



### Hearing impairment in young children

- 1/1000 infants in Canada is born with a severe irreversible hearing loss in both ears
  - Difficulty or inability to detect sounds
  - Limited access to speech sounds (*their own and other people's*)
  - Consequences are severe and wide ranging

### Consequences of a severe hearing impairment

A sensory problem: child cannot hear

↓

A cascade of « secondary » problems

↓

- perception of sounds
- speech production
- **language and communication**
- socialization
- education
- employment

### Consequences of a severe hearing impairment on language

- Linguistic consequences of hearing impairment are primarily due to an auditory (perceptual) deficit, but diminished sensory input results in restrictions in linguistic interactions and opportunities to communicate
- Inadequate linguistic experience leads to **linguistic deprivation**

### Management of young children with a severe hearing loss

- Cochlear implants (CIs) are recognized as a safe and reliable option in the management of severe to profound hearing impairment in young children

### Language gains: a « secondary effect » of cochlear implantation

- Cochlear implant benefits are primarily expressed in terms of auditory perception and speech production
- Language development is also an important outcome of implantation (*Fink et al., 2007*)
- Auditory skills, speech, and language are the three principal aspects of CI rehabilitation for young children (*McConkey-Robbins, 2000*)

## Impact of cochlear implantation on language

- By the time they receive a CI, children may not have developed functional language
- They will likely show a delay in the acquisition of a first language
- CIs appear to improve language development in children with a severe hearing loss
- Research reports wide variability: many factors influence language outcomes



## Clinical and social value of language assessment in CI users

- Professionals and parents need an accurate description of language development in children who receive a CI
- Lack of evidence impedes full support of cochlear implantation and systematic neo-natal screening by decision-makers (government, professionals, Deaf community)



## Objective

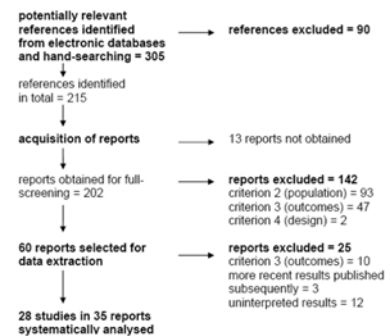
The existing difficulty in obtaining a clear picture from the literature regarding language outcomes appears related to conceptual and methodological issues

- Systematic review of the main outcomes in vocabulary and grammar of profoundly deaf children who received a CI before the age of 3 years

*“Do children who received a CI before their third birthday develop language at a rate equal or surpassing normally-hearing children, and ultimately attain language levels comparable to their hearing age-mates after a certain duration of implant use, or is a language delay still present ?”*



## Methods: Study search



## Methods: Inclusion / Exclusion criteria

Selection criterion	Inclusion	Exclusion
Population	congenitally deaf children; prelingually deafened children (18-months old or younger);	children deafened after the age of 18 months; children with cognitive/intellectual impairment;
Intervention	to have received a cochlear implant at 3-years old (36 months) or younger;	to have received a cochlear implant after the age of 3 (36 months);
Outcomes	language development; receptive and/or expressive vocabulary and grammar;	speech perception; speech production (intelligibility, articulation, voice, fluency); phonological awareness; literacy; reading abilities; phonological processing; babbling; prelexical abilities; pragmatics; narrative abilities; communicative strategies;
Type of design	analytic and observational designs; cohort studies (prospective and retrospective); case-control studies; case-studies/case-series; cross-sectional studies; qualitative research;	personal stories/accounts; literature review; letter to the editor/commentary; expert opinion;
Publication language	English and French;	other languages;
Language studied	all;	none;
Type of implant	multichannel cochlear implants	single-channel cochlear implants



## Methods: Data extraction and quality assessment

- Twenty-one of the total of 35 articles (60%), reporting 28 different studies were analysed independently by two investigators
- Extracted data included general and specific information on the demographics of the study participants, research design, language measures, analyses, and results
- A level of evidence score was attributed to each study, according to the *Oxford Centre for Evidence-based Medicine Levels of Evidence (Phillips et al., 2001)*



**Methods:  
Descriptive synthesis and meta-analysis**

- Each language domain was analyzed separately (vocabulary, grammar, comprehension, expression)
- Studies presenting standard scores, percentiles or age-equivalent scores were eligible for inclusion in a meta-analysis
- To perform the meta-analysis, we used the *Effect Size Calculator*, a statistical tool that generates summary statistics from pooled data (designed by Prs Bernard and Abrami, Montreal)



**Results:  
Descriptive synthesis**

- Language delay was the most common outcome
- When appropriate data was reported, it was possible to infer that some children demonstrated, for one or more language aspects of language, levels congruent with the duration of CI use (corresponding to *hearing age*)
- Other children exhibited levels superior to hearing age (suggesting accelerated development) but inferior to *chronological age*



**Results:  
Meta-analysis**

- The effect-size was considered low to medium (Cohen's criteria) for each language aspect

Language aspect	Number of subjects	g value	Effect size (Cohen's criteria)
receptive vocabulary	25	- 1,57	low to medium
receptive language (global measure)	12	- 0,56	low to medium
expressive vocabulary	22	- 3,24	low to medium
expressive grammar	22	- 8,77	low to medium
expressive language (global measure)	115	- 0,75	low to medium



**Results:  
Two developmental profiles**

1. A large proportion of the studies reported a positive impact of the implant on language achievement but this impact does not seem to be sufficient to allow children to attain normal language levels

*This pattern was observed in 23 studies, either in a large proportion of the children in the sample, or for most of the language components that were assessed in each particular study*



**Results:  
Two developmental profiles**

2. A smaller proportion of the studies indicated a major impact of the implant on language development, allowing children to achieve language levels corresponding to chronological age, sometimes as soon as within the first months after initial stimulation of the device

*These studies primarily examined children who received their implant before 2 years of age*

*This pattern was observed in 11 studies, either in a small proportion of the children in the sample, or for one of the language components assessed in each study*



**Discussion:  
Validity issues**

Study quality and evidence levels were major issues in the systematic review, especially regarding generalizability of the results

- Single case studies
- Heterogenous samples
- Very homogenous samples



## Discussion: Limitations of the review

---

- Inclusion of studies with weaker designs and “grey literature” (master’s and doctoral theses)
- Restriction to English and French publications
- Interpretation of data (variability of methods, designs, analyses, and types of scores employed to express outcomes)



## Conclusions

---

- Despite methodological limitations of studies, and the difficulty in drawing substantial conclusions based on the reviewed literature, the findings confirm that grammar and vocabulary skills improve in children who get a cochlear implant by the age of 3, but the magnitude of improvement is not uniform across language domains
- Studies that found that children with a CI attained a language level equivalent or near-equivalent to hearing age-mates examined specifically children who had the implant before the age of 2 years



## Conclusions : Future research directions

---

- Focus on children who received the implant around age 2
- Control for the potential confounding influence of age at implantation and duration of CI use
  - *Current study on 27 children with the same age at implantation (around 2) and length of CI use as one of the independent variables*
- Examination of more than one single aspect of language
  - *Current study examines receptive vocabulary and grammar and expressive vocabulary*



## Conclusions

---

- Continued research on language outcomes will help improve cochlear implant programs and adjust early intervention programs offered in rehabilitation centers and schools
- Ultimately, optimal language development will enable children with CIs to reach their full linguistic potential, which in turn will support academic achievement and participation in society
- The demonstration of significant benefits promotes early intervention, thus supports the implementation of national systematic newborn screening programs and cochlear implantation of young deaf children



# Thank you

## Acknowledgements:

