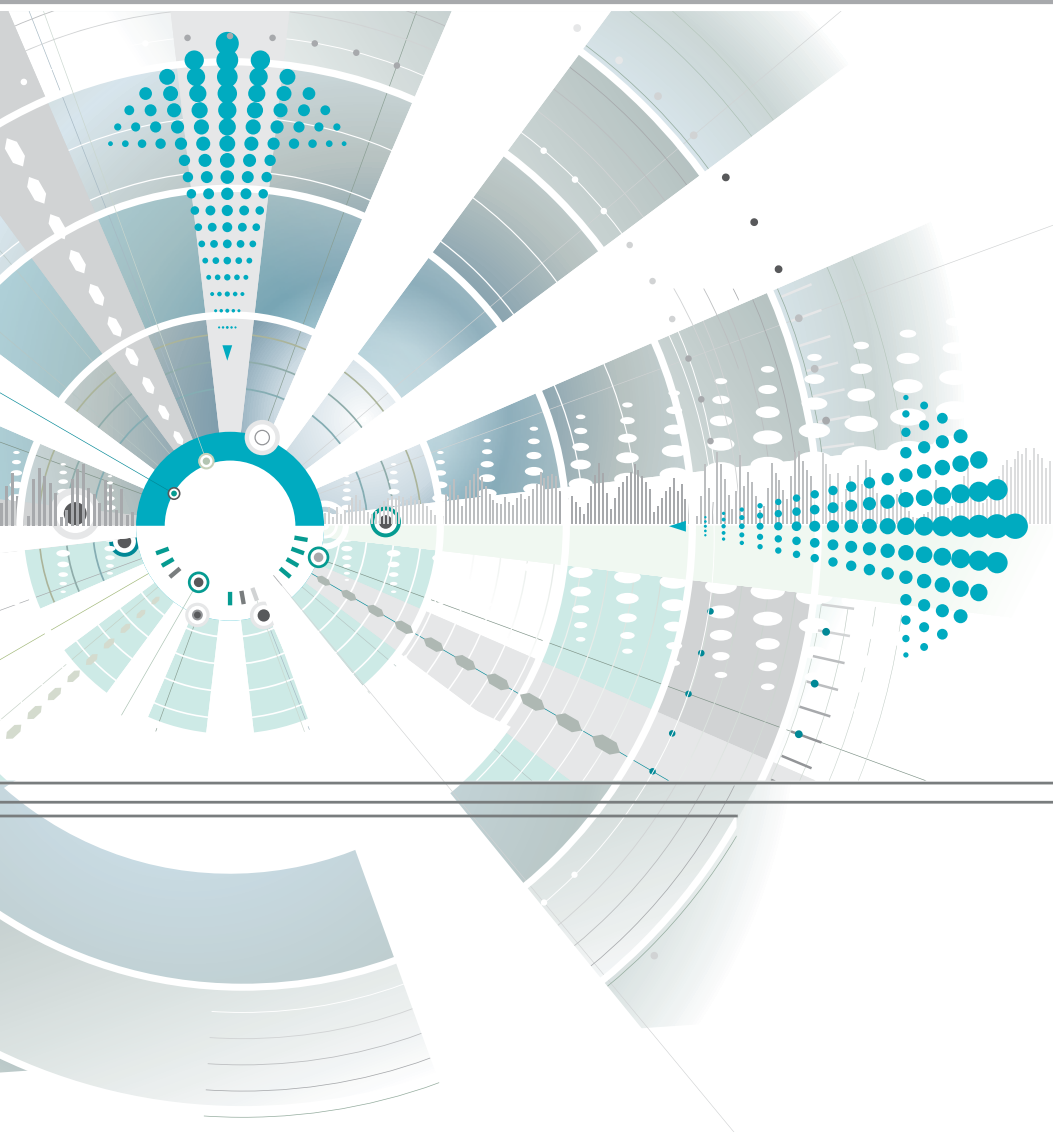


# REFERENCE Guide

Rehabilitation interventions and assessment of auditory benefits for people of all ages who have undergone sequential bilateral cochlear implantation

2016





# Reference Guide

Rehabilitation interventions and assessment of auditory benefits for people of all ages who have undergone sequential bilateral cochlear implantation

Document prepared by the working committee of the Centre intégré universitaire de santé et de services sociaux (CIUSSS) de la Capitale-Nationale, whose members are:

Paola Albornoz, M.Ps., M.Sc., head of the hearing impaired child/adolescent and cochlear implant (all ages) program

Catherine Champagne, M.O.A., audiologist with the hearing impaired child/adolescent and cochlear implant (all ages) program

Geneviève Tremblay, M.O.A., audiologist and clinical coordinator with the hearing impaired child/adolescent and cochlear implant (all ages) program

Judith Lavoie, M.Sc., Planning, Programming and Research Officer with the Academic Affairs and Teaching Directorate

François Bergeron, Ph.D., audiologist, full professor at Université Laval and full researcher at the Center for Interdisciplinary Research in Rehabilitation and Social Integration

## Collaborators

Professionals from the hearing impaired child/adolescent and cochlear implant (all ages) program,  
CIUSSS de la Capitale-Nationale

Julie Lamothe, M.Sc.S, audiologist at the CHU de Québec – Université Laval, Hôtel-Dieu de Québec

Coordination: Judith Lavoie and Geneviève Tremblay

Revision: Marie Bouret

Translation: Edgar Inc

Graphic design: Nancy Benoit

This document may be quoted with acknowledgement of the source: CIUSSS de la Capitale-Nationale (2016) Reference guide: Rehabilitation interventions and assessment of auditory benefits for people of all ages who have undergone sequential bilateral cochlear implantation.

Any reproduction or adaptation, even in part, of the contents in any manner whatsoever (electronic, photocopy or other) is prohibited without written authorization from the CIUSSS de la Capitale Nationale.

Legal deposit : 2018 – Bibliothèque et Archives nationales du Québec

ISBN: 978-2-550-80966-1 (PDF)

(Translation of the French edition 2016)

ISBN : 978-2-550-77308-5 (PDF)

(Original edition in French 2016)

© Centre intégré universitaire de santé et de services sociaux de la Capitale-Nationale ,2018

# Acknowledgements

The working committee would like to thank Mireille Ouellet, Assistant Director of youth physical disabilities, intellectual disabilities and autism spectrum disorders programs at the Centre intégré universitaire de santé et de services sociaux (CIUSSS) de la Capitale-Nationale, for her wholehearted support in developing this service offering.

