start a new drug combination, may rebound if a population of drug resistant HIV is able to emerge.

Diagram 1: How resistance develops

Key to symbols

- ☉ drug-resistant HIV
- drug-sensitive HIV



3 Reducing the risk of resistance

Suppress viral load

Resistance can emerge whenever HIV continues to reproduce whilst anti-HIV drugs are being taken. HIV can develop resistance to all available anti-HIV drugs, but if they are taken together in a combination, resistance can be delayed, hopefully for an indefinite period. This is because together, the drugs are able to exert a much more powerful effect on HIV, and because it's much more difficult for an HIV population to emerge which is resistant to all of the drugs in your combination, rather than to only one drug.

People whose viral load falls and remains below 50 copies when they start

treatment, are at a lower risk of developing resistance than people whose viral load does not fall that low. The current standard is for anti-HIV treatment to involve three drugs. You may receive four or more, for instance if you have taken several anti-HIV drugs already.

The lowest point to which viral load falls after starting treatment, often called the nadir, predicts the likelihood that viral load will rebound in the future whilst you continue with your treatment. The lower the nadir, the lower the risk of rebound, and therefore the lower the risk of developing resistance.

Take care when changing to new drugs

Adding a single new drug to a combination which is not keeping viral load fully suppressed can allow resistance to that drug to emerge rapidly, because the impact of that one drug is unlikely to be enough to stop HIV reproducing. This means that if you are switching from treatment which is not suppressing your viral load, you should replace as many drugs as possible in your combination - ideally all of them - to give the best chance that your new combination will work.

The replacement drugs should be chosen with help from a test to detect whether your HIV is resistant to particular drugs. There is more about this issue in the later section called 'Resistance tests'.

If you are switching drugs because of side-effects, and your viral load is suppressed, this does not present the same risk of resistance emerging. In this situation, your doctor may change just a single drug.

Switch early

The speed at which resistance to different anti-HIV drugs develops varies. HIV needs only one mutation to become fully

resistant to 3TC (lamivudine, *Epivir*), to efavirenz (*Sustiva*) and to nevirapine (*Viramune*). This simple change – just a single mutation – can happen easily even at quite low levels of viral load rebound.

Full resistance to the other drugs may require a particular pattern of several mutations to emerge. This will take a little longer and will happen only if these drugs are taken while there is ongoing HIV reproduction. In other words, this will be more of a risk if you continue to take the drugs while your viral load is rebounding. The higher your viral load rebounds, the greater the risk that a drug resistant pattern of mutations will develop.

For this reason, a rising viral load should signal the need to consider changing to a new combination (so long as you have options to switch to).

Take your HIV treatment as prescribed

It's very important to take anti-HIV drugs exactly as your doctor prescribed them. This means taking every dose on time, and following any guidance about the kind of foods you can or should eat with your dose. Sticking to these instructions is often called adherence.

Missing or delaying doses, or not taking a dose in the right way, will lower the

amount of the drug which is active in your body. This reduces your drug combination's attack on HIV. Virus which was suppressed will then begin to reproduce, increasing the risk of resistant viruses emerging. Diagram 2 on page 7 shows how this works.

Missing even a few doses a month may be enough to cause your treatment to fail, which is why it's vital that you're well prepared to start a new combination, and that you continue to be supported whilst you take it. There are many sources of support available – your treatment centre, a local AIDS organisation, friends and family, other people with HIV.

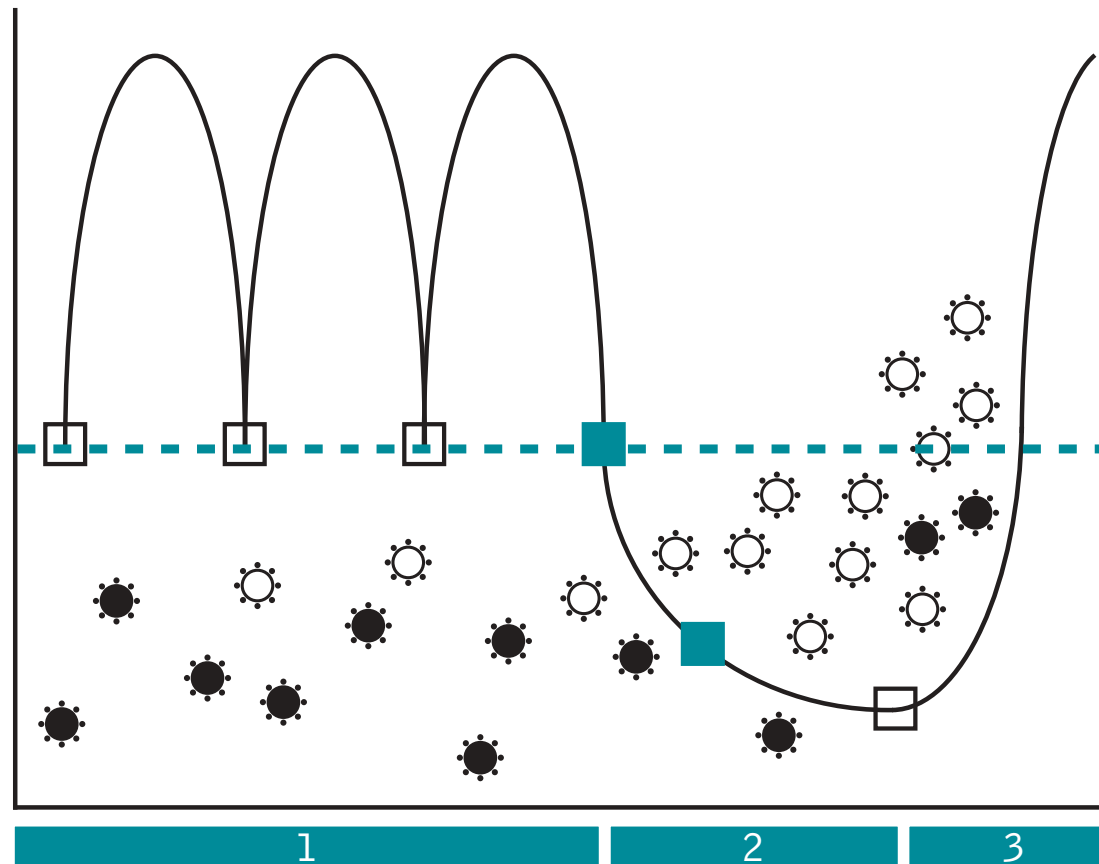
Choosing a combination which suits the way you live, developing a pill-taking routine, and finding ways to avoid missing doses will all be important. But over time, there may be many other issues which might help or hinder your adherence. If you have any concerns, or if you feel your treatment isn't right for you, speak to someone at your treatment centre. Don't stop your treatment abruptly without seeking advice first – for some combinations this can allow resistant HIV to emerge.

For information see the booklet *Adherence* in this series.

7 Diagram 2: The effect of missed doses

Key to symbols

- missed dose
- normal dose
- drug level in system
- - - drug level below which HIV can replicate
- ☉ drug-resistant HIV
- drug-sensitive HIV



Before treatment begins, the HIV viral population is a mix of mostly drug-sensitive viruses plus a range of drug-resistant viruses.

1

These peaks and troughs show how drug levels in the body rise and fall as doses are taken, the drug's anti-HIV effect is maximised and HIV reproduction is minimised.

2

Missed doses allow drug levels to fall. HIV reproduction speeds up again and viral load rises as both drug-sensitive and drug resistant HIV grows.

3

With the next dose taken, the drug's anti-HIV effect is restored. Drug-resistant HIV may have gained a foothold, however, and may continue to cause a rise in viral load. One missed dose is unlikely to cause your treatment to fail, but the more doses missed, the greater the risk.

9 Cross-resistance

Single mutations or patterns of mutations in HIV can produce resistance to several different anti-HIV drugs. This means that once resistance to one drug has emerged, this HIV may also be resistant to drugs you haven't taken yet. This is called cross-resistance.

Cross-resistance may affect all currently available anti-HIV drugs to a greater or lesser extent. So resistance to one nucleoside analogue will affect your choice of other nucleoside analogues, resistance to a non-nucleoside analogue (NNRTI) drug will affect your choice of other NNRTIs, and resistance to a protease inhibitor will affect your choice of other protease inhibitors. Resistance to a

fusion inhibitor seems likely to have implications for your chance of fusion inhibitors in the future.

New classes of anti-HIV drugs are in development, but these too may well be affected by cross-resistance

Infection with drug resistant HIV

With the widespread use of anti-HIV drugs in many parts of the world, and the accompanying problem of drug resistance, it's become more common for people who contract HIV to be infected with a drug resistant strain. This can happen either through sexual transmission, through contact with infected blood (e.g. through injecting drugs), or from an HIV-positive mother to her baby.

