



Government of Western Australia  
Department of Health

# Clinical Guidelines for Adult Cochlear Implantation

Neurosciences and Senses

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## Table of Contents

<b>Acknowledgements</b> .....	<b>5</b>
<b>Summary</b> .....	<b>6</b>
<b>1. Clinical Guidelines for Adult Cochlear Implantation</b> .....	<b>7</b>
1.1 Introduction .....	7
1.2 Definitions .....	7
1.3 The Cochlear Implant Program Team.....	8
1.4 Facilities.....	9
1.5 The Cochlear Implant Device .....	10
1.6 Timing of Cochlear Implantation .....	10
1.7 Prior to referral.....	10
<b>2. Preoperative Assessment</b> .....	<b>10</b>
2.1 Otolaryngology .....	11
2.2 Audiological .....	11
2.3 Speech Pathology .....	12
2.4 Psychology .....	12
2.5 Reporting .....	13
2.6 Other Services and Agencies .....	13
2.7 Pre-operative Information and Counselling.....	13
<b>3. Patient Candidacy</b> .....	<b>14</b>
3.1 Considerations for cochlear implantation.....	14
3.1.1 Duration of hearing loss.....	14
3.1.2 Multiple handicaps.....	15
3.1.3 Complex or borderline cases.....	15
3.1.4 Bilateral implantation .....	15
<b>4. Surgery and In-patient Care</b> .....	<b>16</b>
<b>5. Post Operative (Incl. Education and Awareness)</b> .....	<b>16</b>
5.1 Otolaryngology .....	16
5.2 Audiology.....	16
5.2.1 Switch-on and Tuning of the Speech Processor.....	16
5.2.2 Post-operative Rehabilitation and Assessments .....	17
5.2.3 Follow-up and Long Term Maintenance .....	18
5.3 Other services .....	18
5.3.1 Speech Pathology .....	18
5.3.2 Psychology .....	19
5.4 Device Failure.....	19
5.5 Clinical Governance.....	19
5.6 Patient and Other Feedback and Complaints .....	19

<b>6. Other Considerations</b> .....	<b>20</b>
6.1 Evolving Technology and Candidacy Criteria .....	20
6.2 Other implantable devices .....	20
6.3 Paediatric Cochlear Implant Clinics .....	20
<b>7. References</b> .....	<b>21</b>
<b>7. References</b> .....	<b>21</b>

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## Summary

In an effort to provide optimal care to patients, and provide positive measurable outcomes, cochlear implantation requires a multi-disciplinary team approach. The team includes Audiologists, Speech Pathologists, Otolaryngologists, Psychologists, and Anaesthetists and may be expanded, depending on the specific needs of the client. Family and/or friends can also play a vital role. Determining candidacy for cochlear implantation requires thorough pre-operative assessment by a team of professionals. Pre-operative counselling is also of vital importance. Following implantation ongoing rehabilitation is required, with the most intensive period in the first twelve months following implantation.

The aim of this Guideline is to provide a template for a best practice adult cochlear implant clinic in Western Australia as per the current literature. The Guideline provides a service pathway from the point of identification through to postoperative rehabilitation. The roles of the various agencies involved in the cochlear implant pathway will be outlined as well as their respective inputs along the cochlear implant timeline. This guideline is intended for those health professionals involved in cochlear implant services as outlined above.

# 1. Clinical Guidelines for Adult Cochlear Implantation

## 1.1 Introduction

Cochlear implantation is a multidisciplinary therapy that involves as a key element the surgical implantation of an electrode array in to the cochlea to provide direct electrical stimulation of the auditory nerve. Cochlear implants (CI) are designed for individuals with hearing impairment to compensate for moderately-severe to profound sensorineural or mixed hearing losses, if there is limited or no benefit from hearing aids. CIs bypass the non-functioning part of the auditory system in order to deliver electrical signals directly to the auditory nerve. They can be used effectively by both prelingually and postlingually deafened children and adults. Studies have shown that cochlear implantation is a recognised safe and effective procedure<sup>1,2</sup>.

