SOUTH AFRICAN COCHLEAR IMPLANT GROUP

SUID - AFRIKAANSE KOGLEERE INPLANTINGSGROEP

APPENDIX F

GUIDELINES FOR PRE- AND POST-OPERATIVE AUDIOLOGICAL ASSESSMENT (ADULTS AND CHILDREN) AND LONG-TERM MANAGEMENT.

Each candidate for cochlear implantation presents with a unique set of capabilities and needs. Although the factor of severely compromised hearing is common to this group, the population differs in almost every other descriptor. Age, onset, etiology, progression of deafness, duration of hearing loss, history of amplification use, cognitive and educational level, attention, language competence, family and environment, sensory and motor skills, commitment to re/habilitation and personal motivation all influence the approach and considerations for assessment and long-term management (Niparko, 2009; Zeitler et al, 2023). In South Africa, the socio-economic considerations of the family should always be considered in decisions about candidacy and management.

Additionally, the South African context presents us with unique challenges in assessment and management, and it is imperative that collaboration exists between all role players.

All candidates for cochlear implantation must have a comprehensive CI assessment, the purpose of which is to assess the candidate's functional hearing abilities and to determine whether these are likely to be significantly improved through cochlear implantation

AUDIOLOGICAL ASSESSMENT

EQUIPMENT AND BOOTH

Cochlear Implant Centres who provide cochlear implants should have the following audiometric equipment and facilities in place:

1. Audiological testing will be performed in a soundproof booth according to SANS 10182:2006 standards. The size of the soundproof booth should allow for free-field testing (2.2 meters in dimension).

Children: The test should be performed in a room that is of adequate size to accommodate parent(s), child and a distractor/assistant comfortably.

2. The audiometer and loudspeaker should be calibrated and maintained annually for FM tone, NBN and speech stimuli (live voice and recorded) presentations according to SANS 10154-1/2 10182. The audiometer should have access to the provision of recorded speech material.

3. Audiometer with sound field capability for free-field testing:

3.1 Adults and older children: Loudspeaker positioned at 0° azimuth 1m away from the patient at the level of the patient's head. A comfortable chair should be available for the patient to be seated at or close to the centre of the room.

3.2 Younger children: Loudspeakers shall be positioned at 90° azimuth (reference equivalent threshold sound pressure levels, RETSPLs are only available for these angles of presentation) relative to, and at least 1 m from, the test position to each side (BSA, 2008). The speakers should be approximately level with the child's head; such positioning provides the most efficient means for conditioning the behaviour and establishing Minimum Response Level (MRL).

Visual reinforcers (e.g., multiple animated toys individually housed in dark Plexiglass boxes; illuminated and/or activated remotely) or video reinforcement system located 90-degrees to both sides of the child at eye level (reinforcers positioned at a 45-degree angle are generally insufficient for eliciting an observable head turn). The reinforcers should be located approximately level with the child's head at a distance of 1−2 m. Close proximity between speaker and reinforcer is preferred in order to aid conditioning when using soundfield stimuli. Therefore, adjacent positioning of loudspeaker and reinforcers is recommended. Reinforcers should be positioned to both sides. Earphone masking system for mid-line distracter and parent are recommended.

Examination rooms must meet current appropriate South Africa health and safety guidelines.

A. AUDIOLOGICAL PRE-OPERATIVE ASSESSMENT

The audiological assessment must include:

A.1 Audiometric assessment:

1. Otoscopic examination.
2. Determination of bilateral middle ear function using tympanometric techniques.
3. Determination of unaided hearing thresholds (air and bone conduction) at all frequencies (125 – 8000Hz) bilaterally using pure tone audiometry (5dB steps). Threshold testing at octave and inter-octave frequencies from 125Hz – 8000Hz may provide useful information for device selection (electrode, sound processor) and help to identify individuals who might be candidates for EAS (electroacoustic stimulation) after surgery (Dunn et al., 2024).
4. Objective hearing threshold assessment, including Stapedius Reflexes, Otoacoustic Emissions, Auditory Evoked Response Audiometry (including Cochlear Microphonics) if indicated. Electrophysiology testing should include ASSR, tone burst and click ABR (Leigh, 2019). Recommendations for candidacy for cochlear implantation in children and infants should not be made without both objective (including electrophysiological and behavioural testing confirming the degree of hearing loss.
5. Unaided ear specific speech perception testing (recorded) if indicated. However, unaided (under earphone) are poor predictors of aided speech recognition (McRackan et al., 2018).

Note: confirmation for candidacy for implantation should only be after both objective and behavioural testing confirm the degree of hearing loss (Leigh et al, 2019).

Based on unaided thresholds, patients fall into various categories, which will influence additional test considerations and counselling topics (Dunn et al, 2024). These categories include (**Appendix B**):

a) Traditional
b) EAS (Electroacoustic stimulation)
c) SSD (Single-Sided Deafness) or AHL (Asymmetric Hearing Loss)

Unaided audiometric testing should be performed if testing has not been done within the last 6 months, there are any concerns about the reliability of the previous test results, or there are concerns about a recent change in hearing (Dunn et al., 2024).