In addition, the health technology assessment (Évaluation des technologies et modes d'intervention en santé et services sociaux; ETMISS) that was led by Désirée Nsanzabera of the CIUSSS de la Capitale-Nationale made it possible to guide decisions on available evidences. Thank you to everyone who participated in this assessment.

Mélanie Couture, Research Advisor, participated in the working committee's brainstorming activities regarding the contents of this reference guide, and the working committee is grateful for her contribution.

The visual aspect of this document was finalized by Nancy Benoit, Graphic Arts Technician at the CIUSSS de la Capitale-Nationale.

Finally, the French version of this document was revised by Laurence Sylla and Geneviève Asselin, administrative officers at the Academic Affairs and Teaching Directorate of the CIUSSS de la Capitale-Nationale. Moreover, we would like to thank the ministère de la Santé et des Services sociaux du Québec for this document translation's financial support.



# Table of contents

Introduction .....	1
Logic model.....	2
<b>1-Reference guide objectives and targeted users .....</b>	<b>3</b>
1.1. Clinical questions .....	3
1.2. Targeted users .....	3
<b>2- Reference guide development process .....</b>	<b>4</b>
2.1. Approval of the leading-edge practice project (IRDPO) .....	4
2.2. Regular clinical team meetings.....	4
2.3. Assessment of tests and intervention methods as part of an IFR for clients who have undergone a bilateral cochlear implantation and received follow-up at the IRDPO.....	4
2.4. Health Technology Assessment: submission of the short note.....	6
2.5. Drafting, validation and submission of the reference guide.....	8
2.6. Research project .....	8
2.7. Knowledge transfer .....	9
<b>3- Recommendations.....</b>	<b>10</b>
3.1. Assessing the benefits of a sequential bilateral cochlear implantation .....	10
3.1.1 Assessment tools.....	10
3.2. Interventions.....	12
3.2.1. Intervention Goal .....	12
3.2.2. General and specific objectives, clinical activities and concerned professionals during the IFR.....	12
3.2.3. Recommended frequency of follow-ups .....	18
3.2.4. End of interventions.....	18
3.2.5. Progression of clients .....	19
3.2.6. Additional information by discipline .....	20
<b>Conclusion .....</b>	<b>25</b>
<b>References.....</b>	<b>26</b>

## LIST OF APPENDICES

Appendix 1: Tests and indicators for Francophone clients according to age group (sequential bilateral implantation) .....	31
Appendix 2: Tests and indicators for Anglophone clients according to age group (sequential bilateral implantation) .....	34
Appendix 3: Indications for the use of clinical tests in audiology: Francophone clients .....	37
Appendix 4: Indications for the use of clinical tests in audiology: Anglophone clients.....	40

<b>LIST OF ABBREVIATIONS</b> .....	v
------------------------------------	---

## LIST OF TABLES

Table 1 : List of tests for francophone clients in the context of a sequential bilateral implantation ....	10
Table 2 : List of tests for anglophone clients in the context of a sequential bilateral implantation.....	11
Table 3 : Objectives, clinical activities and concerned professionals.....	13

## LIST OF FIGURES

Figure 1 : Rehabilitation interventions and assessment of auditory benefits for people of all ages who have undergone sequential bilateral cochlear implantation.....	2
Figure 2 : 360 Immersion system.....	8



# List of abbreviations

ALD .....	Assistive listening device
CHU de Québec.....	Centre hospitalier universitaire de Québec
CI.....	Cochlear Implant
CIUSSS de la Capitale-Nationale ....	Centre intégré universitaire de santé et de services sociaux de la Capitale-Nationale
ETMISSS.....	Évaluation des technologies et modes d'intervention en santé et services sociaux (Health Technology Assessment, HTA)
FM .....	Frequency modulation
HINT.....	<i>Hearing in Noise Test</i>
IFR .....	Intensive functional rehabilitation
IIP.....	Interdisciplinary intervention plan
IRDPO.....	Institut de réadaptation en déficience physique de Québec
MSSS.....	Ministère de la Santé et des Services sociaux
ENT.....	Ear, Nose and Throat surgeon
RC .....	Rehabilitation centre
REB.....	Research ethics board
UETMISSS .....	Unité d'évaluation des technologies et des modes d'intervention en santé et services sociaux



# Introduction

Bilateral cochlear implantation is becoming increasingly common worldwide. This is confirmed by the impressive number of scientific papers and presentations on the subject (Dowell, Galvin, Dettman, et al. 2011; Galvin, Hughes and Mok 2010). In June 2012, the Ministère de la Santé et des Services sociaux (MSSS) secured recurring funds to ease access to bilateral implants. This funding gives people with unilateral cochlear implants more opportunities to receive a second implant in the other ear. This commitment confirms Québec's intention to pursue the development of its unique expertise in cochlear implantation and be part of the current global trend. From June 2012 to June 2016, 237 people were selected by the Centre québécois d'expertise en implant cochléaire to receive a second implant.

However, specific rehabilitative interventions that must be implemented with users who have undergone a bilateral cochlear implantation are still unclear. Note that scientific literature shows that the main expected advantages of binaural perception are focused on the areas of sound localization and speech perception in noisy conditions (Bond, et al. 2009).

The announcement of funding by the MSSS therefore made it necessary to formalize intensive functional rehabilitation (IFR) services following bilateral cochlear implantation. To do so, a reference guide was prepared, taking into account:

- The experience of CI clinicians;
- The expertise of a researcher in the area of CI rehabilitation;
- The results of an evaluative study conducted in May 2014;
- The results of a technology and intervention methods assessment conducted in June 2014.

