

# Long Interval Sequential Cochlear Implantation

BINAURAL HEARING SERIES



hearLIFE

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## 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

## Bilateral Cochlear Implantation

Bilateral cochlear implantation can be achieved either simultaneously (both devices implanted in one surgery) or sequentially (first cochlear implant [CI] in one surgery, second cochlear implant later in a separate surgery).

Simultaneous or sequential cochlear implantation at a young age with no or short interval between has been shown to be the most beneficial for children with severe-to-profound deafness.<sup>1,2</sup>

### Long Interval Sequential Cochlear Implantation

Due to a range of factors, many recipients receive their second cochlear implant later than is optimal.

Receipt of the second cochlear implant after a less than optimal duration is referred to as long interval sequential cochlear implantation. This is thought to be suboptimal due to the lack of opportunity to take advantage of the early degree of plasticity in the auditory system.<sup>3</sup>

Despite this suboptimal condition, almost all recipients who use their CI have been shown to gain benefit.<sup>4</sup>

Rehabilitation for long interval sequential CI recipients aims to maximize the benefits of both devices to allow best outcomes. Some focus should be on improving the performance of the usually weaker second CI (CI2) so that performance more closely matches that of the first CI (CI1).

# Rehabilitation With Children

There are two key aims of rehabilitation for children who are long interval sequential recipients.

The first is to maximize spoken language development. The second is to enhance the benefits of binaural hearing potentially conferred by the CI.

**1. Pre-implant counselling** is important for all potential recipients of a cochlear implant. All typical counselling aspects should be covered, such as risks of surgery and need for ongoing rehabilitation. The following important additional considerations for the long sequential interval condition should be discussed.

- a. Potential benefits of CI2. Recipients should be made aware that there is potential for a lesser result than CI1.
- b. The need for commitment to additional rehabilitation to maximize benefit from the new CI and to achieve maximum binaural hearing benefit possible.

**2. Rehabilitation programme for CI.** It is strongly recommended that parents/caregivers are present at all rehabilitation sessions and that all members of the child's educational team are communicated with.

**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. Auditory skill development in background noise should also be included. Activities based on the auditory skills development hierarchy with various types of background noise may be added. 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 users. 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 improves and performance grows.

**4. Caregiver and family education.** Training in how to improve the child's listening environment(s) and use communication strategies to support more successful communication interactions in daily life will be beneficial. This may also involve training for education staff.

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

A "Wear Schedule" should be developed so that the child has some time with the new CI alone. See below for details.

# Rehabilitation With Adults

Rehabilitation for adults needs to focus on maximizing binaural benefit.

**1. Pre-implant counselling** is important for all potential recipients of a cochlear implant. All typical counselling aspects should be covered, such as risks of surgery and need for ongoing rehabilitation. The following important additional considerations for the long sequential interval condition should be discussed.

- a. Potential benefits of CI2. Recipients should be made aware that there is potential for a lesser result than CI1.
- b. The need for commitment to additional rehabilitation to maximize binaural hearing benefits.

**2. Ongoing assessment and monitoring** of the recipient's CI use and speech perception with their CI is important to support best outcomes. Discussion of daily listening abilities and challenges will allow realistic therapy goals to be set collaboratively with the user. Monitoring and sharing progress, even if slow or small, is important.

**3. Development of binaural benefit.** Activities which focus on development of localization and listening in noise can be included in the rehabilitation programme. Some suggestions for suitable activities for development of localization can be found in [Sound Localisation](#). Auditory skill training in background noise should also be included.

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 and performance grows.

**4. Communication therapy** to understand how to improve the listening environment and use clarification strategies. Communication partner training will support more successful communication in daily life. You can read more about this [here](#).

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

When CI2 is first provided, a "Wear Schedule" should be developed to give some time with the new CI alone.

## Developing a “Wear Schedule”

At all times when in the CI2 alone condition, keep the hearing aid nearby and visible to the recipient. If a situation arises of uncertainty or fear (e.g., if a visitor arrives into the home), allow the recipient to replace the hearing aid if desired.

Some recipients will be anxious about removing their familiar hearing aid which they have come to rely on. Reassure them by explaining how long this is for. For example, “It’s just for five minutes”, or “We’ll put it back soon.” Use an egg timer or timer on a phone if visual support is needed. Include time with CI2 alone when the recipient is relaxed at home and involved in typical activities.

Include time with CI2 alone in rehabilitation (as outlined above for children). Establish access to sound with CI2.

1. The first step is to establish access to speech sounds with CI2. This is typically done using the *Ling Six Sound Test*, see [here](#).

If problems persist with access to speech sounds, please discuss with the audiologist or engineer who is responsible for programming to find ways in which this might be improved.

2. Establish current performance in auditory skills with CI2. It is important to establish a current level of functioning in auditory skills as it gives the aim for performance using the new CI.

3. Set goals for auditory skill development with CI2. Begin with diagnostic testing of each skill. Continue until the point of non-performance coupled with stimulability is reached.

4. Begin rehabilitation sessions based on teaching the goals. Usual techniques for rehabilitation for auditory goals should be employed. The recipient may be reluctant to remove CI1 to complete such work. To minimize these effects:

- begin with very short duration activities with CI2 only, interspersed with activities with both CIs, and work up to a longer level of CI2 only time;
- leave CI1 close by where the recipient can see it;
- ensure that activities focus on listening development; and
- reduce cognitive load of activities—ensure that the activity is simple so the focus is on listening. For example, do not include the teaching of new vocabulary or concepts in the CI2 only condition.

Always remember that the ultimate goal is best performance while wearing both devices simultaneously, so this should be the usual condition for recipients.



## MED-EL Resources to Support Rehabilitation

For adult recipients, 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.

The MED-EL Blog 5-part series [Rehab For Adults: Auditory Training With Your Cochlear Implant](#) provides more information and resources for auditory training.

The *Hearing Implant Sound Quality Index*<sup>19</sup> (*HISQUI*<sup>19</sup>) is a validated questionnaire for adult recipients 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 daily 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. Contact MED-EL to obtain a hard copy.

The *MED-EL Expectations Questionnaire* may be helpful in pre-implant counselling discussions. Contact MED-EL to obtain a hard copy.

*The Essential Steps to Paediatric Cochlear Implant Habilitation* 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 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 hard copy.

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 can be tailored to the abilities of individual children. The MED-EL Lesson Kits are available in several languages.

Contact your [MED-EL representative](#) or the MED-EL Rehabilitation Department at [rehabilitation@medel.com](mailto:rehabilitation@medel.com) to obtain copies of any of the mentioned resources.

## References

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