INVESTING IN CHILDREN'S HEARING:

# Deaf Children and the Impact of Cochlear Implantation



**Hearing is fundamental for children to acquire the spoken language of their home. Spoken language enables children to communicate, interact with their families and carers, acquire literacy skills and achieve their educational potential. As the World Health Organisation (WHO) noted in their World Report on Hearing (WRH 2021).**

> ***Unless addressed in a timely manner, those with hearing loss have reduced school performance, slower progression through the academic system, a greater risk of dropping out of school, and lower likelihood of applying for higher education, compared with their hearing peers.***
> *(WHO, WRH, pages 45- 46)*

## WE KNOW THAT:

- For children with greater degrees of hearing loss, cochlear implants (CI) provide hearing not possible with hearing aids.
- Cochlear implantation in children has been shown to be safe, effective and cost-effective.
- Over 300,000 children globally have received cochlear implants (industry estimate).

> ***Cochlear implant is one of the most successful of all neural prostheses developed to date.***
> *(WHO, page 100)*

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## RECOMMENDATIONS:

- Newborn hearing screening should be in place to allow early fitting of hearing aids and cochlear implants, together with early intervention.
- Cochlear implantation should be considered for all those children with greater levels of hearing loss.
- Children's implantation requires access to multi-professional skills including ear surgeons, audiologists, speech and language therapists, teachers of the deaf, psychologists.
- Children with CI require follow-up services, including regular programming of the system and regular habilitation, including communication and spoken language skills.
- Families and local professionals, including teachers and therapists should be involved in the ongoing care of children with CI.
- Following cochlear implantation, children need the opportunity to hear rich spoken language.
- Lifelong services are required, including managing the technology and the transitions to school, higher education and the world of work.
- Access to accessories to support the use of the CI system in education, work and home should be given.
- Family services, including peer to peer support and groups, facilitate the effective use of the CI system in communication.

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## WHAT IS A COCHLEAR IMPLANT?

**A cochlear implant consists of an internal receiver which is surgically implanted into the cochlea, or inner ear, and a microphone, and processor. The processor converts the sounds from the microphone into electrical signals which are then transmitted through the skin to the internal receiver, and from there up the auditory nerve to the brain. Cochlear implants provide deaf children with levels of hearing that allow most to acquire spoken language.**

**Cochlear Implants have been proven to be effective in addressing language deprivation** *(Kral & O'Donoghue, 2010)* **which can follow from deafness, enabling deaf children to acquire age-appropriate language.**

## EARLY COCHLEAR IMPLANTATION SUPPORTS SPOKEN LANGUAGE ACQUISITION

Language is usually acquired through hearing the spoken language of their family and takes years for the full competence of the home language to be reached. 95% of deaf children are born to hearing families *(Mitchell & Karchmer, 2004)*, where the language of the home is a spoken one.

**When children are implanted early in life and have access to a rich spoken language environment and well managed hearing technology studies show spoken language can develop wihin the same range as for children without hearing loss:**

- Newborn hearing screening has been shown to be cost-effective *(WRH, 2021 P86; Yoshinaga -Itano et al., 2021, Sharma et al., 2019; Chorozoglou et al., 2018; Chiou et al., 2017)* and enables hearing aids to be fitted in the first months of life, and cochlear implants in the first year of life, where they are safe and most effective. *(Dettman et al., 2016).*
- Early implantation supports the acquisition of spoken language and the optimum age for implantation for profoundly deaf children is before 1 year. *(Kral et al., 2025; Karltorp et al., 2020; Birman et al., 2012).*
- "Children younger than 3 years of age with cochlear implants have similar trajectories in early auditory and language developments to normally hearing children." *(Zhao et al., 2020).*
- "Participants who received implants before 18 months of age performed at or above age and gender norms for spoken language and academic achievement." *(Cejas et al., 2023) .*
- When implanted by the age of three years, with over four years CI experience, 6–10-year-old children are able to perform similarly to their age-matched hearing peers in terms of their comprehension of newly learned words. *(Pimperton et al., 2018).*
- For neurodivergent children with profound hearing loss CI's have also been shown to be an effective intervention with the potential to improve auditory skills, language, and enhance social engagement. *(Jenks et al., 2021).*
- Parents of complex children with CI valued the changes in their child's communication where the child was more included in family life following cochlear implantation. *(Mulla et al., 2013).*