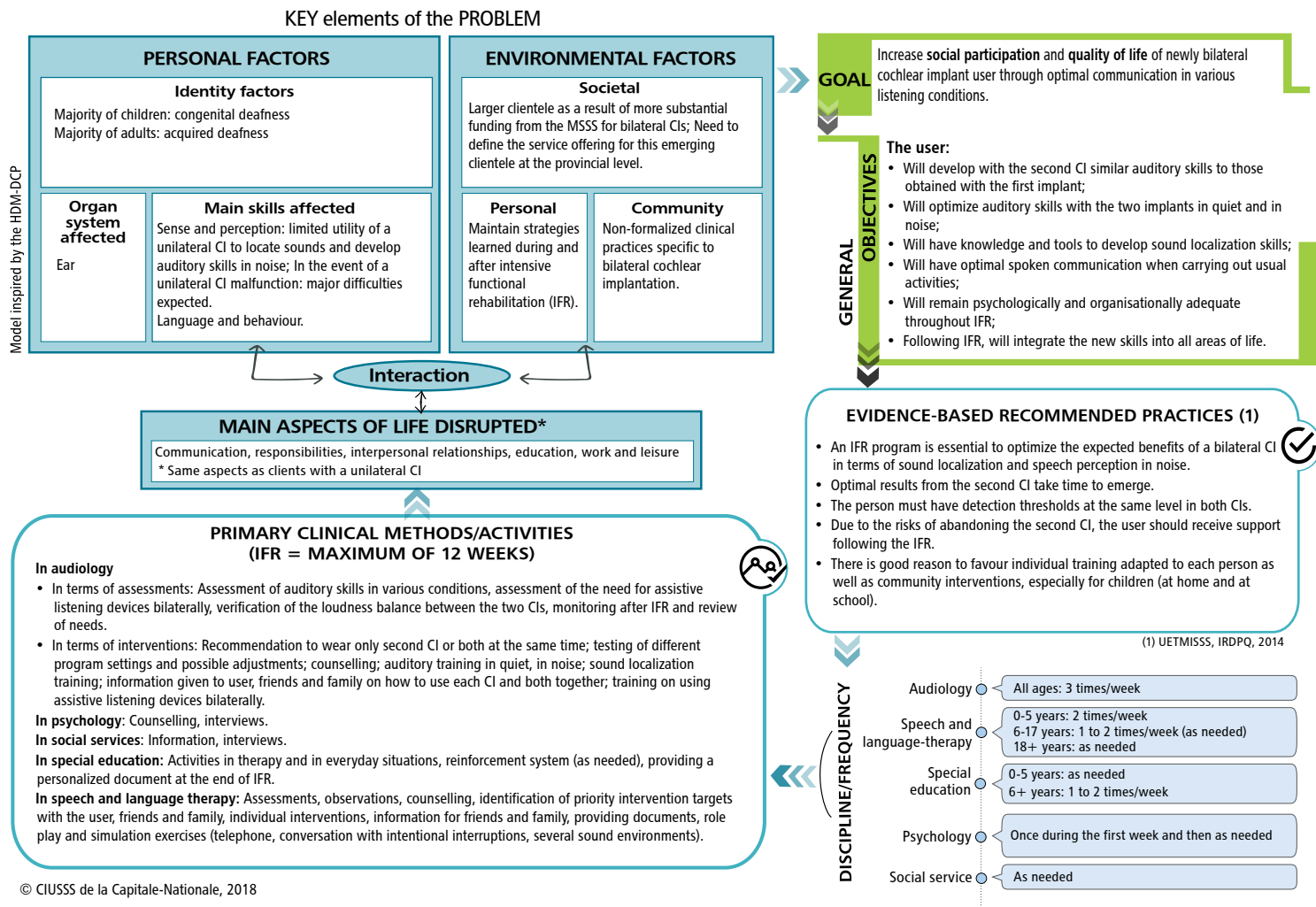
It is important to note two organizational factors that affected the preparation of this reference guide: one, the work began prior to the merging of the Institut de réadaptation en déficience physique de Québec (IRDPO) with the Centre intégré universitaire de santé et de services sociaux (CIUSSS) de la Capitale-Nationale, which is why the name "IRDPO" was retained in the document; and two, the IRDPO and CHU de Québec have been designated the "Centre québécois d'expertise en implant cochléaire" by the MSSS. This reference guide results from the knowledge transfer mandate entrusted to the Centre québécois d'expertise en implant cochléaire.

This reference guide is divided as follows :

1. The logic model, which summarizes the contents, is first presented on the next page;
2. The objectives of this reference guide and the targeted users;
3. The methods used to produce this document;
4. Recommendations.

# Logic model

**FIGURE 1 : REHABILITATION INTERVENTIONS AND ASSESSMENT OF AUDITORY BENEFITS FOR PEOPLE OF ALL AGES WHO HAVE UNDERGONE SEQUENTIAL BILATERAL COCHLEAR IMPLANTATION**





-1-

# Reference guide objectives and targeted users

This section describes the main clinical questions and targeted users for this document.

## 1.1. Clinical questions

This guide explores the following questions:

- What is the recommended procedure for assessing the benefits (e.g., tests and measurement times) for clients who have undergone a sequential bilateral cochlear implantation?
- During and after IFR, what are the main objectives, means and modalities of intervention for this clientele?

## 1.2. Targeted users

This reference guide is mainly intended for Québec's rehabilitation professionals who are involved in IFR with people who have undergone a bilateral cochlear implantation. It was prepared by an interdisciplinary team of audiologists, speech and language pathologists, psychologists and special needs educators from the Centre québécois d'expertise en implant cochléaire.

Professionals in rehabilitation centres (RCs) and other settings having questions on assessments or interventions in the context of an IFR for a first cochlear implant can:

- Sign up for network training or request customized training:



[www.ciusss-capitalenationale.gouv.qc.ca](http://www.ciusss-capitalenationale.gouv.qc.ca)

- Visit the Centre québécois d'expertise en implant cochléaire website (special section for professionals):



[www.implantcochleaire.ca](http://www.implantcochleaire.ca)

- Contact professionals at the Centre québécois d'expertise involved in the client's follow-up.



-2-

## Reference guide development process

### 2.1. Approval of the leading-edge practice project (IRDPQ)

One of the criteria for renewing the designation of a social institution as a university institute is to “contribute to the development of leading-edge disciplinary and interdisciplinary practices.”<sup>1</sup> Clinical staff of the hearing impaired child/adolescent and cochlear implant (all ages) program (the implant team) thus submitted a project that was chosen by members of the IRDPQ orientation, research, assessment and knowledge transfer committee.