A cochlear implant consists of two parts, an external and an internal component. Internally, the implant consists of a receiver-stimulator, which contains the electronics, the receiving antenna and a magnet that holds the coil in place behind the ear, and the electrode array. Externally, the device consists of a sound processor that is generally worn behind the ear and consists of a microphone, which picks up sound, a processing unit which processes and converts sound into a radio frequency signal, and a transmitting coil through which the information is transmitted through the skin to the internal components of the implant. The sound processor also includes manual controls and batteries.

The patient group to whom this guideline applies is adults identified with bilateral, moderately-severe to profound hearing loss, of varying aetiology, who are no longer able to obtain adequate benefit from conventional hearing aids.

This clinical guideline provides a template for an adult cochlear implant program commencing from patient identification, extending through the assessment and management process and ending with cochlear implant rehabilitation. The guideline also provides public information and education strategies.

## 1.2 Definitions

**Sensorineural hearing loss:** a hearing loss related to abnormality in either the cochlea or auditory nerve.

**Mixed hearing loss:** a hearing loss which combines both a sensorineural hearing loss and a conductive hearing loss (i.e. a hearing loss that affects transmission of sound through the ear canal and/or middle ear)

**Congenital hearing loss:** hearing loss that develops in utero and presents at birth or in early childhood.

**Cochlear implant:** a biomechanical device that is placed within the cochlea and directly stimulates the auditory nerve providing electrically mediated neural hearing.

**Pre-lingual:** hearing impairment that is sustained prior to the acquisition of language, which can occur as a result of a congenital condition or through hearing loss in early infancy.

Post lingual: hearing impairment that is sustained after the acquisition of language, which can occur as a result of disease, trauma, progression of a hereditary or genetic hearing loss or syndrome, or as a side-effect of a medicine.

### **1.3 The Cochlear Implant Program Team**

An adult cochlear implant team is a multidisciplinary team made up of the following key personnel:

Otologists: these personnel must have a fellowship in Otolaryngology Head and Neck Surgery from the Royal Australasian College of Surgeons. They should also have specific training in cochlear implantation. The responsibility for cochlear implantation and all completed diagnostic procedures remain with the surgeon.

Audiologists: these personnel must be qualified to post-graduate level, hold an accredited Masters of Clinical Audiology or similar qualification. They will furthermore have extensive clinical experience within the field of cochlear implantation, together with knowledge and understanding of the multidisciplinary areas within the program. A minimum requirement of 1.4 FTE is recommended to ensure adequate leave coverage and to maintain implantation expertise.

Speech Pathologist: these personnel must be qualified to post-graduate level. This must be supplemented with two years practical experience and recognised hearing therapy qualification.

Implant Coordinator: is responsible for the day to day management of the program and will ensure that appropriate services are provided for each adult through the cochlear implant patient pathway. He/she will be a core team member and with further specialist training in cochlear implantation and clinical management of the profoundly deaf. The co-ordinator will have a high degree of clinical, organisational, leadership and professional skills. A minimum requirement of 1.0 FTE is recommended for this position to ensure ongoing clinical care for patients.

#### The Administrator / Secretary

The administrator will hold appropriate secretarial qualifications, have a high level of organisational, communication and information technology skills, and work closely with the Head of Service. A minimum requirement of 1.0 FTE is recommended for this position to ensure ongoing clinical care for patients.

#### Cochlear Implant Head of Service roles

The Head of Service, in addition to the above, is accountable for the delivery of the multidisciplinary service. He/she will provide scientific and clinical leadership and will have managerial responsibility for service design, forward planning, finance, patient management and human resources. Depending on the size of the service, the Head of Service and Implant Coordinator could be a combined role.

Cochlear implant team personnel should be members of the relevant cochlear implant professional groups, nationally and/or internationally.

Clinical team members should attend regular training in developments within the field of cochlear implantation. Attendance at relevant courses,

conferences and meetings at national and international levels is desirable. Regular attendance at national meetings should be available for all team members. All team members should have a plan for their continuing professional development.

All team members should be trained in 'deaf awareness' and practical aspects of communicating with deaf people, as part of their induction.

All professionals must be suitably qualified, registered with their professional body, and comply with their national requirements.

Newly appointed members of the team who are less experienced must undergo an appropriate program of training and supervision provided by relevant experienced members of a cochlear implant team.

#### Cochlear Implant Team: Additional support

The core team should include individuals with skill and experience in fitting of hearing aids to severe and profoundly deaf people, or have access to this service.