A.2 Hearing Aid Evaluation (ear-specific assessment of aided benefit from hearing aids):

Each patient should have their current hearing aid provision re- evaluated and where appropriate have new / loan hearing aids fitted or settings revised.

Appropriacy of hearing aid fitting and verification of the suitability of amplification should have been undertaken prior to assessment of aided benefit from hearing aids: “The prescribed gain from a validated prescriptive method should be verified using a probe-microphone approach that is referenced to ear canal SPL.” (Valente et al, 2006). Ensure that the chosen hearing aid fitting rationale is aligned with the fitting rationale chosen in the verification equipment.

SII values can be used to predict speech understanding (Mueller, 2017) and are therefore useful to include. The stimulus used for verification (speech or a speech-like signal) should include a presentation level of 60dB**SPL** (Gifford, 2013).

Hearing aid verification should be performed and evidence of ear specific appropriate hearing aid fitting prior to conducting free-field aided soundfield threshold and speech recognition measures should be available. It may be necessary to fit the patient with a more appropriate clinic loaner hearing aid for the aided testing.

Assessment of ear-specific aided benefit should include:

1. Aided soundfield thresholds at all frequencies (125-6000Hz) tested with warble tones (frequency modulation) at 0º azimuth (1m from loudspeaker) (5dB steps). Consider marking the floor for consistency).
2. The non-test ear should be isolated using plug/muff or masking depending on the amount of residual hearing.
3. Speech perception testing (auditory only):

3.1. Use recorded speech materials or, in the case of younger children, live voice.

3.2. Presentation level of speech materials should be **40dBHL** (60dBSPL: refer to calibration figures to determine dBHL relative to dBSPL).

3.3. Monosyllabic word tests are recommended to determine candidacy according to the linguistic level of the patient. The word lists should be in the person's native language where possible. Sentence recognition test can be used to supplement word recognition testing. scores are

3.4. Procedure:

3.4.1 Administer one 50-word list to the right ear at 0º azimuth (1m from loudspeaker) at 60dB**SPL;**

3.4.2 Administer one 50-word list to the left ear at 0º azimuth (1m from loudspeaker) at 60dB**SPL;**

Compare scores to determine better versus poorer ear to aide in determination of ear to be implanted.

4. Patients fitted with new hearing aids or with a change of hearing aid settings may require access to a structured programme of auditory rehabilitation. It is recommended that trials with new hearing aids or different settings be conducted.

Speech Perception testing in babies and very young children:

- The speech-language therapist should provide detailed information about functional responses to amplification.
- Aided responses to the Ling Madell Hewitt Test (LMH) can be used to assess ear specific auditory access available through hearing aids across the speech spectrum. A distinction can be made whether the child is able to detect or identify the sounds. The sounds should be presented at a soft conversational level.
- The ESP can also be used to assess speech perception benefit from hearing aids in younger children (https://successforkidswithhearingloss.com/product/esp-early-speech-perception-test/).

A.3 Assessment of Functional Outcomes (questionnaires):

1. Tinnitus Assessment

The Tinnitus Handicap Inventory (Newman, C W; Sandridge, SA & Jacobsen, G P (1998)) should be used if the patient reports a history of tinnitus.

2. *Self-assessment questionnaires:*

Questionnaires to determine additional hearing impairment, handicap, and disability as well as other non-auditory symptoms are recommended. A diagnostic audiogram does not accurately represent the patient's functional status and quality of life as a result of their hearing loss.

The following questionnaires are recommended as a minimum for children 10 years and older and for adults:

1. **Speech Spatial Qualities Hearing Scale Hearing Scale SSQ12**. (Noble, W; Jensen,S; Naylor, G; Bhullar,N; Akeroyd, M A. A short form of the Speech, Spatial and Qualities of Hearing Scale suitable for clinical use: The SSQ 12. 2013, International Journal of Audiology, 52: 409-412.

2. **The Speech, Spatial and Qualities of Hearing Scale, Parents' version** (SSQ-P). (Galvin, K L; Noble, W. Adaptation of the Speech, Spatial and Qualities of hearing scale for use with children, parents and teachers. Cochlear Implants International 2013, 14(3):135-141. Doi:10.1179/175462812Y.0000000014.PMID:23394704.

3. **Listening Effort Assessment Scale**. (Alhanbali, S; Dawes,,P; Lloyd, S; Munro, K.J. Self-reported listening related effort and fatigue in hearing-impaired adults. 2016, Ear & Hearing, 38;1:e39-e48.

4. The Revised Hearing Handicap Inventory and screening tool based on psychometric re-evaluation of the Hearing Handicap Inventories for the Elderly and Adults.(Vassarly, C; Matthews, L.J; Simpson, A N; Dubno, J R. 2021 Ear & Hearing 41,1:95-105).