### 2.2. Regular clinical team meetings

In the interest of having a shared vision of the appropriate assessment tools and modalities of intervention to be used, the clinicians met on a regular basis (disciplinary and interdisciplinary meetings).

### 2.3. Assessment of tests and intervention methods as part of an IFR for clients who have undergone a bilateral cochlear implantation and received follow-up at the IRDPQ <sup>2</sup>

An evaluative study was carried out to explore the assessment tools and the intervention methods currently used by the IRDPQ rehabilitation team.

Several sources of information were consulted:

- Audiologists, speech and language pathologists, psychologists and special need educators who worked with users who had undergone a bilateral cochlear implantation and completed an IFR in Québec City between August 1, 2012, and August 1, 2013 (27 users) through an electronic database;
- Professionals from outside Québec City through an electronic survey (six respondents).

1 MSSS, (2010) Cadre de référence pour la désignation universitaire des établissements du secteur des services sociaux: Mission, principes et critères. p. 26.

2 Lavoie, J., Plaisance, A., Tremblay, G., Champagne, C. (2014) Évaluation des tests et des modalités d'interventions dans le cadre de la réadaptation fonctionnelle intensive pour la clientèle ayant reçu un implant cochléaire bilatéral suivie à l'IRDPQ. Summary report. IRDPQ.

**DATA ANALYSIS HIGHLIGHTS:**

- The length of stay in IFR varies particularly due to the diversity of the clientele;
- The recommendation to wear the second CI alone for at least five hours a day is relevant;
- The audiology tests and questionnaires were administered as expected, except for the Iowa questionnaire, which appeared less consistent. Moreover, the tests and questionnaires currently administered do not explore other potential benefits (e.g., less fatigue, increased concentration, decreased tinnitus);
- The tests used in audiology were considered relevant for assessing the equivalence of auditory skills between the two CIs and auditory skills in noise. A new test to assess sound localization in adults is under development. The one used for children appears problematic for several children who answer at random. Sound localization training could optimize benefits;
- No specific intervention for sound localization was carried out for the majority of users who completed an IFR. Among the respondents from outside Québec who were surveyed, only one mentioned having tried sound localization exercises with a few users;
- Interventions focused on developing auditory skills in noise are the most common practices;
- In speech and language therapy, the tests used for children and adolescents were administered as expected. For most users, no other test was used;
- In psychology, further reflection is needed on the assessment of psychosocial benefits;
- Professional's responses to the survey do not reveal any consensus in terms of interventions to promote: each team intervenes with clients to the best of their knowledge.



## 2.4. Health Technology Assessment: submission of the short note<sup>3</sup>

To support the decision process regarding the choice of rehabilitation interventions, the clinical team solicited the services of the IRDPQ's Unité d'évaluation des technologies et des modes d'intervention en santé et services sociaux (UETMISSS). This unit used a strict methodology to analyze evidence. The assessment questions were as follows <sup>4</sup> :

Which **sound localization** training interventions are effective?

Which **speech perception in noise** training interventions are effective?

How are services organized to ensure **optimal conditions** for service delivery?

A short note presents information intended for managers and clinicians to support decision making with regard to technology or intervention methods in health and social services. It consists of a summary of information taken from reports produced by organizations or evidence-based data sources.

Of the 20 publications that were subject to quality assessments by two assessors, six publications were included in the short note, i.e., three systematic reviews and three articles.

3 A supplementary report was also published to present elements from the literature, without relying on the traditional methodological approach for technology assessment and intervention methods in health and social services. The supplementary report is available at the following address : [www.irdpq.qc.ca/sites/default/files/docs/UETMISS/rapport\\_complementaire\\_version\\_finale\\_juin\\_2014.pdf](http://www.irdpq.qc.ca/sites/default/files/docs/UETMISS/rapport_complementaire_version_finale_juin_2014.pdf)

4 Unité d'évaluation des technologies et des modes d'intervention en santé et en services sociaux (UETMISSS). Pratiques d'entraînement pour la localisation des sons et la perception de la parole dans le bruit chez des personnes ayant bénéficié d'une implantation cochléaire bilatérale séquentielle. Note brève. Report prepared by Désirée Nsanzabera, M.A.P., M.A., and Normand Boucher, Ph.D., Québec. [www.ciusss-capitalenationale.gouv.qc.ca/pratiques-dentrainement-pour-la-localisation-des-sons-et-la-perception-de-la-parole-dans-le-bruit](http://www.ciusss-capitalenationale.gouv.qc.ca/pratiques-dentrainement-pour-la-localisation-des-sons-et-la-perception-de-la-parole-dans-le-bruit)





### The main findings drawn from the short note are as follows: <sup>5</sup>

- An IFR is essential to optimize the expected benefits of bilateral cochlear implantation, i.e., sound localization and speech perception in noise, in both children (KuhnInacker, et al. 2004; MacIver-Lux 2009) and adults (Litovsky, et al. 2006; Fu and Galvin 2008). However, the interventions (programs, protocols and forms of service organization) are currently not well documented and those that are produce mixed results;
- Optimal benefits related to the second implant take a lot of time—from 6 to 24 months—to emerge. Yet, the documented auditory training programs last only a few weeks;
- It is very important that both ears are at the same detection level (thresholds). Without a symmetrical binaural hearing, a person with bilateral implants can feel an unpleasant sensation (that may translate into headaches), and runs a greater risk of being less diligent about wearing the second implant than the first and even abandoning it altogether (Kuhn-Inacker, et al. 2004; Sparreboom, et al. 2012) if he is disappointed with the performance. **This is a fairly dramatic consequence and justifies efforts to develop rehabilitation programs that help reap the benefits expected from the second implant.** Rehabilitation following a sequential bilateral implantation must therefore be approached with care and be at least directed, in the short term, at achieving some symmetrical binaural hearing;
- The possible risk factors that might cause users to stop wearing the second implant (especially those previously mentioned) allude to the importance of supporting the user following intensive rehabilitation. A follow-up of rehabilitation services seems to be in order based on the literature;
- The interventions reported in the literature suggest taking an individualized approach to auditory training as well as community interventions, especially for children (at home or at school). The involvement of the person, and of the parents in the case of children, as well as the adaptation of the environment (reduction of sources of noise and obstacles to communication) should also be considered;
- Computer-based training programs, generally designed in English, are the most documented intervention strategies. Contexts where public health insurance covers little to no auditory rehabilitation (US context, among others) initiated this trend, as a result of the lower cost (less travel to clinics or RCs), comfort of use and accessibility for persons with reduced mobility (doing exercises at their own pace, at home), and the possibility to adapt programs for different cultures (Gil and Lorio 2010). However, computer-based approaches have limits, particularly in relation to users' low compliance with the exercises (Sweetow and Sabes 2010);
- Among the documented training programs, very few focus on one specific aspect of auditory perception (e.g., speech perception in noise or sound localization). Most of the documented programs focus on a variety of aspects and produce various results (outputs/outcomes). Moreover, the integration of what clients learn from the program into other areas, though difficult to measure, seems to be an indicator of the value of the program as well as the level of compliance it instills in its clients and the durability of the results obtained over time. These are therefore elements to consider when developing a rehabilitation program;
- No publication specifies forms of service organization (professionals involved, interventions carried out by each one, chronology of interventions, etc.).

