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# hiv drug resistance

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## acknowledgements

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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.

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# 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?

- **Diagram One** How resistance develops

1

## Reducing the risk of resistance

- **Suppress viral load**
- **Take your HIV treatment as prescribed**
- **Take care when changing to new drugs**
- **Diagram Two** The effect of missed doses
- **Switch early**

3

## Cross-resistance

9

# contents

<b>Infection with drug resistant HIV</b>	<b>10</b>
<b>Resistance tests</b>	<b>12</b>
■ <b>Using and interpreting resistance tests</b> ■ <b>Which tests to use</b>	
<b>Summary</b>	<b>14</b>
<b>Glossary</b>	<b>15</b>

# 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 from the one before. These tiny 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 are less easily controlled by the drugs. These HIV strains are called drug-resistant.

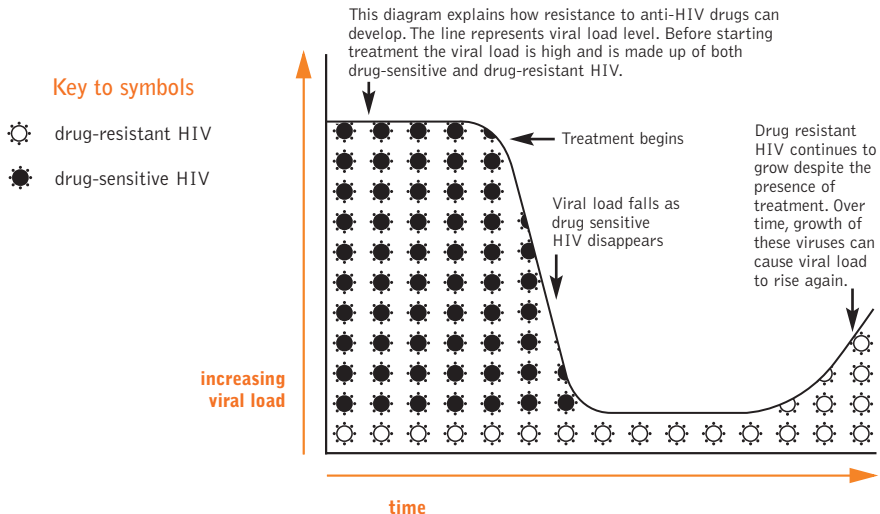
Drug resistant HIV strains vary - some may be highly resistant to anti-HIV drugs while others may be less so. When an anti-HIV drug is started, HIV that is

fully susceptible to that drug disappears rapidly, leaving behind drug resistant viruses. These viruses continue to reproduce themselves despite the drug's presence. The *How resistance develops* diagram on page two 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 drug resistant HIV is able to emerge.

# How resistance develops

2



## 3 Reducing the risk of resistance

### Suppress viral load

Resistance can emerge if 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 prevented. This is because together, the drugs have a much more powerful effect on HIV, and because it's much more difficult for HIV to emerge which is resistant to all of the drugs in your combination, rather than to only one drug.

If your viral load falls below 50 copies (an undetectable viral load) when you start treatment, and remains below 50 copies, you will have a much lower risk of

developing resistance than people whose viral load does not fall that low. Getting viral load below 50 copies/ml is the aim of all anti-HIV treatment. The current standard is for anti-HIV treatment with 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 controlling 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. *The effect of missed doses* diagram on page seven 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, and other people with HIV.

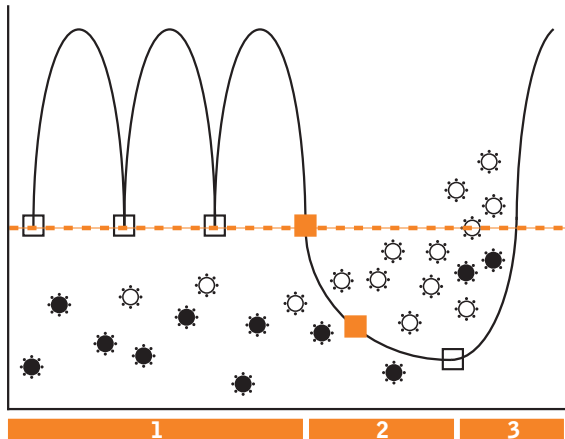
Choosing a combination which suits the way you live, developing a pill-taking routine, and finding ways to avoid missing doses will all be important. But over time, there may be many other issues which might help or hinder your adherence. If you have any concerns, or if you feel your treatment isn't 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 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 (NRTI) will affect your choice of other NRTIs, 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 fusion, entry and integrase inhibitors may have implications for your choice of drugs from these classes in the future.

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

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, about 10% of people newly infected with HIV have drug resistant virus. 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 not just in the UK, but also in Europe and north America.

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 30 or so

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. You can also read more about superinfection in the NAM booklet in this series, *HIV and Sex*.

Blood tests are available which detect whether the HIV in your body is resistant to anti-HIV drugs. 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 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

Results should be interpreted by someone who is experienced in their use. 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 are now of value if your viral load is above 200 copies - it used to be the case that you had to wait until your viral load was 1000 copies or more before they could produce accurate results.

Resistance tests will also be more accurate if done while you are still taking a failing combination rather than after you've stopped it.

### 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.

- 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. A small number of people have been superinfected with resistant virus.
- Resistance tests can be used to help choose replacement drugs if your anti-HIV drug combination is not controlling your viral load.

**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.

**entry inhibitors** Anti-HIV drugs that target HIV's entry into immune cells. So far one entry inhibitor (maraviroc) has been approved.

**fusion inhibitors** Anti-HIV drug targeting the point where HIV locks onto an immune cell. So far, one fusion inhibitor (T-20) has been approved.

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

**genotype** The genetic make-up of an organism.

**integrase inhibitors** Anti-HIV drugs that target HIV's integration into immune cells. So far one integrase inhibitor (raltegravir) has been approved.

**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, FTC and abacavir. Tenofovir belongs to a very similar class of drugs and is a nucleotide analogue.

**phenotype** Trait or behaviour which results from a particular genotype.

**protease inhibitor** Family of antiretrovirals which includes atazanavir, darunavir, fosamprenavir, indinavir, lopinavir, nelfinavir, ritonavir, saquinavir and tipranavir.

**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

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