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Medical Genetic Testing: Health information for you and your family

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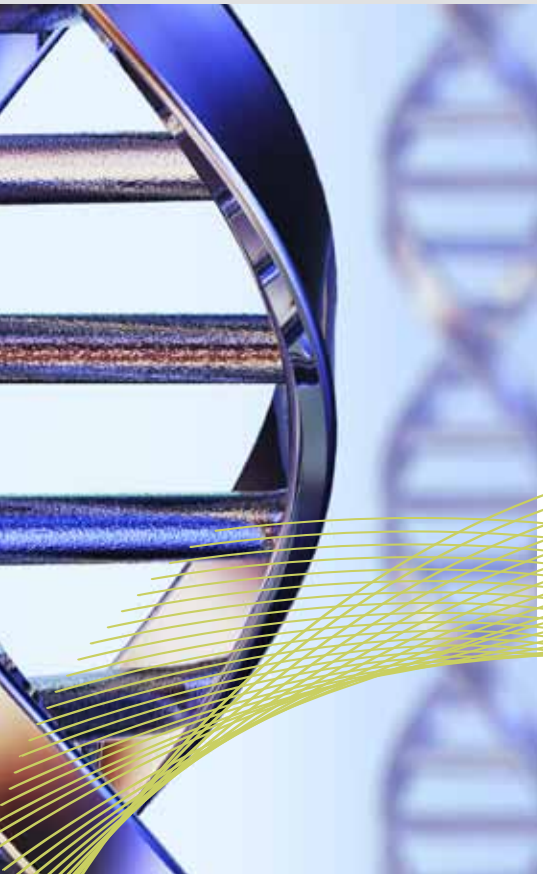

Part 1 – The Basics

DNA, genes and chromosomes

The human body is made up of millions of cells. Most cells in your body carry a complete set of DNA or deoxyribonucleic acid. DNA provides your cells with the information or codes needed to make your body work and grow. DNA is also responsible for determining many of your characteristics, such as your hair and eye colour.

DNA is arranged into structures known as chromosomes. Every human cell contains 46 chromosomes, arranged in 23 pairs, with one member of each pair inherited from each parent. Of these 23 pairs, 22 pairs are 'autosomal chromosomes', which have the same structure in both men and women. The final pair is composed of the X and Y chromosomes, which are known as the 'sex chromosomes'. Males have one X and one Y chromosome, whereas females have two X chromosomes. Genes are sections of DNA that are carried on chromosomes.

DNA, you and your family

Because you inherit your DNA from your parents, the genetic information your DNA contains may also be shared by other family members. This is why families often share similar physical characteristics. Despite sharing DNA with your family, you are still unique—even identical twins develop some differences in their DNA during pregnancy, making each unique when they are born.

Genetic variations, mutations and health

Within your DNA there are many small differences or variations in the code. Most of these variations don't affect the way your body works. In fact, it is these variations that make you unique.

Unlike DNA variations that are present in the egg or sperm cells (known as 'germ' cells), variations that occur in body (or 'somatic') cells, affect only the cells of that tissue, e.g. a breast or skin cell. Somatic variations cannot be passed from parent to child.

Everyone has mutations; mutations are variations in your DNA that are not part of the standard variation that occurs normally in people. Some of these mutations can affect your health by:

- directly causing a genetic condition
- leading to a change in your risk of developing certain health conditions, and/or
- affecting how you react to outside factors, such as medicines.

DNA variations also build up in our cells as we age and may affect the usual way that cells grow. These variations are copied when cells replicate and may cause cells to grow out of control and form a tumour (cancer). However, it is important to remember that not all mutations are bad. In some cases, a mutation can help protect against certain conditions.

As genes come in pairs, you can have one copy that is faulty while the other copy is working as it should. In such cases, you may or may not have or develop a condition. It depends on whether one working copy of the gene is enough to keep your body working as it should. Even though you may not have a condition, you can still be a 'carrier' of the faulty gene and may pass it onto your children. If you are a carrier, your children may be at risk of the condition you carry, particularly if there is a chance that they can inherit two copies of the same faulty gene (one from each parent.)

Where one faulty gene directly causes, or indirectly affects susceptibility to a health condition, and that gene is passed from parent to child there is a family history of the condition. That is, it is said to 'run in the family'.

Part 2 – Genetic Testing

Genetic testing and health information

Medical genetic tests look for variations in your DNA sequence, since these variations provide important information about your health. This information can be about your current or future health, the health of your child, or that of your developing baby during pregnancy. Because of this, genetic testing results can help you make important decisions about your lifestyle and family planning.

For example, finding out that you have inherited a mutation that puts you at increased risk of certain cancers can help you manage your health. It can allow you to access options such as screening or early treatment to prevent the development of cancer. However, for some genetic conditions, such as Huntington Disease, there currently is no prevention or cure. Genetic testing results can therefore return mixed news, and it is important to consider this when making your decision about whether to get tested.

