

# Simultaneous Bilateral Cochlear Implant Users - Children

## 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 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

Simultaneous bilateral cochlear implant users are those who use a cochlear implant (CI) on one side and a CI in the other ear and received both implants in one surgery.

Recipients can take advantage of the binaural hearing this condition provides to access the benefits listed.



**Rehabilitation aims to maximize the benefits of both devices to allow best outcomes for the user.**

Early bilateral simultaneous cochlear implantation provides an advantage for developing language. Compared to children with a unilateral implant, children with bilateral implants have more complex verbal skills and better language scores that are more similar to children with typical hearing.<sup>1,2,3</sup> Preverbal communication skills were also noted to be improved for children bilaterally (simultaneous and sequential) implanted. Results showed that they were significantly more likely to use vocalization to communicate and to use audition when interacting vocally with an adult when compared to children unilaterally implanted.<sup>4</sup>

Additional benefits for simultaneous implantation include an easier adjustment to two devices as both ears are adjusting to new sound processing over the same time period, always having access to sound in case one device is not available (e.g., needing part replacement), and assuring that for children with differences between ears the ear with better potential is implanted. Bilateral cochlear implantation is now considered acceptable medical practice. For children and adults who are candidates for CI in both ears, it is clear from the literature that they perform better with two cochlear implants rather than one, and bilateral cochlear implants are strongly endorsed.<sup>5</sup>

There is evidence of a sensitive period or “window” of opportunity to acquire effective binaural integration. Research suggests that bilateral implantation, whether simultaneous or sequential, occurring within the sensitive period of a child's first 3.5 years, takes advantage of the high degree of plasticity in the developing central auditory nervous system. The same sensitive period and time course for normalization of the central auditory evoked potential is now known to exist for the second implanted ear.<sup>6</sup> One study found that children receiving early simultaneous bilateral cochlear implantation had P1 latencies near normal limits by one month post-implantation leading the authors to suggest early bilateral implantation preserves the integrity of the central auditory system.<sup>7</sup> As with the first ear, earlier is better when considering cochlear implantation of the second ear to be able to preserve the plasticity of the auditory pathway.

# Rehabilitation

After cochlear implantation, rehabilitation can help facilitate best listening and spoken language development. A child will need exposure to key strategies for developing listening skills to reach full potential as a verbal communicator. Family involvement is essential to this process. MED-EL has resources that may be helpful in empowering parents/caregivers. Informative booklets include *The First Steps: A Parent's Guide to Cochlear Implants*. It introduces parents/caregivers to the topic of cochlear implantation and rehabilitation. Discussion of early communication skills and how to facilitate a child's development of these skills can be found in [Little Listeners](#). To learn about the benefits of music and how to introduce music into a child's life refer to [Music and Young Children With CIs](#). The two key aims of rehabilitation are to maximize spoken language development and to enhance the benefits of binaural hearing. Following CI, there are six core aspects of rehabilitation.

**1. Pre-implant counselling.** This is important for all potential recipients of a cochlear implant. Typical counselling aspects covered include areas such as risks of surgery and need for ongoing rehabilitation. The following additional considerations for the bilateral condition should be discussed.

- a. The expectation that both devices will need to be worn during all waking hours.
- b. Expected benefits of each device. During pre-implant evaluations, each ear will have been tested separately. For many children, the configuration of the hearing loss, aetiology, and expected outcomes will be similar for both ears. For others there may be a difference, and parents/caregivers will need to understand that one ear may be considerably more dominant than the other.

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

**2. Ongoing assessment and monitoring.** Evaluation of the use of both devices is important to support best outcomes. Assessment and monitoring of detection and speech perception provides valuable information regarding the child's auditory skills. It is beneficial to assess these two skills with each CI alone as well as together. Assessment should include the [Ling Six Sound Test](#) and speech discrimination tasks. Informal

speech discrimination tasks can include sets of words that differ by vowel only or by one consonant only. If a significant discrepancy in skills is noted between ears, additional specific listening activities are recommended for the poorer ear. Discussion with parents/caregivers about a child's daily listening abilities and challenges provides information for the rehabilitation professional to set realistic therapy goals collaboratively with the family. Ongoing monitoring of speech, language, and literacy skills is also important.

**3. Development of listening and spoken language skills.** Children with hearing loss are at risk of delays in their speech, language, and literacy development. Goal-directed therapy based around family involvement is recommended. For details of this refer to *The Essential Steps to Paediatric Cochlear Implant Habilitation*. For a complete rehabilitation programme of activities which cover all needed aspects download the [MED-EL Lesson Kits](#). The [MED-EL Blog](#) provides information and tips & tricks for facilitating a child's communication skills.

**4. Development of binaural benefit.** Sound localization and improved listening in noise are significant benefits of binaural hearing.<sup>8</sup> For children who have developed some auditory and language skills, activities which focus on development of these two skills can be included in the rehabilitation programme. Sound localization skills develop over time and require practice. [Sound Localisation](#) provides information and tips on how to develop these skills. Assisting a child in becoming aware of and in which direction a sound is coming from will help the child learn to use binaural hearing to develop localization skills. Practising already mastered activities in the presence of background noise will help the child listen and understand in situations of competing noise.

**5. Caregiver and family education.** Provide 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. For further information see MED-EL Resources to Support Rehabilitation.

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

## Tips & Tricks

### Tips & Tricks for Sound Localization

Point out environmental sounds as they happen or when out on a listening walk. Point to your ear that is closest to the sound and say, "I hear that." Then point to the sound source to help the child make the connection.

Play games that require the child to listen for speech before performing an action. Say the words from different locations (e.g., to the child's right ear, left ear, directly behind) to help the child start to localize.

