

Deep Brain Stimulation

WHAT IS DEEP BRAIN STIMULATION?

Deep Brain Stimulation (DBS) is a treatment, not a cure, for Parkinson's. It is a therapy that treats a number of the symptoms of Parkinson's.

DBS uses mild electrical pulses to stimulate a precisely targeted area of the brain. It is thought this therapy works by 'stunning' the target area which blocks the abnormal nerve signals being transmitted by areas in the brain that are not functioning properly. As a result of the symptoms being better controlled by the DBS, the person usually has a reduction in the medication they need to take. The average reduction in medication of people who have had DBS is 30% to 40%.

In New Zealand DBS is only carried out on a small number (less than 20) of highly selected patients each year. This is because there are only certain patients in whom it will work satisfactorily. The majority of these people have Parkinson's although DBS is also used to treat some other conditions.

One of the advantages of DBS is that it does not cause permanent damage to healthy brain tissue by destroying nerve cells. So if a newer more promising treatment or a cure is developed in the future, the DBS procedure can be reversed.

WHAT SYMPTOMS ARE TREATED BY DBS?

The main symptoms that are treated by DBS are

- Dyskinesia – involuntary or abnormal movements, from writhing and spasms to jerks and twitches, which can affect any part of the body and vary in their severity.
- Motor fluctuations – slowness and stiffness and /or weakness. This may also include 'on-off syndrome', the abrupt and unpredictable changes in mobility that occur in some people with Parkinson's. In the 'on' state they are able to move and in the 'off' state may be virtually immobile.
- Tremor – shaking movements of the hands and sometimes the legs, neck, face, or jaw that occurs in people with Parkinson's.

WHEN IS DBS CONSIDERED?

When a person first goes on Levodopa (Sinemet or Madopar) treatment they have a 'honeymoon' period where the effect of the medication is good and there is little need to change the dosage or when the medication is taken. This period may last somewhere between three to seven years.

Then the person may begin to have problems with dyskinesia and/or motor fluctuations. It may be that the dose of Levodopa they are taking doesn't seem to last as long or it isn't as effective at controlling the symptoms of Parkinson's. The person's doctor or neurologist may adjust the timings or dosage of the medication, or change the drugs the person is on. They may try putting the person on Apomorphine which is administered under the skin by a pump and may give better control of Parkinson's symptoms than Levodopa alone. Once all the other available

options have been exhausted DBS can be considered if the person is likely to meet the criteria for this treatment.

WHAT ARE THE CRITERIA?

There are only certain people for whom DBS will work well. In order to assess a person's suitability the following factors are taken into account.

- Levodopa responsive – if a person does not respond well to Levodopa and it has little effect on their condition then they will not respond well to DBS.
- General health – the person must be fit enough to undergo the operation and healthy enough that there is a reasonable expectation they will not die within the next five years of some other medical condition.
- Emotionally stable – the part of the brain that is stimulated is closely connected to the area of the brain that controls emotions. Because of this people with unstable or untreatable emotional conditions may not be suitable to receive DBS.
- Cognitive decline – one of the symptoms of Parkinson's is cognitive decline. This can range from being very mild to people having dementia which is quite limiting. It is known from overseas research that people with advanced cognitive decline don't respond well to DBS.
- Age – there is evidence that the elderly don't do so well with DBS surgery and the risk of complications are higher. While there is an age limit of 70 years for the surgery, people who are 'young for their age' at 70 may still be considered.
- Have had Parkinson's for five years or more – there are a number of conditions that in the early stages look like Parkinson's but aren't. To ensure that the person being treated definitely has Parkinson's they usually need to have been diagnosed at least five years ago, however this criteria is not rigid.

WHAT IS THE ASSESSMENT PROCESS?

Usually a neurologist will refer a person to the Movement Disorders Clinic, Neurology Department, at Auckland City Hospital (the Centre for DBS in New Zealand) if they think they are a candidate for DBS. The Neurologist in charge of DBS will ask for supporting information and often request the candidate provide a home video showing them at their best on medication, and at their worst both with bad dyskinesia and in an 'off' state. This information is reviewed by the Neurologist and the Movement Disorder Nurse who decide if the person is a likely candidate and arrange for them to come to Auckland for an assessment.

During the two day assessment the candidate will

- Meet with one of the Auckland Hospital's Movement Disorders Clinic Neurologists to discuss the procedure, its risks and the benefits of having DBS.

- Meet with the Movement Disorder Nurse who also discusses the procedure with them and the arrangements that will need to be made prior to the operation if they are accepted.
- Undergo a Levodopa Challenge Test – during this test the person comes completely off their medication so that their condition can be assessed. They then go back on their medication so the effect of the Levodopa can be seen. Usually a video is taken of the person performing tasks while on and off their medication so the difference can be seen by others. If the Levodopa appears to have little or no effect on the person's condition then DBS will also have little effect on their condition.
- Meet with a psychologist and psychiatrist for assessment. There is no pass or fail in this part of the test, it is an assessment of the person's current situation. It may be that as a result of this assessment it is decided that the person should undergo some treatment prior to undergoing DBS to ensure they are in the best psychological and psychiatric state for the procedure.

WHO DECIDES IF YOU ARE ELIGIBLE FOR DBS?

There is a National Deep Brain Stimulation Committee who decides if a person is suitable for the surgery. The Auckland Hospital DBS group meet on a monthly basis and review the assessments of the people who have been put forward to undergo the surgery and decide if this is the right treatment for the person. Once accepted, while there is no waiting list for the operation, it will usually be three to six months until the procedure is carried out.

WHAT DOES THE SURGERY INVOLVE?