5. A Quality of Life Questionnaire is recommended.

All adults and older children under consideration for bilateral implantation (sequential or simultaneous) and any patient with vestibular / disequilibrium-related complaints should be screened for vestibular symptoms and referred on as appropriate **(Appendix R).**

Final audiological evaluation of all the above should be done no more than 3 months prior to the team discussion regarding candidacy for implantation.

If cochlear implantation is recommended, a questionnaire to assess expectations is helpful.

B. AUDIOLOGICAL POST-OPERATIVE ASSESSMENT

Outcomes assessment is a critical component of cochlear implant follow-up care and evidence-based best practice. Outcomes measures include qualitative and quantitative measures that can serve as methods of validation for both adult and paediatric cochlear implant recipients.

Outcomes assessments can help provide documentation of benefit derived from use of a cochlear implant, help identify potential programming parameters that need to be adjusted during routine programming, as well as determine the need for any additional recommendations outside of the purview of the programming audiologist. Therefore, outcomes assessments should be performed at regular intervals after initial stimulation of the device.

B.1 Audiometric assessment:

1. Otoscopic
2. Tympanometry

The patient should be referred to their ENT surgeon should a problem be identified during (1) and / or (2).

3. Unaided hearing thresholds (refer to A.3) of the implanted ear post-surgery at the day of device activation and then at one-year post-surgery interval. For patients potentially using EAS, it is recommended to wait one month to allow for resolution of possible issues that may be present in the middle ear that may impact results (Dunn et al., 2024).
4. Annual unaided audiometric testing on the un-implanted ear should be performed annually if a hearing aid is worn in the non-implanted ear.

5. If the implanted ear is using EAS, unaided audiometry is recommended prior to each follow up programming visit.

Sound-field detection thresholds of implanted ear with sound processor 250Hz – 6000Hz using warble tones tested in 2dB steps . If the threshold levels are above or below the manufacturer recommended dB sound field levels the technology and the MAP should be investigated.

Intervals:

- Young children: 3 monthly for the first two years, 6 monthly for the following two years and annually thereafter.
- Older children: 6 monthly for the first two years and annually thereafter.
- Adults: at 3 months, 6 months, one year and annually thereafter.

B.2 Speech perception testing:

Recorded age and linguistically appropriate speech perception materials should be used at the following intervals after activation:

- Young children: 6 monthly for the first two years and annually thereafter.
- Older children: 6 monthly for the first two years, and annually thereafter.
- Adults: 3 or 6 months, one year and annually thereafter (determine 3- or 6- month interval according to outcome and clinical needs)

Dunn et al (2024) recommend speech perception assessment at 3 months, one year, annually. They recommended removal of the 6-month interval based on research demonstrating that CI patients typically plateau after 3 months.

Speech test materials: 50 word-list monosyllabic word and sentence materials (same condition as pre-implant) should be used. Presentation level at 60dB**SPL** 0˚ azimuth 1m from loudspeaker. Choice of material will be determined by the scores obtained for sentence testing to avoid ceiling effects. If sentence scores exceed 80% only use monosyllabic word testing thereafter.

With long-term / congenitally deafened adults lipreading may also be used together with audition to assess benefit.

If recipient has residual hearing in the non-test ear (NTE) careful consideration should be given to effectively isolate the test ear.

Compare pre-operative test results from baseline results to determine pre- to post-operative benefit.

If scores are poorer than expected, evaluate programming and datalogging; adjust or counsel as needed and retest. Encourage attendance of Auditory Skills Training therapy.

Compare an additional list in the recipient's everyday listening condition (i.e. bimodal / bilateral) if additional information is required.

B.3 Self-assessment questionnaires

The same self-assessment questionnaires used pre-operatively and be administered at the 3- or 6- month interval and re-administered annually until plateau is reached to assess functional hearing post-implantation.

C. AUDIOLOGICAL LONG-TERM MANAGEMENT PROTOCOL

The responsibility of long-term care lies with the implant centre. All efforts should be made by the managing audiologist to contact patients who do not respond. The following services should be provided:

1. MAPPING: This should be performed at a minimum of yearly intervals. After the 3-year post-activation interval adults can be seen for MAPping every alternate year and after 9 years every third year. Contact should be made with them annually to ensure that performance has not declined, to check magnet site and that equipment in optimal working order.

In the case of children, they should be seen annually during their school career. After the age of 18 years children can be followed up according to the adult protocol.

If remote care follow ups are possible, this can be done annually.

2. EQUIPMENT: In the event of faulty equipment, the implant centre should provide the necessary support and guidance. In the event of a faulty sound processor, the clinic should immediately provide a loaner/ replacement sound processor and the patient's sound processor should be sent for repair.

3. TECHNOLOGY UPGRADE: Patients should be informed when new technology is available and assisted in the process of obtaining it.

4. REHABILITATION AND EDUCATIONAL SUPPORT: The clinic needs to ensure that the appropriate rehabilitative support is provided for both children and adults. In addition, appropriate school placement needs to be ensured.

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Authors:

Jenny Perold, Lida Müller