## THE BENEFITS OF BINAURAL HEARING

- A literature review concluded that "cochlear implants promote development of hearing in children and the best outcomes are achieved by providing early access to sound in both ears." *(Sharma et al., 2020).*
- A study on 84 deaf children with bilaterial implants found that;" Congenitally deaf children who were fitted bilaterally in the 1st year of life can develop age-appropriate language skills by the time they start school." *(Illg et al., 2024).*
- A Belgian study of longitudinal outcomes for children with single-sided deafness with CIs reported levels comparable to their peers with normal hearing, particularly in grammar development and speech perception in noise. *(Van Wieringen, 2025).*
- *Wie (2010)* found that for children implanted bilaterally between 5 and 18 months of age "developed language skills at a faster pace than their hearing ages would suggest and over time achieved expressive and receptive language skills within the normative range."

## EARLY INTERVENTION AND FAMILY SUPPORT AND INTERACTION FACILITATES SUCCESSFUL OUTCOMES

- Parental engagement, educational level and socio-economic status have a significant impact on language acquisition and successful usage of CI for children *(Mueller L, et al., 2025, Sarant, et al., 2015).*
- Caregiver language input is hugely important during the early years in ensuring good language acquisition for deaf children *(Holzinger et el., 2020; Nittrouer et al., 2020; Holt et al., 2022)*.
- A study in the Netherlands found that children with CI who are placed in early intervention environments that facilitate auditory development are able to achieve good auditory speech perception levels in the long term. Ensuring that "In principle this even enables the acquisition of age-appropriate language comprehension for children that are referred to mainstream education." *(Langereis, et al., 2015).*
- Children who followed the designated program of postoperative mapping/programming and auditory verbal therapy (AV) for a minimum period of 1 year did equally well as their hearing peers in terms of hearing perception and speech intelligibility, "irrespective of the socioeconomic status of the family." *(Sharma et al., 2017).*
- "AV intervention is associated with improved outcome for children with CI." *(Percy-Smith et al., 2018).*
- A recent scoping study found that; "Positive parent-child interactions, placement in a mainstream education setting, and auditory or oral therapy were the microsystem factors associated with better speech perception outcomes." *(Corbett & Van Zalk, 2025).*
- In one study children with who are "early diagnosed; received amplification by 3 months; enrolled into AV intervention by 6 months and received a cochlear implant by 18 months if required, were able to "keep up with" rather than "catch up to" their typically hearing peers by 3 years of age on measures of speech and language, including children with profound hearing loss. By 5 years, all children achieved typical language development and 96% typical speech." *(Fulcher et al., 2012).*
- Research with Arabic-speaking children found that "Children with CI who have no additional disabilities can reach receptive vocabulary levels similar to typical hearing peers." *(Hariz et al., 2026).*

## PARENTS VALUE COCHLEAR IMPLANTATION AND ARE SATISFIED WITH THEIR DECISION

- Most parents report overall benefits from cochlear implantation for their children *(Chavan & Nandurkar, 2017)* and parents of children with additional disabilities also valued the impact CIs had for their children's quality of life and positive impact on family life *(Nasralla et al., 2018).*
- In research with parents 99% of respondents were pleased with their decision to obtain a CI. The most important reasons reported for choosing CIs by parents were for their child to use the same language as their families and to effectively communicate in hearing society: "According to parent report, 95% of K-12 children and 100% of preschool children used spoken language as their primary mode of communication; majority of K-12 children performed same as or better than peers across academic subjects." *(Nelson et al., 2016).*
- Other research found that "at the end of the study, satisfaction level of the parents and children about cochlear implant was found high." and "88.3% of the parents expressed that the advancement in their children after cochlear implantation application met their expectations." *(Sahli et al., 2018).*
- Sach et al., (2004) found, using a willingness to pay model in the UK with 219 parents, that they would be willing to pay £127 per month (2001 values) for their child's implant, a substantial amount, and most parents saw no alternative to paediatric cochlear implantation that could improve their child's quality of life to the same extent.
- "The vast majority of parents did not regret their decision to proceed with implantation." *(Sach and Whynes, 2005).*
- A comprehensive review of the literature found "Overall, parents of children with CIs worldwide assess their child's well-being positively across multiple domains of CI-specific QoL." *(Warner-Czyz et al., 2022).*

