MED EL

# Single-Sided Deafness & Cochlear Implant Rehabilitation

## BINAURAL HEARING SERIES

# Single-Sided Deafness & Cochlear Implant Rehabilitation

**Binaural hearing gives optimal access to sound.**
Hearing is normally accomplished with two ears, and the brain is organized to receive and then process sounds from two ears.

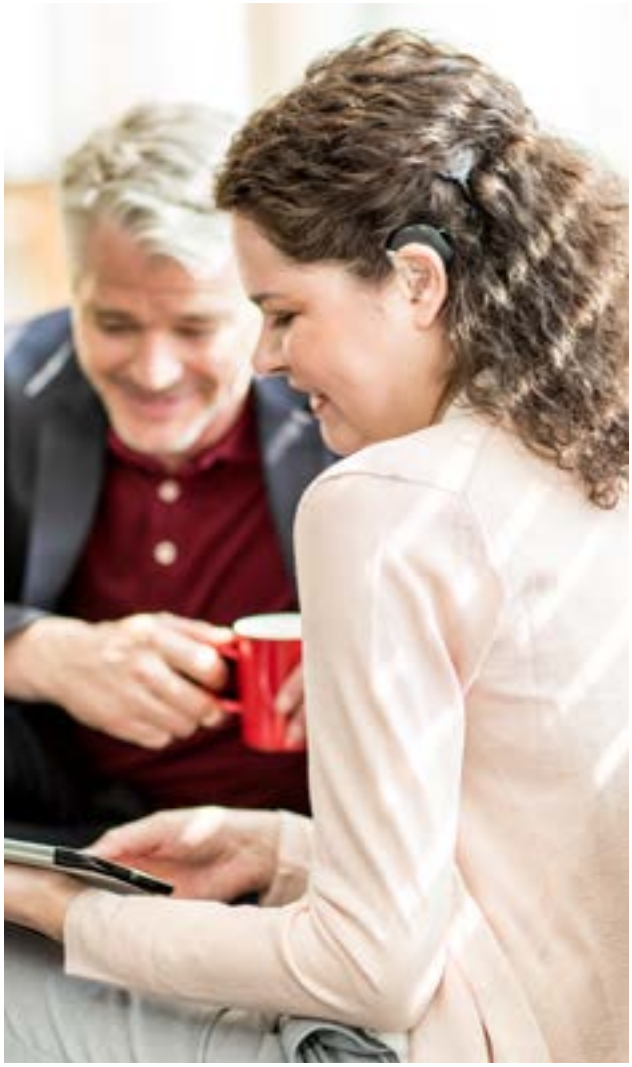
The following are the key benefits conferred by binaural hearing:

1. Binaural loudness summation and redundancy
    - A sound heard by two ears is usually judged as louder than a sound heard by one.
    - In the bilateral condition there is redundancy of information which assists in speech recognition.
2. Head shadow effect
    - The head acts as an acoustic barrier when sound is presented.
    - Therefore, sound arrives at the two ears in different ways (time and intensity).
3. Binaural squelch effect
    - The central auditory system processes the different stimuli received from each ear and represents it with a higher signal-to-noise ratio (SNR) by comparing the interaural time and intensity differences.

These benefits result in:

- Localization of sound
- Better understanding of speech in both quiet and noisy situations
- Improved ability to follow conversation
- Reduced listening effort
- Improved feeling of balance

Single-sided deafness (SSD) causes the loss of the mentioned binaural hearing effects resulting in difficultly localizing sound and poor speech perception in noise. In children, the difficulties resulting from SSD may negatively impact language development, academic performance, emotional development, behaviour, and social interactions.[1,2] In adults, SSD may also lead to withdrawal from social activities, tinnitus, and a reduced quality of life.[3,4]



Pre-implant counselling and active rehabilitation is essential for best outcomes and long-term cochlear implant (CI) use for recipients with SSD.[5]

Pre-implant counselling ensures recipients, parents/caregivers, and families

- have realistic expectations for the outcomes that can be achieved with a CI;
- understand the factors that affect outcomes following CI, such as device use, opportunities for daily practice, recipient commitment to rehabilitation, medical findings, additional disabilities, nonverbal intelligence, and duration of deafness;
- understand that input from the CI will not sound the same as sound from the typically hearing ear, especially soon after activation. The reduction of the perceptual difference and the ability of the brain to make sense of information from the CI is varied and takes time;
- understand the need for structured rehabilitation and home practice to obtain optimal outcomes; and
- understand the need for CI use at least 10 hours per day.

The *Expectations Questionnaire for Children (EQC)* and *Expectations Questionnaire for Adults (EQA)* may be helpful in pre-implant counselling discussions.