Where the core team does not include professionals from the following services or disciplines it should have access to them as required:

- Tinnitus management
- Vestibular services including vestibular physiotherapy
- Radiology
- Medical physics
- Psychology
- Psychiatry
- Genetic counselling
- Audiological medicine
- Interpreter services
- Social services for the deaf
- Deaf advocate

Cochlear implant teams may develop partnership services with local services where appropriate. Such partnership services must have appropriate training and expertise.

### **1.4 Facilities**

Adult cochlear implant programs should have facilities available to conduct the following:

- Pure tone audiometry
- Sound field audiometry
- Sound localisation tests (if required)
- Hearing aid testing (probe tube measures and/or aided thresholds) and hearing aid fitting
- Tympanometry
- Otoacoustic emissions
- Objective measurement facilities
- Evoked response audiometry
- Electrical evoked potentials
- Electrocochleography
- Speech perception testing

- In quiet
- In noise
- Access to balance function testing
- Access to MRI/CT or X-ray imaging

#### Audiological equipment

All audiological equipment must be calibrated annually to Australian Standards. Testing rooms including sound proof booths or consultation rooms where hearing levels are assessed must comply with Australian Standards for ambient noise. This should be assessed as the standards specify, as required and undergo a daily on-site system check.

### **1.5 The Cochlear Implant Device**

There are different manufacturers currently supplying cochlear implants in Australia. Further information regarding the technical specifications of these different devices should be made available to patients.

The patient should be given information on all cochlear implant devices currently available along with their advantages and disadvantages. The patient should be given an explanation as to why they have been offered a particular device, or choice of devices. Written information/ brochures on the device/s offered should also be made available.

Cochlear Implant centres should only use and implant devices that have FDA approval and have the highest quality clinical and technical support available from the manufacturer.

### **1.6 Timing of Cochlear Implantation**

Once cochlear implant candidates are assessed as suitable, they are put on a waiting list. Timing of surgery should comply with Health Department Western Australia Guidelines.

Severe to profound hearing losses caused by specific diseases, e.g. Meningitis may result in ossification of the cochlea structures. In such cases urgent implantation may be required

Waiting times for diagnostic testing and treatment should comply with current national and local targets.

Fast tracking of patients through the assessment process must be available when clinically indicated.

### **1.7 Prior to referral**

For a patient to be seen in a cochlear implant centre, the following is required from the referrer;

- Clinical history
- Full Audiological history, including Hearing Aid / Amplification history
- Most recent audiograms

## **2. Preoperative Assessment**

The assessment process shall be performed in the most efficient and timely way possible. The purpose of the assessment process is to assess the

patient's functional hearing abilities and to determine whether these are likely to be significantly improved through cochlear implantation. Co-ordinated management of the pre-implant assessment process by a coordinator of clinical implant services and administration staff is essential to ensure the flow of the process.

## **2.1 Otolaryngology**

The role of the otolaryngologist encompasses preoperative counselling, surgical implantation of the device and post-operative follow-up. Preoperative assessment of the patient occurs in conjunction with all of the agencies above. Specific attention is paid to the otological history of the patient, family history and associated medical conditions. Radiological evaluation of the temporal bone and auditory nerve is performed with a combination of CT scan and MRI.

Once a patient is confirmed as a candidate, a preoperative meeting is scheduled and informed consent is obtained.

All patients referred to the cochlear implant centre should have a medical consultation with the team consultant otologist.

The referral of patients for MRI, CT or x-ray is the responsibility of the consultant otologist or locally agreed other appropriately trained and experienced professional. Appropriate referral for balance / vestibular assessment should be available if indicated.

It is the responsibility of the surgeon to complete the following tasks for each patient:

- To undertake a medical consultation during the assessment process, and pre-admission, to ensure the patient is medically fit to undergo the treatment
- To discuss associated risks of the treatment pre- and post-surgery
- To discuss necessity for vaccination to minimize the risk of pneumococcal meningitis
- To refer for genetic counselling if required
- To obtain fully informed patient consent for the treatment

## **2.2 Audiological**

Each patient must receive a full audiological assessment performed to professionally accepted protocols.