- Jump around: set out coloured circles that are large enough for a child to stand on. The child waits until "go" or "jump" is heard. The child then jumps to a circle in the direction that the speech was from. When the child leaves one circle to jump to the next, remove the circle previously on. End the game when the child is standing on the last circle.

Play with noisemakers. Hide different noisemakers throughout a room and have the child use localization skills to find the toy/object.

- Adaptation to [LittLEARS® Diary Activities](#) - Week 2 Toys/Objects that make noise. Introduce noise making toys/objects to the child. Then hide the noisemakers to the left, right, in front, and behind the child. Have the child sit with eyes closed, make a noisemaker go off, move away from it, and have the child open eyes and identify where it is coming from.

When presenting information, reading, or singing to the child, make sure to alternate sides so one ear is not being treated as the primary listening ear.

- Adaptation to [Lesson Kit #6 Cats and Dogs](#). When singing "How Much Is That Doggie in the Window?" booklet, alternate ears for each verse. This also provides the child with exposure to books and to music. Additional resources to provide exposure to books include [All in a Day](#) and [The Murat Reader Series](#).

### Tips & Tricks for Listening in Background Noise

Start with low intensity background noise. Suggested background noise to add from easiest to hardest are:

- 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 challenging for recipients. Keep activities brief (less than ten minutes).

Monitor carefully the level of background noise presented. It is suggested that activities start at +15 dB signal-to-noise ratio progressing to louder background noise levels as confidence grows and performance improves.

Target already well-established auditory skills and use language the child is already familiar with.

- Adaptation to [Lesson Kit #24 My Family](#). Use with a child who is familiar with and able to easily identify family member names. Start the background noise source and check the loudness before you begin. The child listens for specific family member names, picks out the correct picture, and follows simple directions (e.g., "Glue Mummy next to Daddy." and then glues it on the family tree).

# MED-EL Resources to Support Rehabilitation

## MED-EL Rehabilitation Online Resources

[MED-EL Blog](#) provides further information on auditory training, language development, and communication strategies.

[MED-EL Lesson Kits](#) are free paper-based CI rehabilitation resources. The Lesson Kits are a series of themed kits to support rehabilitation sessions with young children. Each kit has multiple activities with goals at different levels so that activities may be tailored to the abilities of individual children.

[Little Listeners](#) discusses early communication skills and how to facilitate a child's development of communication.

[Music and Young Children With CIs](#) provides information about the benefits of music and how to introduce music into a child's life.

[Sound Localisation](#) provides information and tips on how to develop these skills.

[LittEARS® Diary Activities](#) provides ideas to practise listening and language in the home environment. It can be used in conjunction with LittEARS® My Diary.

[All in a Day](#) is a booklet that tells the story of a boy, who has a cochlear implant, and his day. It provides suggestion for facilitating a child's listening and communication skills.

[The Murat Reader Series](#) is a series of books about a boy who has a cochlear implant. It contains parent's/therapist's pages to provide the user with ideas for listening activities and games to support conversations with a child.

[Why You Hear Better With Bilateral Cochlear Implants](#) is a blog post that explains hearing with bilateral cochlear implants.

[The Ling Six Sound Test Explained](#) describes what the Ling Six Sounds are and why they are important.

## Additional MED-EL Rehabilitation Resources

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.

*The Essential Steps to Paediatric Cochlear Implant Habilitation* is a guide that includes three different levels of communication goals, key strategies, and an explanation and examples of Play Sounds.

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

*LittEARS® My Diary* is designed for professionals and parents/caregivers to gather information about a child's early auditory, speech, and language development.

*A Child's Journey Developmental Milestones (Birth to 6 Years)* provides a guideline of skill acquisition for children in eight domains important to communication development.

*LittEARS® Auditory Questionnaire* assesses auditory behaviours up to 24 months of hearing age.

*EARS® (Evaluating Auditory Responses to Speech)* evaluates long-term listening development in children and includes tests of various difficulty levels.

*Auditory Skills Checklist* is a criterion-referenced assessment for tracking progress of a child's auditory development.

*The First Steps: A Parent's Guide to Cochlear Implants* introduces parents/caregivers to the topic of cochlear implantation and rehabilitation.

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## MED-EL Offices Worldwide

### AMERICAS

#### Argentina

medel@medel.com.ar

#### Canada

officecanada@medel.com

#### Colombia

office-colombia@medel.com

#### Mexico

office-mexico@medel.com

#### United States

implants@medelus.com

### ASIA PACIFIC

#### Australia

office@medel.com.au

#### China

office@medel.net.cn

#### Hong Kong

office@hk.medel.com

#### India

implants@medel.in

#### Indonesia

office@id.medel.com

#### Japan

office-japan@medel.com

#### Malaysia

office@my.medel.com

#### Philippines

office@ph.medel.com

#### Singapore

office@sg.medel.com

#### South Korea

office@kr.medel.com

#### Thailand

office@th.medel.com

#### Vietnam

office@vn.medel.com

### EMEA

#### Austria

office@at.medel.com

#### Belgium

office@be.medel.com

#### Finland

office@fi.medel.com

#### France

office@fr.medel.com

#### Germany

office@medel.de

#### Italy

ufficio.italia@medel.com

#### Portugal

office@pt.medel.com

#### Spain

office@es.medel.com

#### South Africa

customerserviceZA@medel.com

#### United Arab Emirates

office@ae.medel.com

#### United Kingdom

customerservices@medel.co.uk

MED-EL Medical Electronics  
Fürstenweg 77a | 6020 Innsbruck, Austria | office@medel.com

medel.com