<sup>5</sup> Idem (4)



## 2.5. Drafting, validation and submission of the reference guide

A working committee (audiologist project leader, planning, programming and research officer, clinical audiologist and manager) drafted this document. Team members also drafted sections related to their discipline. The content was supplemented by comments from the program’s researcher.

All of the team members and the assistant director validated the initial version of the reference guide. The visual content was later reviewed by the knowledge promotion, network training and outreach sector.

## 2.6. Research project

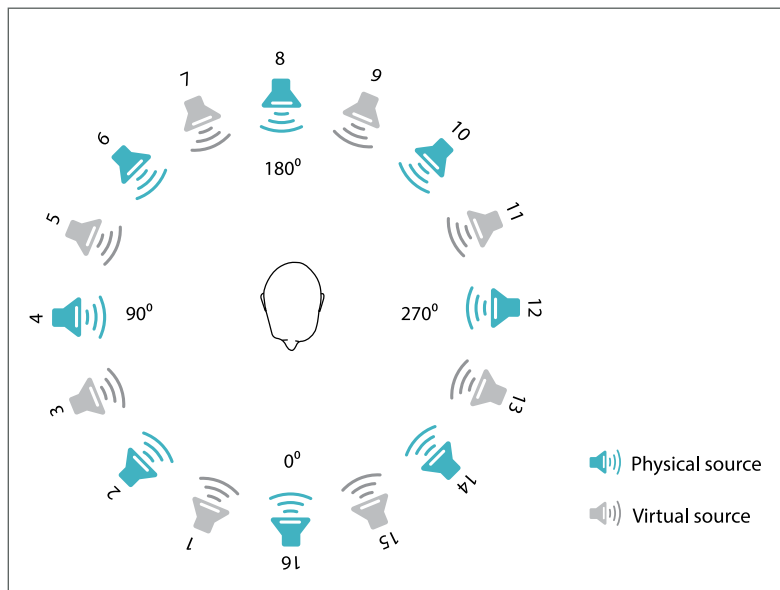
As part of developing this leading-edge practice, a research protocol was drafted:

“Bénéfices d’un programme d’entraînement auditif pour la reconnaissance de la parole dans le bruit chez des personnes ayant bénéficié d’une implantation cochléaire bilatérale” (Benefits of an auditory training program for speech recognition in noise for people who have undergone a bilateral cochlear implantation). This project attempts to explore the effectiveness of a training auditory program for speech recognition in noise. Standard auditory training exercises (e.g., conversation, speech tracking, words and sentences recognition) will be done in environmental noisy situations generated by the 360 Immersion system.

This system consists of 8 physical speakers and 8 virtual speakers for a total of 16 sound sources (see Figure 2). The speakers are equally spaced out along a 360-degree horizontal arc and several recorded sound sources from daily life are available (e.g., car, cafeteria, day care).

Assessments will be carried out using the Hearing in Noise Test (HINT). The Speech, Spatial and Qualities of Hearing Scale will also be used to generate qualitative data.

**FIGURE 2 : 360 IMMERSION SYSTEM**





## 2.7. Knowledge transfer

Throughout the process of developing the service offering, the content of the training intended for new rehabilitation clinicians and new rehabilitation settings designated by the MSSS to provide IFR for implantation was improved.

This English version of the document has been prepared to facilitate the transfer of this knowledge outside Québec.

Several knowledge transfer strategies are planned such as:

- The official launch of the reference guide;
- The online publication of the reference guide on the Centre québécois d'expertise en implant cochléaire website (professionals section) and on the CIUSSS de la Capitale-Nationale website;
- Proposals for national and international conferences;
- Publications;
- Training adapted to the needs expressed by partners.



# -3- Recommendations

This section is divided into two parts: procedure for assessing benefits and intervention methods.

## 3.1. Assessing the benefits of a sequential bilateral cochlear implantation

The current practice of rehabilitation clinicians at the Centre québécois d'expertise en implant cochléaire consists of using clinical tools to measure the progress of users who have undergone a bilateral cochlear implantation. Tools are chosen based on their availability and the clinical/scientific evidence.

Tables 1 and 2 present the clinical tools selected by the rehabilitation team for clients who have undergone a sequential bilateral cochlear implantation. The clinical tools used with each user vary according to his native language, the age group, the specific discipline or measurement time. Other clinical tools could also be used on a case-by-case basis, depending on a user's specific clinical needs (e.g., monosyllable lists from Benfante).

Appendices 1 and 2 present the assessment modalities based on user's native language and age group. Note that a psychology measurement tool is currently being studied. Specific indications for the use of these tests can be found in Appendix 3 (Francophone clients) and Appendix 4 (Anglophone clients). It is also possible to click on the hyperlinks associated with each test for more details on the administration procedure.

### 3.1.1 Assessment tools

**TABLE 1 : LIST OF TESTS FOR FRANCOPHONE CLIENTS IN THE CONTEXT OF A SEQUENTIAL BILATERAL IMPLANTATION (CONTINUED ON THE NEXT PAGE)**

TESTS	MEASUREMENT TIME			
	<i>Start of IFR</i>	<i>End of IFR</i>	<i>1 year and 2 years after IFR</i>	<i>3 years after IFR</i>
<b>Audiology</b>				
HINT <sup>?</sup> with special features for bilateral CIs or EARS <sup>?</sup> depending on age	X	X	X	X
IRD PQ scale <sup>?</sup>	X	X	X	X
Sound lateralization/localization (children and adults) <sup>?</sup>		X	X	X
LITTLEARS questionnaire (children under 6 years old) <sup>?</sup>	X	X	X	
Multimedia (administered by the Centre québécois d'expertise) <sup>?</sup>	X	X	X	X

For adults, only the measurement time "1 year after IFR" is mandatory for all tests.