Deciding whether to get tested

As we share our DNA with our genetic relatives, your genetic testing results can have implications for other family members. Therefore, doctors who refer you for genetic testing must take into account not only the technical and scientific aspects of a test, but also the wider implications that it can have on your family. To make an informed decision about taking a genetic test, your doctor can help you in a number of ways, including:

i) Determining the right test for you

After talking to you about your health and family history, asking about your symptoms, and perhaps drawing a family tree (sometimes called a pedigree), your doctor might suggest that you consider having a specific kind of genetic test. Types of genetic tests available include:

- diagnostic tests – used to confirm a diagnosis if you have symptoms of a condition
- genetic carrier tests – used to show whether you are a carrier of the variation causing a genetic condition
- predictive tests – used if you have a family history of a genetic condition to show whether you have inherited the faulty gene that directly causes, or puts you at increased risk for the condition, before signs or symptoms appear
- prenatal tests – used if you are pregnant to find out whether your unborn child will be affected by, or develop a particular condition
- pharmacogenetic tests – used to help determine the type or dose of a medicine that is best for the treatment of certain conditions.

ii) Providing information, advice and support

It is important to have all the information you need before you decide whether to undertake a genetic test. Your doctor may advise you to also see a genetic counsellor, or refer you to a clinical geneticist or genetic service. Professional advice can help you and your family to think about the medical, emotional and ethical factors that could affect your decision.

Things to consider in making a decision to be tested:

i) What is known about the condition for which testing will be done?

Factors include:

- how the condition could affect your health, lifestyle and family
- whether the condition can be prevented or whether any treatments are available, and what they are
- current understandings about whether the condition is inherited and how this occurs
- the availability of information and contact details of support groups or organisations that can give you more information about the condition and support for it.

ii) What does the test involve?

Factors include:

- how many appointments will be needed
- details of the costs involved (if any)
- details about the testing process (including the kind of sample that is needed, e.g. a cheek swab or saliva sample, and how it will be taken)
- how long it will take to get the results.

iii) What are the benefits and risks of genetic testing?

Possible benefits can include:

- reducing or putting an end to uncertainty about your future and/or your child's future if you are at risk of a genetic condition
- helping you to make informed choices about your future (e.g. to get treatment; to plan having children; to make lifestyle choices to lower your chance of getting the condition, or to have regular screening tests to detect early signs of the condition), and/or
- confirming that a faulty gene is not present (and that you don't have a certain condition) providing you with relief, and your doctor with more information to help uncover the cause of any ill-health.

Possible risks can include:

- raising anxiety, especially while you are waiting for results
- receiving results that may cause distress, particularly if they are not clear-cut, or if they show that you have or will get a condition that currently can't be treated
- causing tension and complications within family relationships if testing in families is not carefully managed (e.g. family members that find they have the faulty gene may feel overwhelmed, angry or resentful, while others who do not may feel guilt)
- receiving results that may involve and/or reveal information about close genetic relatives, including unwanted information (e.g. about paternity, maternity, adoption or children conceived with donated eggs or sperm), and/or
- implications for life insurance

Outcomes of the genetic testing process

What happens to your DNA sample and results?

Once your sample has been taken, the DNA it contains is removed and analysed in a specialist laboratory. When testing is complete, the test results are sent to your doctor.

Some laboratories keep your DNA for a period of time, so that the result can be checked if necessary.

What do the results mean?

When considering your genetic test result, it is important to remember that genetic test results have a few features that make them different from other health tests:

1. *They're not just about you* — your genetic test results may also reveal information about your relatives. If you have inherited a faulty gene, there is a chance you will pass it on to your children. It may also be present in other relatives (e.g. brothers, sisters and cousins).

2. *They don't always tell the whole story* — some genetic test results, such as a test for Huntington Disease, can be very precise and identify with great accuracy that an individual has or will develop a genetic disorder. However, your environment and lifestyle can also impact on your health. So, with some DNA genetic tests, there are still limitations on our current understanding of how a test result might affect your risk of developing a particular condition.

3. *They are not always concrete* – many test results can only indicate the likelihood of risk, such as with breast cancer (*BRCA1* and *BRCA2* gene tests). Where a gene variation results in an increased risk of developing a condition, the condition will only develop if another 'environmental' factor is present as a trigger. Though a test result may tell you that you are more likely than average to develop the condition associated with that faulty gene sometime in your life (referred to as a 'positive' result), it doesn't always tell you that you will definitely get it, nor when, or how severe it will be. Furthermore, a 'negative' result may not guarantee that you won't develop the condition.

Your doctor can help you to understand your results and what they mean for you and your family.

Access to your results

In some ways, your genetic test results are like those of any other test. Your doctor discusses them with you and your confidentiality is assured. But because DNA is shared within families, your doctor may ask you to talk to your genetic relatives about your results if the results indicate that your genetic relatives may also have inherited the faulty gene. Similarly, while your non-genetic relatives (e.g. spouses, partners or those related by marriage) are not at personal increased risk of the condition, it may be appropriate to discuss your result with them, particularly if your present or future children could inherit the condition or the increased risk.

You can speak to your family yourself, or ask your doctor or genetic counsellor to tell your family on your behalf. In some cases, it may not be necessary for you to be identified if you don't want to be. If your genetic relatives know they may be at increased risk, they can choose for themselves whether to be tested, just as you did.

Disclosure of information to genetic relatives without your consent

The *Privacy Act 1988* (Commonwealth) applies to health professionals in the private sector. Similar legislation exists in the States and Territories that apply to those working in the public sector. These laws prohibit health professionals from disclosing personal information without your consent.

Changes to the Commonwealth Privacy Act made in 2006 affect the disclosure of relevant genetic information by private health professionals. This only applies in cases where your genetic test result indicates that there

is a serious risk to genetic relative/s, and you do not inform them or consent to them being informed of that risk. Under these rare circumstances, a private health professional may disclose this information to your genetic relative/s. However, this can occur only in cases where such disclosure is considered necessary to lessen or prevent a serious threat to the life, health or safety of your genetic relative/s.

Doctors working in the public health system were not affected by this change and are currently not able to disclose any information to your genetic relatives without your consent. This issue is under review by State and Territory governments.

Implications for insurance

Life insurance is based on an assessment of the risk that you will make a claim because of the onset of an illness or death. Life insurance is described as risk-rated insurance. The assessment is based on information that you have about your family and personal history of illnesses. The assessment also considers aspects of your lifestyle that may have an impact on your future health, such as whether you smoke. This information becomes part of the overall assessment of your application, but is not passed on to anyone else.

By law, insurers are able to discriminate on the basis of the information provided, as long as their assessment is reasonable. That is, discrimination is lawful as long as it is based on appropriate statistical (e.g. scientific) data. This means that some people will have to pay more than usual for their policy or even be unable to obtain cover for life insurance products.

In Australia, when you apply for life insurance, you are currently not required to have a genetic test. But if you have had a test and know the results, you are required to tell the insurance company, just as you need to tell them all the other relevant information.

Unlike life insurance, health insurance in Australia is based on community rating. Health insurance does not involve individual risk rating, therefore disallowing any legal discrimination of an individual by health insurers.

Do all genetic tests need to be ordered through a doctor?

A growing number of genetic tests are available direct to the public, often over the internet. Known as direct-to-consumer (DTC) genetic tests, these usually involve scraping a few cells from inside the cheek and mailing the sample to the company. The company's laboratory analyses the sample and sends the results directly back to you.

DTC tests are relatively simple and can allow you an opportunity to take a greater interest and responsibility in your own health. The test might also appeal to your curiosity to discover what makes you unique. However, it is important to know that there are potential problems and risks associated with any genetic testing, as already mentioned. One key issue is that the usefulness of a test result depends on correct laboratory processes being followed and on accurate interpretation by a health professional. However, health professional involvement can be limited in the DTC process. Regulation of DTC testing laboratories, which are often located offshore, is difficult and interpretation of results can also be complex. Special training is required to be able to analyse genetic test results and to understand how they apply to you and your situation.

Doctors, clinical geneticists and genetic counsellors have an important role in giving you support and information before, during and after genetic testing. If you are considering having a DTC genetic test, it's a good idea to discuss this with your doctor or a genetic counsellor first.

More information on the DTC process, including risks and benefits, is also available in *Direct-to-Consumer (DTC) DNA Genetic Testing: An information resource for consumers*, which is available on the NHMRC website.

What about testing in children?

There are many different things to think about with any sort of genetic testing in children, especially when the child is too young to understand their results and you are making decisions on their behalf.

We don't know enough about the impact on children of knowing that their lives may be seriously affected by a genetic condition sometime in the future. For this reason, the Human Genetics Society of Australasia recommends that parents consider having their children tested only when the result is likely to directly benefit the child's health during childhood – relieving uncertainty or anxiety within the family is not considered a valid reason.

Where can I find more information and support?

The diagnosis of a genetic condition can place a lot of pressure on a family. Support is available for families and individuals who are affected by genetic conditions.

Ask your doctor, genetic counsellor, clinical geneticist, or clinical genetic service for more information or visit the Australasian Genetic Alliance website at **http://www.australasiangeneticalliance.org.au/member_groups** for more details on available support services.

Remember…

- It is important that you fully understand the benefits and risks before you consent to testing. If you want to know more, keep asking questions. Don't rush the decision.
- Your doctor or genetic counsellor can help you think things through and give you the information you need to make an informed decision.
- If you think it will help, talk about it with your family, particularly those who may also be affected by the results.
- If you're still not sure, discuss alternatives, such as postponing the test, or get a second opinion.
- Testing is voluntary. You can pull out from the testing process at any stage. Even after the testing has been done, you can decide not to find out your results.
- People have many different reasons for being tested, and the decision is easier to make in some situations than in others. Ultimately, having a genetic test is your decision to make.

How was this information developed?

This resource is a consumer summary of Medical Genetic Testing: Information for Health Professionals 2010, which is available online at our website: **www.nhmrc.gov.au**

NHMRC developed this consumer information in consultation with its Human Genetics Advisory Committee 2010–12. The document was recommended to the CEO for publication by the Council of NHMRC in 2011.

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