Becoming infected with a drug resistant strain may seriously limit your treatment options in the same way as developing resistance while taking treatments, narrowing down the range of drugs which you might benefit from.

In the UK, the transmission of drug resistant HIV is on the increase. This is also the case in other parts of Europe and in North America. With time, and the greater use of multiple classes of HIV drugs, the transmission of HIV which is multi-drug resistant (resistant to a number of drugs and therefore more difficult to treat), is becoming more common.

It is becoming clear that somebody who is already HIV-positive can be re-infected with a drug resistant strain. This is called superinfection. It is not known how common this is, but so far it appears to be rare, and only a few cases from around the world have been recorded. If you would

like to discuss any concerns you may have about this, such as how it might affect your sexual behaviour, a health adviser at your HIV treatment centre or another member of your healthcare team should be able to help.

Blood tests which detect whether the HIV in your body is resistant to anti-HIV drugs are available. These tests are a relatively recent addition to HIV care. In the coming years, we can expect to learn more about the best way to use them, and for technology to improve to make them a more accurate measurement tool.

At the moment, it's recommended that drug resistance tests are used when a person is first diagnosed with HIV. It is also recommended that everybody who is about to start anti-HIV treatment for the first time should have a resistance test. You should also have a resistance test whenever you change your treatment.

Resistance tests are also recommended to help guide the choice of treatment in women who are pregnant, and in children.

Using and interpreting resistance tests

Resistance tests are a complex new development in HIV care. Results should be interpreted by someone who is experienced in their use, who is likely to be at the centre which performs the analysis of your blood sample sent for resistance testing, and not at your HIV treatment centre. Test results should be considered alongside a full treatment history, rather than in isolation. This is because drug

resistance is not the only reason why HIV treatment can fail – missed doses, poor absorption and drug interactions are other possible causes to consider.

Resistance tests may be unreliable if your viral load is below 1,000 copies. You may need special advice about the results of a drug resistance test if you are infected with a type of HIV called non-B subtype. These subtypes are found more commonly in most parts of the world, particularly outside Europe and North America.

Most HIV-positive people in the UK who contracted HIV in Africa will be carrying a non-B subtype of HIV, as well as an increasing proportion of those who have contracted HIV through heterosexual sex.

Resistance tests will also be more accurate if done while you are still taking a failing combination rather than after you've stopped it. This is because when you stop your current drugs, drug resistant HIV will be no more likely to reproduce than drug sensitive HIV – and usually less likely. Resistant viruses that once were the most common will be outgrown by sensitive viruses until they form one of many sub-groups of HIV within the body. Resistance tests are unable to detect sub-groups which make up less than 10-20% of the total HIV in your body. Starting a drug which a sub-group of your HIV is resistant to will allow that group to grow back again, causing your treatment to fail.

Which tests to use

There are two main methods of testing for HIV drug resistance:

- Genotypic tests which look for specific mutations in HIV's genes that are known to be linked with resistance to anti-HIV drugs.
- Phenotypic tests which measure the concentration of a drug required to reduce viral replication by a set amount. When resistance to a drug begins to develop, higher levels of that drug will be required to stop HIV growing.

There is no clear indication that one type of test is more useful than another at the moment – each has its pros and cons. Genotypic tests are cheaper and deliver results sooner. Changes in phenotype result from changes in genotype, so genotypic testing may produce the earliest clues about emerging resistance.

Phenotypic testing provides a quantitative guide to a drug's effects on the HIV in your body. However, these tests are more expensive and take longer to produce results.

The Virtual Phenotype™ is an interpretation system which may be used more often to analyse genotypic resistance test results in future.

It provides a 'phenotypic' result based on the matching of resistant HIV strains within a large database of genotypic and phenotypic information.

Summary

- Resistance is an important reason why anti-HIV drugs stop working.
- HIV which is resistant to one drug may also be resistant to other drugs which you haven't taken yet.
- The chance of developing resistance will be reduced if your viral load while on treatment is undetectable, and you take every dose of the drugs prescribed to you at the correct time and in the correct way.
- The more you miss doses, the more likely it will be that your drug combination will fail.
- Some people contract HIV which is drug-resistant when they become infected.
- Resistance tests can be used to help choose replacement drugs if your anti-HIV drug combination is not controlling your viral load.