## CHILDREN WITH CI ARE ACQUIRING LITERACY SKILLS WITHIN THE NORMAL RANGE

**Cochlear implantation facilitates the development of literacy skills within the normal range.**

> ***"children with severe to profound hearing loss with CIs can achieve at or above expected levels compared with hearing peers.***
> *(Cejas et al., 2023)*

Acquiring and improving literacy skills throughout life is an intrinsic part of education. Literacy enables greater participation in education and the work place, improves child and family health, reduces poverty and expands life opportunities. Historically poor literacy levels have held deaf children back from educational achievement and participation in the workforce. *(Mayer & Trezek, 2018).*

By providing access to sound and therefore spoken language, cochlear implantation has resulted in greatly improved literacy levels compared to previous reports. *(Mayer et al., 2021 Wang et al., 2021; Ching et al. 2018; Archbold & Mayer, 2012).*

- *Wang et al., (2021)* reviewed 47 research papers of group differences in reading skills between children with cochlear implants and hearing peers and found that children and young people with CIs "achieved within the normal range on standardised reading tests."
- *Meyer & Trezek (2018)* reviewed 21 empirical studies from 1997 to 2016 which reported on research covering over 1000 students with CIs. It was found that even when literacy outcomes reported were lower than those of the hearing comparison group, "children with CIs in these studies are still performing within the average range and are therefore successfully acquiring literacy."
- *Camarata et al., (2026)* found that "language and reading comprehension abilities were often within the typical range" for children with CI.
- Deaf students aged 9 to 18 years, educated in mainstream settings in a large Canadian city showed performance within the average range on standardized assessments of both reading and writing indicating achievement surpassing outcomes of the past (*Mayer & Trezek, 2024*). Spoken language was the primary means of communication of the children reported in this research.
- For eighty-six orally educated children "The mean reading passage comprehension standard score was within the normative range for typically hearing age-mates at both elementary-age and adolescent testing." *(Davidson et al., 2025).*
- "Over 90% of the sample had academic skills in the average range in both kindergarten and second grade . . . children with CIs in an inclusive program, with intensive intervention and strong language and social models, can develop skills commensurate with typically developing peers across a variety of core skills." *(Wilson et al., 2023).*
- Children implanted below 42 months had age-appropriate reading 5 and 7 years after CI. *(Archbold et al., 2008).*
- Reading skills were found to be linked to the amount of spoken language input in communication, access to spoken language through a cochlear implant, and age at implantation. *(Van der Kant et al., 2013).*

**This evidence confirms a positive shift in literacy outcomes for deaf students with CIs, exceeding the historically reported ceiling for children without CIs with the majority performing in the average range.**

**The improvement in literacy through children using CIs represents "a fundamental and significant shift, arguably unprecedented in the history of the field with respect to literacy."**
*(Mayer & Trezek, 2018)*

## INCREASED ACCESS TO MAINSTREAM EDUCATION, AND POSITIVE IMPACT ON EDUCATIONAL ATTAINMENTS.

Cochlear implantation has resulted in increased levels of mainstream school attendance and educational attainments. "Integrating into regular schools and being able to experience sounds along with better speech skills." *(WHO, 2021, page 98)*

- Mainstream educational placement was achievable for most of the children fitted with CIs including those implanted at an older age in a global study *(Muller, L., et al., 2023).*
- Auditory speech perception of children with CI in mainstream education enables them to acquire language and educational levels that are comparable to those of their hearing peers. *(Langereis et al., 2015).*
- More children in mainstream and hard-of-hearing environments were found to be resilient than in deaf educational settings. *(Langereis et al., 2015).* By high school, 75% of implanted children were in mainstream education, with grade placement of the teenagers appropriate to their chronologic age in a North American study. (Geers et al., 2011)
- A study from the Netherlands found that children with CIs who switched from special to mainstream primary education "achieved comparable levels of language and mathematics as their hearing peers." *(Straaten, T, et al., 2021).*

## SPECIALIST EDUCATIONAL SUPPORT IS IMPORTANT FOR ACCESS

Whether in mainstream education or a special school, educators need to ensure the technology is functioning well, and that the educational environment supports good communication and learning.