The audiological assessment must include:

- Examination of the ears with a otoscope (or a similar device),
- Determination of unaided hearing thresholds and speech discrimination bilaterally using pure tone audiometry and speech audiometry
- Determination of bilateral middle ear function using tympanometric techniques
- Aided Speech perception testing in quiet and where possible, in noise with optimally fitted hearing aids

In addition to the above core audiological assessments, the Cochlear Implant Program must have access to appropriate electrically evoked response audiometry, promontory stimulation test and otoacoustic emissions.

## Hearing Aid Evaluation

Each patient should have their current hearing aid provision evaluated and where appropriate have the best available hearing aids fitted or settings revised.

Real ear measurements should be performed and hearing aids should be set optimally according to the NAL-RP or NAL-NL1 fitting procedure. Facilities should be available to measure the electroacoustic performance of hearing aids according to current standards and program them to the most suitable settings.

Patients fitted with new hearing aids or with a change of hearing aid settings need access to a structured program of auditory rehabilitation. For some patients the period may be extended to several months for clinical reasons.

## Consent

Clients should sign a consent form to indicate that they have been fully informed of the cochlear implant procedure, expectations in terms of outcomes and risks involved.

## **2.3 Speech Pathology**

Pre-operative assessment may include an overview of the client's mode of communication, either verbal, non verbal or total communication. The client's expressive and receptive language skills play an important role when counselling realistic expectations with regards to cochlear implants.

These assessments may take the form of observation, subjective description or evaluation using formal test procedures. The assessment procedure will take into account the patient's age and hearing status and will normally include a detailed case history, and an assessment of the patient's receptive and expressive skills.

The following areas may be assessed by a speech pathologist

- Receptive skills - listening skills for speech
- Lip reading skills
- Comprehension of spoken language
- Expressive skills
- Language skills in all communication modes
- Intelligibility, voice and speech sound system
- Details should be collated about the communication environments in which each adult typically function and where they find most difficulty.

## **2.4 Psychology**

Not all patients require a psychological assessment. However, a referral to a qualified psychologist or psychiatrist should be instigated when there are concerns regarding the candidate's mental health, learning ability, personality and motivation, adaptation to their deafness, or unrealistic expectations about cochlear implantation which cannot be addressed through counselling by the cochlear implant program team. In some cases, family members supporting the client may require a counselling session with the psychologist.

## **2.5 Reporting**

Following the pre-operative assessment a written report detailing the outcome of the assessment will be sent to the referring agent, the patient and the ENT surgeon, no later than two weeks after a decision has been made by the cochlear implant team regarding candidacy.

## **2.6 Other Services and Agencies**

All members of the cochlear implant team should meet on a regular basis to ensure effective communication thereby ensuring a quality service for each patient. Ideally, the agenda should include opportunity for clinical as well as academic discussions.

Contact must be maintained with the referring agent and local professionals.

The cochlear implant program should liaise as appropriate with other agencies including the following:

- Other hospital departments
- Audiology, radiology, medical physics, wards, ambulatory care etc.
- Social services
- Local/national support groups
- Community services
- Educational services

Contact with support services should only be made with the permission of the patient and at the discretion of the cochlear implant team.

If the outcome of the assessment demonstrates that the patient would not benefit from a cochlear implant, the report to the referring agent will include:

- Reasons why a cochlear implant is considered to be unsuitable for the adult.
- Recommendations for future management, and referral for other equipment and /or services for deafened adults if appropriate.
- Recommendations (if appropriate) for future reviews should there be an indication of possible future deterioration in hearing.

## **2.7 Pre-operative Information and Counselling**

Whenever possible, information should be given to patients in a language or medium that is appropriate to their preferred method of communication. Interpreters should be offered as and when required and in accordance with local practice.

Teams should continuously monitor, review and update the quality and quantity of the information they provide and have a written protocol to determine which information is given at which time.

Verbal information should be supported by a written summary to the patient whenever indicated.

Throughout the assessment period patients should have a clear understanding of the main benefits and limitations of implantation. They should demonstrate that they have realistic expectations of cochlear implantation, e.g. by using a measurement tool such as an expectations questionnaire.