17 Glossary

adherence The act of taking a treatment exactly as prescribed.

antiretroviral A substance that acts against retroviruses such as HIV.

cross-resistance The mechanism by which HIV that has developed resistance to one drug may also be resistant to other similar drugs.

fusion inhibitors Anti-HIV drug targeting the point where HIV locks onto an immune cell.

gene A DNA sequence which determines the structure of a protein.

genotype The genetic make-up of an organism.

mutation A single change in gene sequence.

nadir Lowest point out of a series of measurements

NNRTI Non-nucleoside reverse transcriptase inhibitor; the family of antiretrovirals which includes efavirenz and nevirapine.

nucleoside analogue Family of antiretrovirals which includes AZT, ddI, 3TC, d4T, ddC and abacavir.

phenotype Trait or behaviour which results from a particular genotype.

protease inhibitor Family of antiretrovirals which includes amprenavir, indinavir, lopinavir, nelfinavir, ritonavir, and saquinavir.

resistance A drug resistant HIV strain is one which is less susceptible to the effects of one or more anti-HIV drugs because of its genotype.

resistance test Blood test which detects resistance to anti-HIV drugs.

superinfection Reinfection with a virus, possibly with a different strain, subtype, or a strain which is resistant to treatments.

strain A variant characterised by a specific genotype.

viral load Measurement of the amount of virus in a sample. HIV viral load indicates the extent to which HIV is reproducing in the body.

Notes

Notes

Notes

Notes

Notes



www.aidsmap.com

keep yourself up to date

get more from nam

AIDS Treatment Update

NAM's free monthly newsletter. It is written to keep you up to date about the latest news and developments about HIV, help you talk to your doctor, and make decisions about your health and treatment.



HIV Weekly

NAM's new weekly email digest of the latest HIV news. Sign up today for straightforward news reporting and easy to read summaries of the latest HIV research.

To order either of these publications, please use the form on the reverse

Order form

Please set up my free subscription to the following publications

AIDS Treatment Update - NAM's monthly newsletter

Please tick which format you require Paper Email (PDF) Audio Tape

HIV Weekly - NAM's weekly HIV news digest by email

name

address

postcode

email

signature

- Please do not send me information about NAM's full range of publications on HIV and AIDS
- Please tick this box if you would **not** like to receive information about NAM's fundraising campaigns.

NAM is unable to provide free subscriptions to professionals or organisations - please contact us for prices

Please complete this form and send to NAM, FREEPOST LON17995 London, SW9 6BR

HIV & AIDS Helplines

The Sexual Healthline

from the Department of Health

telephone 0800 567123

opening hours daily, 24 hours

Terrence Higgins Trust Helpline

telephone 0845 1221 200

opening hours Monday-Friday, 10am-10pm
Saturday & Sunday, 12noon-6pm

HIV i-Base Treatment Phonenumber

telephone 0808 800 6013

opening hours Monday-Wednesday, 12pm-4pm

The booklet series includes: ■ adherence ■ anti-hiv drugs ■ clinical trials ■ glossary
■ hiv & children ■ hiv & hepatitis ■ hiv & sex ■ hiv & tb ■ hiv & women ■ hiv therapy
■ lipodystrophy ■ hiv & mental health ■ nutrition ■ resistance ■ viral load & CD4

More from NAM

NAM Information Forums

Monthly, free meetings offering an opportunity to hear the latest news, views and research around HIV treatments. Held in the evening at a central London location. Call NAM for details.

NAM information series for HIV-positive people

This booklet is part of an easy-to-read series available free from NAM to people personally affected by HIV. Call NAM for your copies.



contact details

NAM

Lincoln House
1 Brixton Road
London
SW9 6DE
UK

tel +44 (0) 20 7840 0050

fax +44 (0) 20 7735 5351

email info@nam.org.uk

website www.aidsmap.com

Sixth Edition 2006

© NAM

All rights reserved

design Alexander Boxill

photography Photodisc

print Lithosphere

This booklet can be viewed in large print as a pdf file using Acrobat Reader.

Call NAM on +44 (0) 20 7840 0050.

www.aidsmap.com

Visit NAM's website for

- an introduction to HIV and AIDS
- online access to other booklets in this series
- NAM Factsheets - one page plain language guides to over 90 HIV-related topics
- contact details for over 3200 AIDS service organisations in the UK and worldwide
- a searchable database of HIV treatments information
- a complete list of HIV treatment centres in the UK