TESTS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Speech and language Pathology (children and adolescents)</b>				
Inventaire MacArthur-Bates du développement de la communication (IMBDC): “version mots et gestes” for 8 to 16 month-olds and “version mots et énoncés” for 16 to 30 month-olds, to be completed by the parent	X		X	
Phonemic inventory (up to 11 years 11 months old)	X		X	X
CELF CDN-F sentence repetition test (ages 12 and up)	X		X	X
EOWPVT-R (5 years to 7 years 11 months old) Québec French adaptation	X		X	X
EOWPVT-2000 or EOWPVT-4 for those who do not have the 2000 version (3 years to 4 years 11 months old, and 8 years to 17 years 11 months old)	X		X	X
EVIP (3 years to 17 years 11 months old)	X		X	X

**TABLE 2 : LIST OF TESTS FOR ANGLOPHONE CLIENTS IN THE CONTEXT OF A SEQUENTIAL BILATERAL IMPLANTATION**

TESTS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
HINT <sup>?</sup> with special features for bilateral CIs or ESP <sup>?</sup> depending on age	X	X	X	X
Monosyllables <sup>?</sup>	X	X	X	X
IRDPO scale <sup>?</sup>	X	X	X	X
Sound lateralization/localization (children and adults) <sup>?</sup>		X	X	X
LittleEARS questionnaire (children under 6 years old) <sup>?</sup>	X	X	X	
<b>Speech and language Pathology (children and adolescents)</b>				
MacArthur-Bates Communicative Development Inventories (MBCDIs): Words and Gestures form for 8 to 16 month-olds and Words and Sentences form for 16 to 30 month-olds, to be completed by the parent	X		X	
Goldman-Fristoe Test (2 years to 11 years 11 months old)	X		X	X
Phonemic inventory (up to 11 years 11 months old)	X		X	X
CELF-4 “Recalling Sentences” evaluation (ages 12 and up)	X		X	X
EOWPVT-4 (3 years to 17 years 11 months old)	X		X	X
ROWPVT-4 (3 years to 17 years 11 months old)	X		X	X

For adults, only the measurement time “1 year after IFR” is mandatory for all tests.



## 3.2. Interventions

This section presents the goal of IFR in the context of sequential bilateral implantation, general and specific objectives, clinical activities and the concerned professionals. Specific information is also presented for each discipline.

### 3.2.1. Intervention Goal

The intervention goal is to support social participation and enhance quality of life of the person who recently underwent a bilateral cochlear implantation through optimal communication in various listening conditions.

### 3.2.2. General and specific objectives, clinical activities and concerned professionals during the IFR

With some exceptions (specified as applicable), the table on the following pages presents the general and specific objectives pursued following an IFR in users who have undergone a sequential bilateral cochlear implantation. Moreover, for each specific objective, the clinical activities/methods and responsible clinicians are specified. Note that, for each user, an interdisciplinary intervention plan (IIP) is developed, in which the objectives and methods can be modified to take into account their specific needs.



**TABLE 3 : OBJECTIVES, CLINICAL ACTIVITIES AND CONCERNED PROFESSIONALS**

Note that this section concerns rehabilitation teams in integrated health and social services centres and CIUSSSs that have been authorized to provide an IFR for the targeted clientele. In addition, other objectives and clinical activities can be added to users' IIPs to take into account their specific needs.

<b>GENERAL OBJECTIVE 1</b>		
The user will develop similar auditory skills with his second implant (2nd CI) as with his first implant (1st CI).		
<b>Specific objectives</b>	<b>Clinical activities and methods put in place by the rehabilitation team that provides IFR for Cis</b>	<b>Concerned professionals</b>
<b>1.1</b> The user will have an optimal fitting of his 2nd CI.	<ul style="list-style-type: none"> <li>• Collaboration between rehabilitation team clinicians and the audiologist responsible for the implant programming to:                             <ul style="list-style-type: none"> <li>• Assess detection thresholds in a booth with the new implant</li> <li>• Test the various programming parameters available with the 2nd CI and assess the impact on auditory skills</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Audiologist</li> <li>• Collaboration with a special needs educator</li> </ul>
	<ul style="list-style-type: none"> <li>• Psychological support (as needed)</li> </ul>	Psychologist
<b>1.2</b> The user will develop auditory skills in quiet and in noise with the 2nd CI alone.	<ul style="list-style-type: none"> <li>• With regard to wearing the 2nd CI alone:                             <ul style="list-style-type: none"> <li>• Recommendation to wear it for most of the day (at least 5 hours per day for very young children, from rising to supper for others) until auditory skills with the 2nd CI are equal to those obtained with the 1st implant OR reach a plateau</li> <li>• Counselling adapted to the user and his family</li> <li>• Psychological support (as needed) due to the difficulties that wearing the 2nd CI alone can cause. Follow up may be required, particularly in the area of motivation, especially with adolescents</li> <li>• Use of a reinforcement system (if needed)</li> </ul> </li> </ul>	The entire team: <ul style="list-style-type: none"> <li>• Audiologist</li> <li>• Speech and language pathologist</li> <li>• Psychologist</li> <li>• Social worker</li> <li>• Special needs educator</li> </ul>
	<ul style="list-style-type: none"> <li>• Assessment of auditory skills with the 2nd CI alone at the start and end of IFR:                             <ul style="list-style-type: none"> <li>• See Section 3.1 to identify the tests, measurement times and modalities</li> </ul> </li> </ul>	Audiologist
	<ul style="list-style-type: none"> <li>• Auditory training in quiet and in noise with the 2nd CI alone:                             <ul style="list-style-type: none"> <li>• Application of an auditory training program similar to the one used for unilateral implantation<sup>6</sup> with the same follow-up frequency (3 times a week in audiology, special education support and personal exercises at home)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Audiologist</li> <li>• Collaboration from a special needs educator</li> </ul>

6 AERDPQ (2007), Cadre structurant les services spécialisés de réadaptation relatif à l'implant cochléaire [[http://aerdpq.reseaut.net/fichiers/publications/implant\\_cochleaire.pdf](http://aerdpq.reseaut.net/fichiers/publications/implant_cochleaire.pdf)]. Accessed on June 14, 2016.