The key focus of Cochlear Implant Rehabilitation for CI recipients with SSD is to develop auditory skills with the CI to restore or establish the benefits of binaural hearing. As the recipient has one typically hearing ear, listening activities which target the auditory skills of the CI side alone can be challenging. To overcome this, activities may be completed using

- free field technique: the typically hearing ear is blocked during listening tasks with an occluding earmold, earplug or earphones; or
- Direct Audio Input (DAI) where speech and/or rehabilitation material is sent directly to the CI processor via a device (computer, phone, tablet) using Bluetooth streaming, a cable or frequency modulated (FM) signals. DAI is preferred as this method ensures that only the CI side is stimulated.[5] The use of an audio cable splitter (to enable the recipient as well as another person to listen to the auditory stimulus) or video calling from a different space are additional options for delivering auditory training activities with DAI. Consult with the recipient's audiologist if planning to use DAI. A dedicated MAP for listening with DAI may be required.[5]

For very young paediatric CI recipients with SSD, targeted listening practice with the CI alone may not be required. See below for further information.

# SSD & Cochlear Implant Rehabilitation With Children

Following CI, there are five core aspects of CI rehabilitation when working with children with SSD.

1. Ongoing assessment and monitoring of the child's CI use, speech, language, and literacy skills is important for this population to ensure progress in all developmental domains is in line with typical hearing peers. Depending on the age of the child, assessment and monitoring of speech perception using CI alone may also be possible. This information along with ongoing diagnostic assessment and discussion with parents/caregivers of the child's daily listening abilities and challenges will allow realistic therapy goals to be set. For guidance in goal setting, review *The Essential Steps to Paediatric Cochlear Implant Habiliation*; details below.

2. Development of listening and spoken language skills. As all children with hearing loss are at risk of delays in their speech, language, and literacy development, children with SSD may also require support in these areas. Parents/caregivers and family members being active in the therapy process is vital to successful rehabilitation for paediatric CI recipients. Goal-directed therapy based around family involvement is recommended. For guidance in therapy planning and parent/caregiver coaching, review *The Essential Steps to Paediatric Cochlear Implant Habilitation* and the *MED-EL Lesson Kits*. Parents/caregivers and family members can be coached to move close to and direct spoken language to the side of their child's CI as an easy daily strategy to support auditory skills on the CI side.

Depending on the child's age at cochlear implantation and duration of deafness, targeted listening practice with the CI alone may be required to support the child to integrate the CI delivered auditory information. If the child has a duration of deafness of longer than 24 months, targeted listening practice with the CI alone using the free field technique or DAI is recommended.

3. Development of binaural benefit. For children who have developed some auditory and language skills, activities which focus on development of localization and listening in noise can be included in the rehabilitation programme. Suggestions for suitable activities for development of localization can be found in *Sound Localization* and on the MED-EL Blog. In addition, it may be beneficial to practise auditory skills in background noise. Activities based on the auditory skills development hierarchy with various types of background noise can be helpful. Phonological development, global language skills, attention, and memory influence listening-in-noise performance.

Start with low intensity background noise and target already well-established auditory skills. Suggested background noise to add, from easiest to hardest:

- Steady state noise (e.g., white noise), other noise unrelated to spoken language (e.g., orchestral music)
- Multi-speaker babble (individual speakers indistinguishable)
- Speaker babble with highlighted salient spoken phrases

Activities carried out in background noise are taxing for recipients. Keep activities brief (less than ten minutes). Monitor carefully the level of background noise presented. It is suggested that activities are started at +15 dB SNR and progressed to louder levels as confidence grows and performance improves.

4. Parent/caregiver and family education providing training in how to improve the child's listening environment(s) and use communication strategies to support more successful communication interactions in daily life. This may also involve training for education staff. See *MED-EL Resources to Support Rehabilitation* for further information below.

5. Ongoing expectations counselling is important to support parents/caregivers to maintain high but realistic expectations for their child's progress.

# SSD & Cochlear Implant Rehabilitation With Adults

Following CI, there are five core aspects of CI rehabilitation when working with adults with SSD.

1. Ongoing assessment and monitoring of the recipient's CI use and speech perception testing with the CI alone is important to support best outcomes. Discussion of daily listening abilities and challenges will allow realistic therapy goals to be set collaboratively with the recipient. Monitoring and sharing progress, even if slow or small, has shown to be an important factor in motivating recipients to persevere with CI use and rehabilitation.[5,6]

2. Auditory training is essential and may include analytic and synthetic listening exercises (as with adult CI recipients with bilateral hearing loss) using the free field technique or DAI. Use of materials which are tailored to the interests of the recipient will support motivation. Daily home practice of between 20–30 minutes is recommended. Active focused listening activities with a rehabilitation professional, partner, family member, or self has shown to be more beneficial than passive listening tasks (e.g., watching TV).[5] Audio files of a family member speaking, online videos, ebooks, and online materials used to teach English as a second language can all be used for auditory training.[5] Enable captions, provide the written text of what is being said, use familiar vocabulary, and/or slow down the reading rate to make tasks easier. See further resources for therapy under *MED-EL Resources to Support Rehabilitation* below.