- Teachers of the Deaf play a crucial role in ensuring that children have access to the curriculum. *(Hartman et al., 2023).* However, "limited number of therapists or teachers of the deaf available to provide this, particularly in low and middle-income countries." *(WHO,2021, page 100).*
- Surveys of parents of children with CI repeatedly raise the issue of appropriate educational support for their children as the major challenge for them. "a fight for education." *(Archbold S, Mayer C. 2012; Archbold et al 2008, Sach and Whynes, 2005; Mulla et al., 2013).*

## COCHLEAR IMPLANTATION SUPPORTS A POSITIVE QUALITY OF LIFE FOR CHILDREN AND YOUNG PEOPLE

- In a comprehensive longitudinal study children using CIs reported better QOL across several scales including emotional, social, and school functioning compared with children without implants and adolescents' self-reported QOL was within the same range as for hearing peers. *(Cejas et al., 2023).*
- Improved QOL was found in a systematic review which concluded that "results indicated a significant improvement in QoL, as reported by both parents and through self-assessment. The treatment also demonstrated high levels of adherence. Both congenital and post-lingual groups yielded similar outcomes in terms of QoL and device usage time." *(Piva de Freitas et al., 2025).*
- A global survey of young people's views found that satisfaction rates with CI were high, with 70% being very satisfied, 27% satisfied and only 2 out of the 84 responding not satisfied. *(Archbold et al., 2024).*
- Young people in a group of 29, aged between 13 and 16, felt positive about their cochlear implants and the decisions made on their behalf by parents. *(Wheeler et al.,2007).*
- *Boerrigter et al., (2021)* showed that self-concept levels of profoundly hearing-impaired children with CI are comparable to those of hearing peers.

> "
> ***My cochlears have given me a life I never would have had. I'm able to attend school and college, work and support myself, and enjoy laughing with friends and family as well as music and things other kids enjoy.***
> *Young person with CI (Archbold et al., 2024)*

> "
> ***I owe pretty much my entire life to my CI. It allows me to attend a mainstream school, helps me build relationships and enables me to integrate and be a part of the hearing world."***
> *Young person with CI (Archbold et al., 2024)*

## COCHLEAR IMPLANTATION HAS A POSITIVE EFFECT ON EMPLOYMENT PROSPECTS AND ECONOMIC WELLBEING

- Children and young people are achieving better academic outcomes and experiencing better quality of life after cochlear implantation. *(Cejas et al., 2023).*
- In a study of 30 young people, all were in education, higher education or employment, 10-14 years after implantation. *(Beadle et al., 2005).*
- One study reported a higher percentage of individuals with CIs completed high school and obtained a 4-year college degree compared to the general population. *(Spencer et al., 2012).*

Individuals using CIs can achieve education and employment levels similar to their hearing peers when using oral communication. *(Venail et el., 2010, Choi et al., 2020).*

## INVESTMENT IN COCHLEAR IMPLANTATION IS COST EFFECTIVE

Cochlear implants, including bilaterial implants, for children and young people have been found to be cost effective in many studies. *(Bond et al., 2009).*

- Pre-lingually deaf children with bilateral CI had a lifetime positive outcome net benefit of 433,000 Euros. CI led to a reduction in educational costs of approximately €118,000 per child due to more children attending mainstream provision. *(Neve, et al., 2021).*
- For a specific cohort of children in the Netherlands in 2018 they estimated a net benefit of 26 million euros. *(Neve, et al., 2021).*
- A study in the UK reported a reduction in educational costs of €44,000 for the CI group, compared to a control group, due to the greater use of mainstream provision for deaf children with cochlear implants. *(Barton, et al., 2006).*

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- A study in Colombia found that for every dollar invested in rehabilitation of a child with cochlear implant, there was a return on investment of US$ 2.07. *(Penaranda et al., 2012).*
- CI was considered cost-saving in children when net savings from education expenses are taken into account. *(Schulze-Gattermann et al., 2002; and Semenov et al., 2013).*
- The total lifetime education cost savings from CI per child in a US study ranged from USD $167,000 to $191,000 depending on age of implantation. They estimated nearly $1.26 billion of societal savings over the lifetime of the current 60,000 paediatric cochlear implant candidates in the US at the time of the study. *(Semenov et al., 2013).*
- A study of low to middle income countries in Africa found that "Cochlear implantation and deaf education are equally cost effective in lower-middle and upper-middle income economies of Nigeria and South Africa. Device cost may have greater impact in the emerging economies of Kenya, Uganda, Rwanda, and Malawi." *(Emmett et al., 2015).*