<b>GENERAL OBJECTIVE 2</b>		
The user will optimize his auditory skills with his two CIs in quiet and in noise.		
<b>Specific objectives</b>	<b>Clinical activities and methods put in place by the rehabilitation team that provides IFR for CIs</b>	<b>Concerned professionals</b>
<b>2.1</b> The user will wear both CIs every day according to the rehabilitation audiologist's recommendations (a few hours a day, and then at all times once auditory skills with the 2nd CI alone are equal to those with the 1st CI or reach a plateau).	<ul style="list-style-type: none"> <li>Information to the user, his family and friends (including the educational institution) on the functioning of each CI and bilateral options</li> <li>Counselling adapted to the user and his family</li> <li>Psychological support (as needed)</li> <li>Use of a reinforcement system if needed</li> </ul>	The entire team: <ul style="list-style-type: none"> <li>Audiologist</li> <li>Speech and language pathologist</li> <li>Psychologist</li> <li>Social worker</li> <li>Special needs educator</li> </ul>
	<ul style="list-style-type: none"> <li>To determine when both CIs can be worn together at all times: auditory training exercises and assessments carried out with each CI separately (achieving equal auditory skills with each CI)</li> </ul>	Audiologist in charge of making the decision to have both CIs worn at all times
<b>2.2</b> The user will have an optimal fitting for each CI in quiet and in noise.	<ul style="list-style-type: none"> <li>Collaboration between RC clinicians and the audiologist responsible for implant programming to:                             <ul style="list-style-type: none"> <li>Assess detection thresholds in a booth with each CI alone and both CIs together (as needed)</li> <li>Test the various programming parameters available for listening in quiet and in noise with each CI and assess the effects on auditory skills</li> <li>Adjust bilateral programming parameters as needed</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>Audiologist</li> <li>Collaboration with a special needs educator</li> </ul>
<b>2.3</b> The user will develop auditory skills in quiet and in noise with both CIs.	<ul style="list-style-type: none"> <li>Continuation of auditory training in quiet adapted to the user's age, level of auditory skills and level of language</li> <li>Continuation of auditory training in noise with the Immersion 360 system<sup>7</sup> or with conventional speakers</li> <li>Activities in therapy and personal exercises at home (e.g., auditory training in quiet and in noisy conditions)</li> </ul>	<ul style="list-style-type: none"> <li>Audiologist</li> <li>Collaboration with a special needs educator</li> </ul>
	<ul style="list-style-type: none"> <li>Assessment of auditory skills in noise (during and after IFR):                             <ul style="list-style-type: none"> <li>See Section 3.1 to identify the tests, measurement times and modalities</li> </ul> </li> </ul>	Audiologist

<sup>7</sup> A description of the Immersion 360 system is presented in Section 2.6.





<b>GENERAL OBJECTIVE 3</b>		
The user will have the knowledge and tools to develop his auditory localization skills.		
<b>Specific objectives</b>	<b>Clinical activities and methods put in place by the rehabilitation team that provides IFR for CIs</b>	<b>Concerned professionals</b>
<p><b>3.1</b> The user will have optimal programming for each CI.</p>	<ul style="list-style-type: none"> <li>• Collaboration between RC professionals and the audiologist responsible for implant programming to:                             <ul style="list-style-type: none"> <li>• Ensure a reasonable loudness balance between the two CIs (so that sounds are perceived at an equal intensity with each CI)</li> <li>• Make adjustments and test the various programming parameters available for localization with each CI and assess the impact on localization (equivalent entry signal processing with each processor, including omnidirectional microphones)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Audiologist</li> <li>• Collaboration from a special needs educator (for children)</li> </ul>
<p><b>3.2</b> The user will develop the prerequisites for sound localization.</p>	<ul style="list-style-type: none"> <li>• Counselling adapted to the user and his family, including development of the reflex to turn his head to seek out the origin of sounds</li> </ul>	Audiologist
<p><b>3.3</b> The user will develop sound localization skills</p>	<ul style="list-style-type: none"> <li>• Assessment of sound localization skills after the IFR, and before if it's necessary                             <ul style="list-style-type: none"> <li>• See Section 3.1 to identify the tests, measurement times and modalities</li> </ul> </li> </ul>	Audiologist
	<ul style="list-style-type: none"> <li>• Auditory training for sound localization                             <ul style="list-style-type: none"> <li>• Activities in therapy and personal practices at home (e.g., hiding, remote-controlled sound toys, localization of sounds from different speakers and localization of direction of vehicles in the street)</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Audiologist</li> <li>• Collaboration from a special needs educator</li> </ul>



<b>GENERAL OBJECTIVE 4</b>		
The user will have optimal spoken communication when carrying out his everyday activities.		
<b>Specific objectives</b>	<b>Clinical activities and methods put in place by the rehabilitation team that provides IFR for CIs</b>	<b>Concerned professionals</b>
<p><b>4.1</b> The user will show progress in his language and/or speech skills in relation to the targeted objectives</p>	<ul style="list-style-type: none"> <li>• Assessment at start of IFR: See Section 3.1 to identify the tests, measurement times and modalities</li> <li>• Identification of priority targets for intervention together with the user and his family and friends</li> <li>• Individual speech and language therapy</li> <li>• Depending on the targeted objective, it may be advisable to wear the new CI alone or both implants together (e.g., to work on speaking, phonology and certain morphological elements)</li> <li>• At the end of the IFR: recommendations on whether or not to continue with treatment</li> </ul>	<p>Speech and language pathologist</p>
<p><b>4.2</b> The user will know the communication strategies.</p>	<ul style="list-style-type: none"> <li>• Wearing of the new CI alone during speech and language therapy interventions</li> <li>• Observation/assessments of strategies used by the user</li> <li>• Presentation of various obstacles and strategies (e.g., written documents, illustrations, simulation exercises and audiovisual material)</li> <li>• Information given to family and friends</li> </ul>	<ul style="list-style-type: none"> <li>• Speech and language pathologist</li> <li>• Audiologist</li> <li>• Collaboration from a special needs educator</li> </ul>
<p><b>4.3</b> The user will apply the communication strategies relevant to his situation.</p>	<ul style="list-style-type: none"> <li>• Wearing of the new CI alone during speech and language therapy interventions</li> <li>• Role play and simulation exercises with obstacles</li> <li>• Exercises on the telephone when possible</li> <li>• Conversation with intentional breakdown of communication</li> <li>• Exercises in different sound environments (e.g., in the street, break room and hallways)</li> </ul>	<ul style="list-style-type: none"> <li>• Speech and language pathologist</li> <li>• Audiologist</li> <li>• Collaboration from a special needs educator</li> </ul>