3. Development of binaural benefit. It is useful to include activities which focus on the development of localization to promote this binaural benefit. Suggestions for suitable activities for development of localization can be found in *Sound Localization* and on the MED-EL Blog. Activities based on the auditory skills hierarchy with various types of background noise may be helpful. Global language skills, attention, and memory influence listening-in-noise performance.

Start with low intensity background noise and target already well-established auditory skills. Suggested background noise to add, from easiest to hardest:

- Steady state noise (e.g., white noise), other noise unrelated to spoken language (e.g., orchestral music)
- Multi-speaker babble (individual speakers indistinguishable)
- Speaker babble with highlighted salient spoken phrases

Activities carried out in background noise are taxing for recipients. Keep activities brief (less than ten minutes). Monitor carefully the level of background noise presented. It is suggested that activities are started at +15dB SNR and progressed to louder levels as confidence grows and performance improves.

4. Communication therapy to understand how to improve the listening environment, use clarification strategies, and communication partner training to support more successful communication in daily life. See *MED-EL Resources to Support Rehabilitation* for further information below.

5. Ongoing expectations counselling is important to support recipients to adjust to their CI and to facilitate maintaining high but realistic expectations for their progress.

# MED-EL Resources to Support Rehabilitation

For further information about SSD, view the Expert Web Series on the MED-EL Professionals Blog.

Gain a deeper understanding of the everyday effects of SSD with this simulation and website.

Visit the MED-EL Blog for further information on auditory training and communication strategies including how to improve the listening environment, use clarification strategies, and communication partner training. Learn more about how MED-EL technology manages noisy environments and find further ideas for practicing sound localization.

The MED-EL Blog 5-part series *Rehab For Adults: Auditory Training With Your Cochlear Implant* provides more information and resources for auditory training. These activities may require modification in how they are presented if using the DAI technique for auditory input.

Download the *MED-EL Lesson Kits* for free paper-based CI rehabilitation resources. The Lesson Kits are a series of themed kits to support rehabilitation sessions with young children. Each Lesson Kit has multiple activities with goals at different levels, so that activities may be tailored to the abilities of individual children. The MED-EL Lesson Kits are available in several languages. Some of the activities may require modification in how they are presented if using the DAI technique for auditory input.

*The Essential Steps to Paediatric Cochlear Implant Habilitation* is a guide for professionals working with families who have children using cochlear implant(s) or being considered for cochlear implantation. It lists goals for parents/caregivers and the child, pre-implant and at three levels post-implant. It can be used to identify intervention targets and monitor progress. In addition, it includes an explanation of key strategies effective in facilitating best listening and spoken language outcomes and information about Play Sounds and how to use them. Contact MED-EL to obtain a copy.

*Sound Localization* includes a range of tips to help develop recipients' ability to perceive and localize the direction of sounds. Available for free download.

*Auditory Skills Checklist* is an assessment measure used to assist in tracking the progress of a child's auditory development and in setting goals. The Auditory Skills Checklist is available as an app. Alternatively, contact MED-EL to obtain a hard copy.

The *Hearing Implant Sound Quality Index (HISQUI)* is a validated questionnaire that can be completed in 10–15 minutes. It will support discussions with the recipient about their daily listening abilities and challenges and assist in identifying therapy goals collaboratively. Available for free download.

*Hear Today* allows clinicians to evaluate recipients' current level of functioning with their CI. It also provides recipients with tips to improve their listening skills in everyday situations. Hear Today is available as an app. Alternatively, contact MED-EL to obtain a hard copy.

*Hear at Home* provides exercises for auditory training designed for use at home with family or in therapy. The exercises provide the speaker with detailed instructions on how to present the materials and can be adapted according to the abilities of the recipient. These activities may require modification if using the DAI technique for auditory input. Contact MED-EL to obtain a hard copy.

*Expectations Questionnaire for Children (EQC)* may be helpful in pre-implant counselling discussions. Contact MED-EL to obtain a hard copy.

*Expectations Questionnaire for Adults (EQA)* may be helpful in pre-implant counselling discussions. Contact MED-EL to obtain a hard copy.

Contact your MED-EL representative or the MED-EL Rehabilitation Department at rehabilitation@medel.com to obtain copies of any of the mentioned resources.

# References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