The surgery is done in two stages, usually with around six weeks between operations. After the first stage of the surgery the person can often experience a transient improvement where their condition will be much improved. This is because when the wire is put into the brain a small amount of damage is done which causes the target area of the brain to swell. This swelling turns off the overactive nerve cells in the same way the electrical stimulation will once the patient's DBS is switched on. The swelling only lasts for two to four weeks, so stage two of the surgery is not done until after the improvement caused by the swelling has gone away as the person needs to be back to their pre-surgery state.

Stage One

The person is admitted to hospital the day before surgery. They get an opportunity to see the High Dependency Unit where they will be after the surgery. They meet with the neurologist who once again goes through the procedure with them and discusses the risks involved in the surgery. A final medical check is carried out to ensure the person is in good health to undergo the operation.

On the day of the surgery the person is off their Parkinson's medication. They need to be off their medication to ensure that when the probes are tested during surgery the medical team



THE DBS TEAM IN AUCKLAND. LEFT TO RIGHT: MR ARNOLD BOK, DR GREG FINUCANE, DR DAVID MCAULEY, DR BARRY SNOW, DR MARK SIMPSON. BACK ROW: LORRAINE MACDONALD, DR JAMIE MACNIVEN

can see the effect this is having to ensure the probes are in the right place.

The person then has their head shaved and the metal frame is fitted. This has to be bolted to the person's head so local anaesthetic is given to relieve any pain associated with this. Once the frame is fitted the person is taken for the CT scan that will help determine the location for the probes to be inserted.

The frame on the person's head is then clamped to the operating table so their head remains still. For the majority of the surgery, the patient needs to be awake. A light sedative is given to them before the surgery.

The surgical team are behind the person so can't be seen. The Movement Disorder Nurse sits with the person to reassure them and offer them sips of water. They can't see what is happening but they can hear the surgeons and the brain electrical activity as it is being recorded over speakers.

When the probe is put in to the Sub Thalamic Nucleus it makes a characteristic noise. There is no pain associated with the insertion of the probe.

A stimulation current is run down the wire to ensure the probe is placed in the optimum location. With this completed the wire is held in place with a plastic clip and tucked under the scalp.

The entire procedure is repeated on the other side of the brain and then everything is closed up.

After a couple of nights in hospital to ensure everything is healing well, the person is able to return home.

Stage Two

The second stage of the operation is done under a general anaesthetic. In this surgery the Implanted Pulse Generator (IPG), which is similar to a heart pacemaker and generates the electrical stimulation to the brain, is placed under the skin on the chest. The wires that are attached to the probes and sit under the scalp are connected to a wire which runs behind the ear, down the neck and is connected to the IPG.

The day after surgery programming of the IPG begins. This programming usually takes around five days but can take up to two weeks. The person can leave hospital once the wounds

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have started to heal and just come in each day to have the programming done. Once the programming is completed and the person's medication has been adjusted they can go home.

Follow up

The first follow up appointment is six weeks after surgery where there may be further programming if needed. Another check is made a further six weeks later. After that the check ups occur every six months, with a big review done a year after the surgery. During this check the person temporarily comes off their medication to ensure the DBS is working correctly.

HOW DO THEY WORK OUT WHERE TO PUT THE PROBES?

Usually the DBS probes are inserted into Sub Thalamic Nucleus. This is a small structure about the size of an almond located at the bottom of the brain. There is another target for DBS that is used less often which is the Globus Pallidus interna. This is targeted where the person has a risk of increased psychiatric problems as a result of the surgery.

In the days or weeks prior to the surgery an MRI of the person's head is done. An MRI shows the internal structure of the brain in great detail, but it isn't a reliable form of measurement. On the day of surgery, and with the frame used during surgery bolted to the person's head, a CT scan is taken. This is very accurate for measurements, but does not show the detail of the MRI scan. These two images are overlaid on a computer and accurate measurements in three planes are recorded in relation to the frame to ensure the exact spot is targeted when the probe is inserted.

HOW IS THE IMPLANTED PULSE GENERATOR POWERED?

The IPG is a completely sealed unit with batteries inside it. These batteries last around five or six years. Although rechargeable units are available, in general people with Parkinson's are implanted with non-rechargeable units and the IPG is replaced when the batteries are running out. The benefit of this is that they receive the latest IPG technology every time it is changed.

WHY DO YOU HAVE TO BE AWAKE FOR THE OPERATION?

The person being operated on needs to be awake during the surgery as the probe is stimulated to see what effect it is having and to ensure it is in the optimum place. If for some reason the probe has missed the target the DBS won't work. It may also stimulate an area that should not be stimulated, so by having

the person awake, the Neurologist can run tests to confirm the probe is in the right place. The person can also let the Neurologist and Neurosurgeon know of any other changes they might be experiencing that may be the result of a haemorrhage, one of the risks of DBS.

HOW LONG DOES DBS LAST FOR?

The original group of people who received DBS surgery are still getting good results after 10 or even 15 years. However, once Parkinson's starts, it doesn't stop progressing, and DBS does not change this or influence the rate of progression. In the long term, even with reprogramming of the DBS, a person's dosage of medication may have to be increased to help control their symptoms of Parkinson's.

WHAT ARE THE RISKS OF DBS?

As with any surgery there are risks involved, including death, stroke or heart attack. Infections, should they occur, can be difficult to treat as the wires to the probes can allow infection to get into the brain. In some people, DBS surgery can induce apathy, anxiety or depression. Some of this can be reversible, but not always. Through careful selection of who will receive the operation, many of the risks can be minimised. The risk of a serious complications, e.g. stroke or death is about 1% - 2%.

The Parkinsonian would like to thank Dr David McAuley and Lorraine Macdonald for their assistance with this factsheet.