It is recommended that candidates, and where possible a family member/friend, meet adults who have experience of using a cochlear implant. Matching candidates and users in terms of age and duration of deafness and cochlear implant device may be beneficial. Patients' relatives and friends should be encouraged to become involved in all aspects of pre-and post-implant management. This should always be done with the permission of the patient and at the discretion of the cochlear implant team.

Issues surrounding cochlear implantation, including the views of the deaf community, should be discussed and the patient should have an opportunity to meet people who have decided against implantation, if they wish.

Waiting times for surgery and information about the hospital stay and postoperative follow-up should be outlined at the end of assessment.

Patients should be given information about cochlear implantation support organisations, national and local charities, self help organisations, and equipment and services for the Deaf and Hard of Hearing.

The opportunity for members of the implant team to discuss the implantation process and limitations and benefits of the implant with the patient's work colleagues or employers should be offered to the patient. Contact should only be made with the permission of the patient and at the discretion of the cochlear implant team.

There should be a timetabled final discussion at the end of assessment between the patient and key team members at which agreement is reached about whether or not to proceed.

If the outcome of the assessment is that cochlear implantation is not recommended for a patient, an exit clinic appointment should be offered to discuss this recommendation and provide patient support. Recommendations for future management should be discussed together with the opportunity for re-referral in the future. These issues must be covered in a written report to the referring clinician or agency.

### **3. Patient Candidacy**

The selection criteria for cochlear implantation in adults <sup>3,4</sup>.

- UNAIDED testing
  - moderately-severe to profound bilateral sensorineural hearing loss
- Little or no useful benefit from hearing aids
- AIDED testing (audition alone)
  - open-set *sentence scores* in quiet in the worse ear < 65% and in the better ear < 85%
  - open set *phoneme scores* in quiet in the worse ear < 45% and in the better ear < 65%
- No radiological or medical contraindications
- Appropriate expectations and commitment from client and family
- Client must be motivated

#### **3.1 Considerations for cochlear implantation**

##### **3.1.1 Duration of hearing loss**

Typically adult cochlear implant recipients, have a post-lingually acquired hearing loss. However a pre-lingual or congenital profound deafness is no longer a contra-indication and an individual with such a loss may be considered for implantation at the discretion of the cochlear implant team <sup>5</sup>. Factors such as communication mode, previous use of amplification, and motivation must be considered in these cases. In such cases it is vital that the expectations of all people involved, including family and friends, are closely assessed and managed.

### **3.1.2 Multiple handicaps**

Although the presence of other disabilities might influence outcomes, it is no longer a contra-indication, although the majority of research has focused on children with multiple disabilities <sup>6,7</sup>. It is important that a team should be available to attend to all of the needs of clients with multiple handicaps. Realistic expectations are of utmost importance.

### **3.1.3 Complex or borderline cases**

These cases should be presented at a clinical meeting for discussion with a team of professionals who make up the cochlear implant team, before a final decision regarding candidacy is made. For the patient to achieve the most benefit from their cochlear implant, they need to be within the criteria listed previously.

### **3.1.4 Bilateral implantation**

It is well accepted that there are significant benefits with binaural hearing and that bilateral implantation provides the maximum outcome for the individual patient <sup>8,9</sup>. Bilateral implantation has proven to be beneficial with regards to improved speech perception in the presence of noise as well as sound localization.

Bilateral implantation has become the treatment of choice in people with bilateral severe to profound sensorineural hearing loss, who are unable to obtain bimodal benefit (i.e. CI in one ear and hearing aid in the other). Whenever possible, bilateral implantation should be performed.

In the case of post-lingually deaf adults simultaneous and sequential implantation appear to provide similar outcomes <sup>10,11</sup>. Simultaneous bilateral implantation will require funding and surgical considerations, which should be taken into account. Sequential bilateral implantation should be considered if a patient receives limited or no benefit from the contralateral hearing aid.

## **4. Surgery and In-patient Care**

The consultant cochlear implant surgeon is responsible for the overall medical care of the patient.

The surgical team is responsible for briefing the patient about the surgical procedure and potential complications and for obtaining the patient's informed consent.

The surgeon will continue to check and monitor the patient's progress during the post-operative period and will be responsible for dealing with any surgical or medical problems that may arise in relation to the implant.

Information regarding the outcome of surgery must be documented and should be made available to the audiological and rehabilitation teams immediately after the operation.

Thus it is important that state of the art surgical techniques are implemented and surgeons remain up-to-date with current techniques.

## **5. Post Operative (Incl. Education and Awareness)**

### **5.1 Otolaryngology**

The Implant surgeon is responsible for postoperative patient reviews. These include inpatient care and post discharge review of the operative site.

Vestibular rehabilitation, if required, should be organised for the immediate post-operative period by the surgeon.

Good communication between surgeon and audiologist is essential to confirm appropriate healing has occurred to allow for switch-on of the device.

Further appointments are generally made after switch-on and as required thereafter.

### **5.2 Audiology**

#### **5.2.1 Switch-on and Tuning of the Speech Processor**

Speech processors should be fitted and programmed once the patient's wound has healed satisfactorily. An average waiting period before the activation of the cochlear implant is 2-4 weeks following surgery date; however, this should not be performed if there is any surgical contra-indication or if the wound has not completely healed

Speech processors should be fitted and programmed only by an experienced clinical audiologist who has been fully trained in the relevant protocols and procedures (and by a less experienced audiologist only if under direct supervision).

Prior to the switch-on appointment relevant team members should be aware of any surgical issues. Thus a copy of the surgical report should be available for the audiologist. It is good practice to ensure that all components of the external device are present and functioning appropriately prior to the switch-on appointment.

Upon activation of the device, an impedance test should be performed to assess the internal functioning of the implant. Each device should be

programmed according to the manufacturer's recommended programming procedures with consideration for patient benefit and preferences.

A comprehensive explanation on the use of the speech processor must be given. Patients should be encouraged to contact the implant program if they have any queries or concerns.

Printed materials on the handling, operating and care of the speech processor should be issued to the patient and relatives/carers as appropriate.

A written report should be sent to the referring agent following activation of the implant and after for at least two reviews following implantation within the first 12 months. A written report should also be sent to the referring agent if any serious problems arise.

The patient must have open access to the cochlear implant centre (or a designated more local partner-service) for programming, device evaluation and general assistance with the cochlear implant.

### **5.2.2 Post-operative Rehabilitation and Assessments**

Several days after activation of the device, the patient should be offered an additional appointment to:

- facilitate acclimatisation to the new sensation of sound
- reprogram the device as required
- assist with device management
- outline the rehabilitation program

The rehabilitation program should be tailored to each individual's needs. Counselling should support the patient and his/her family regarding expectations, the rehabilitation procedures, and continuing commitment to the rehabilitation program.

The rehabilitation program may include evaluation of and training in:

- detection of sound, including localisation and spatial tests
- auditory discrimination
- voice quality
- speech intelligibility
- language comprehension and expression
- social and communication skills
- lip reading
- hearing tactics
- telephone training

The patient must have open access to the cochlear implant centre (or a local partner-service) for rehabilitation and counselling as required.

Appropriate audiological, standardised speech perception and quality of life measures through validated questionnaires and general feedback should be performed at regular intervals to enable progress to be monitored.

Listed below is a recommended test battery for review appointments. It is recommended that the full battery of tests is completed at 3, 6, 12 and 24 months post-implantation. Additional testing can be completed as deemed necessary by the audiologist.

- Aided thresholds measured through free field using warble tones

- Aided Speech perception tests: (Calibrated testing material, including calibration tones)
- CUNY sentence test in quiet and in noise
- CNC word tests, measuring word and phoneme scores in quiet and in noise
- BKB/SIN test with noise coming from different directions (0:0, 0:90, 0:180)
- Questionnaires, including quality of life, music appreciation and tinnitus questionnaires (if applicable)

It is recommended that the referrer and local involved professionals should receive written reports on progress.

Following implant surgery, the patient must be reviewed by the implant surgical team and have open access to additional appointments as required. The patient should be offered open access to further annual medical review, and a check of the implant and speech processor function.

After the first year following implant surgery, the patient should be offered annual audiological review. This can take the form of an offered appointment, or patient-led follow up. In addition patients should have access to additional appointments as required.

Standardised audiological and speech perception measures should be performed on at least two occasions in the first year following surgery.

### **5.2.3 Follow-up and Long Term Maintenance**

The patient must have open access to the cochlear implant centre (or a local partner-service) for programming, rehabilitation and surgical reviews as required.