It is expected that outcomes have improved further since these studies were undertaken due to:

- The improving technology of CIs, better programming and fitting techniques and improved language and educational support *(Gordon et al., 2023).*
- Early implantion and bilateral implantation are becoming more common and associated with better outcomes *(Kral et al., 2025; Illg et al., 2024; Cejas et al., 2023; Pimperton, et al., 2018).*

Improved coding could also allow for reduced costs in ongoing support for speech therapy and similar interventions *(Benifla et al., 2024)* while increased volume should reduce costs of the CI as provision increases *(Thum et al., 2022; Benifla et al., 2024).*

## IN SPITE OF THE PROVEN BENEFITS, THERE IS WIDE VARIATION IN ACCESS TO CI

Globally there is massive under provision of CI for children and young people who could benefit

In the United States, where only around 50% of the children who could benefit receive cochlear implants *(Raine et al., 2016).*

- For state funded programmes there are significant variations in candidacy criteria for cochlear implantation. *(Vickers et al., 2016; De Raeve et al., 2020).*
- A review of CI criteria in the United States found that "insurance payer criteria tend to lag behind the best clinical practice." and that "criteria certainly do not capture all circumstances in which a child may benefit from implantation." *(Varadarajan et al., 2021).*
- A study of third-party payers in the United States found that "audiologic and speech perception criteria are more stringent for children than adults across all policies." Also, that third-party payers employed a number of variable criteria to decide the medical necessity of CI, which was not up to date with evidence or best medical practice. *(Moses & Friedmann, 2021).*
- A global review of evidence also found that "Despite the importance of bilateral hearing in childhood, there is a great global discrepancy in terms of the availability of bilateral cochlear implants." *(Sharma et al., 2020).*
- A survey of 17 European countries on CI provision found that only 60% provided bilateral implantation. The respondents considered that financial restrictions were the deciding factor in this lack of provision. *(Vickers et al., 2016).*
- With the exception of countries which provide universal healthcare coverage, families from a lower socioeconomic status may have poorer access to cochlear implantation and associated services. Given resources to support CI provision speech and language benefits of cochlear implantation for children can be realized regardless of the family's annual income. *(Sharma et al., 2020).*

**A review of the barriers for children and young people receiving the benefits of CI identified the key ones:**

- Awareness of the impact of hearing loss and of the benefits of CI which has limited access and demand
- Restrictive guidelines or the lack of referral pathways including a lack of or limited hearing screening programmes leading to late implantation
- Funding restrictions on access to the technology and ongoing services
- Training and expertise of health and education professionals
- Ongoing lifelong services including access to repairs, accessories, and revision surgery when needed
- Appropriate educational services and support. *(Archbold & Lamb 2024).*

# SUMMARY

Access to CI and services for children is limited and varied across the globe.

Newborn Hearing Screening ensures early identification and facilitates early implantation which is key to the acquisition of spoken language

Early cochlear implantation enables deaf children to acquire age-appropriate spoken language

Cochlear Implantation is effective in developing literacy skills within the normal range

Cochlear Implantation enables more deaf children access mainstream education and achieve outcomes in line with hearing peers with the appropriate accommodations

Parents have very high levels of satisfaction with the impact of CIs for their children

Children and young people with CI experience a positive quality of life and achievements in line with hearing peers

Cochlear implantation is safe and cost effective

Children and families need the right support from professionals, teachers and education services to ensure the potential of the technology is realised.

Cochlear Implantation has a positive effect on later employment prospects and economic wellbeing

**Cochlear implantation has opened up access to sound which, with the right support, has transformed the lives of deaf children by creating the opportunity to acquire spoken language, improved literacy and educational attainment and improving the quality of life for hundreds of thousands of children and young people and their families.**

**We now need to build on the transformational opportunities that this technology offers for children and young people.**

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