Adequate spares/ replacements of external equipment must be available as required. Access to replacement equipment should be managed such that parts can be issued or despatched on the same or next working day. Batteries should be available to implant users either from their cochlear implant program or from a local audiology department by prior agreement.

Where it is necessary for the patient's speech processor to be repaired, a loan or replacement speech processor should be available for the patient until their own processor has been repaired and returned to them. A policy for replacement of lost or damaged processors that is equitable for all patients is necessary.

The implant team should have a documented system for the management of device upgrades. Arrangements should be in place to upgrade patient's speech processors at a minimum of 5 yearly intervals, subject to funding and availability of new technology. Speech processor insurance options should be discussed with clients.

## **5.3 Other services**

### **5.3.1 Speech Pathology**

Where indicated, the Implant team should refer for thorough assessment. Patients that may benefit from these services include those with pre-lingual, congenital or long standing hearing loss.

### **5.3.2 Psychology**

Where indicated, the Implant team should refer for thorough assessment. This may include patients with anxiety, unrealistic expectations or cognitive impairment.

### **5.4 Device Failure**

If a cochlear implant internal device failure is suspected, the patient should be offered an appointment with the clinic within 2-3 days to check the internal and external components.

The implant manufacturer should be contacted urgently regarding investigation of the device failure. If indicated, a clinical/engineering representative from the company should be available at the patient appointment to provide support.

Upon confirmation of an internal device failure the clinical personnel must inform the otologist and the head of service/co-ordinator and an urgent appointment should be offered with the implant otologist surgeon to discuss re-implantation or other options.

If the patient wishes to proceed with re-implantation this should be carried out as soon as medically possible to minimise the period of auditory deprivation.

Re-implantation and programming should be carried out as detailed above. Further rehabilitation needs should be assessed and implemented as appropriate.

### **5.5 Clinical Governance**

The cochlear implant service should have appropriate systems in place to ensure accurate and efficient record keeping for all aspects of the service. This will facilitate audit and planning requirements.

The implant program should perform regular audit and comply with national requirements of responsible authorities.

The audit should cover:

- Clinical activity
- Staffing levels
- Patient performance outcomes
- Medical / Surgical complications
- Device failures
- Research interests and outcomes
- Patient feedback on the service

### **5.6 Patient and Other Feedback and Complaints**

Documentation provided by the cochlear implant program should include written information about the complaints procedures within the hospital trust and other relevant services.

Patient and carer feedback should be managed according to local policy and should be systematically collected to inform service review.

## **6. Other Considerations**

### **6.1 Evolving Technology and Candidacy Criteria**

Refinements in cochlear implant design have resulted in widening criteria for implantation<sup>12</sup>. Current technology allows for attempts at preservation of residual hearing and electro-acoustic stimulation thus offering a viable hearing solution for patients with steeply-sloping high frequency sensorineural hearing losses<sup>13,14</sup>.

Early stage research is also currently looking into cochlear implantation for the treatment of tinnitus and as a hearing solution for some forms of single-sided hearing loss<sup>15,16</sup>. Cochlear implantation has also been considered in various studies for the treatment of auditory neuropathy/dysynchrony<sup>17,18,19</sup>. More rigorous research needs to be completed before these criteria become standard practice.

There is a great deal of research being completed into improving efficiencies of cochlear implant programming both within the clinic, and remotely to assist in the issues of distance, which are particularly problematic in this state. The development of remote implant programming software should be encouraged and funding guidelines will need to be mindful of these newer technologies and be ready to incorporate them into existing programmes.

### **6.2 Other implantable devices**

There are also alternate implantable hearing devices in the way of middle ear implants and bone anchored implants. Although out of the scope of this document, implant clinics need to be aware of these devices as alternate treatment options for candidates who do not fit the cochlear implant criteria or cannot wear (or do not benefit from wearing) hearing aids.

### **6.3 Paediatric Cochlear Implant Clinics**

An adult cochlear implant team may function independently or as part of a combined paediatric and adult implant centre. Provisions need to be made available in an adult unit for patients transferring from an educational agency or paediatric program. Adult units should work closely with paediatric unit/s to ensure continuity of care for all cochlear implant recipients over the long term.

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