<b>GENERAL OBJECTIVE 5</b>		
The user will actively participate in his IFR.		
<b>Specific objectives</b>	<b>Clinical activities and methods put in place by the rehabilitation team that provides IFR for CIs</b>	<b>Concerned professionals</b>
<b>5.1</b> The user will remain appropriately available psychologically during IFR.	<ul style="list-style-type: none"> <li>At the beginning of the IFR: systematic structured interview in psychology or social work and continuation as needed</li> </ul>	<ul style="list-style-type: none"> <li>Psychologist</li> <li>Social worker</li> </ul>
<b>5.2</b> The user will make the necessary arrangements to participate in his IFR.	<ul style="list-style-type: none"> <li>Information on available financial assistance, transportation and housing services</li> <li>Support for carrying out steps (as needed)</li> </ul>	Social worker

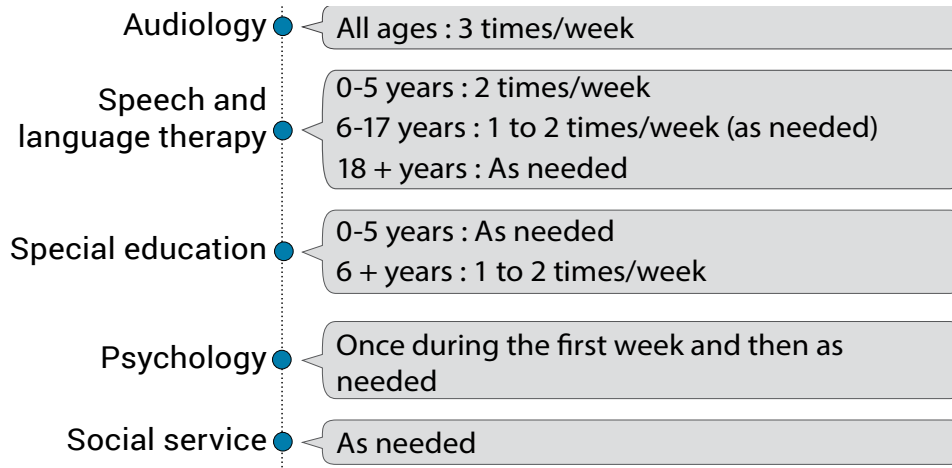
<b>GENERAL OBJECTIVE 6</b>		
Following IFR and during the year that follows, the user will integrate what he has learned into all areas of his life.		
<b>Specific objectives</b>	<b>Clinical activities and methods put in place by the rehabilitation team that provides IFR for CIs</b>	<b>Concerned professionals</b>
<b>6.1</b> The user will be referred to the appropriate external resources.	At the end of IFR: referral to external resources (as needed)	<ul style="list-style-type: none"> <li>Social worker</li> <li>Psychologist</li> <li>Audiologist</li> <li>Special needs educator</li> <li>Speech and language pathologist</li> </ul>
<b>6.2</b> The user will be informed of the strategies to perform his everyday activities in an optimal manner.	At the end of IFR: <ul style="list-style-type: none"> <li>Provision of documents adapted to the user's situation (e.g., documents on using CIs with assistive listening devices [ALDs] and documents specifying optimal positioning in difficult hearing conditions such as in a restaurant)<sup>8</sup></li> <li>During audiological follow-ups after IFR : review of needs according to lifestyle and referral to appropriate resources (e.g., RC professionals, programming audiologists, CI technical support and ALD distributors)</li> </ul>	<ul style="list-style-type: none"> <li>Éducateur spécialisé</li> <li>Audiologiste</li> <li>Psychologue</li> <li>Travailleur social</li> <li>Orthophoniste</li> </ul>

<sup>8</sup> A kit that incorporates all of these methods is currently being developed.



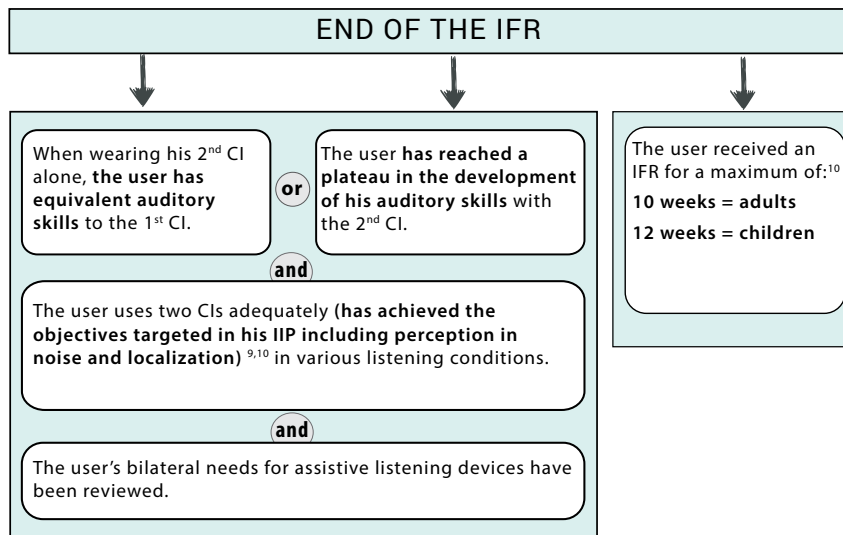
### 3.2.3. Recommended frequency of follow-ups

The following diagram presents the recommended frequency of individual follow-ups by discipline. This is in addition to the user's personal commitment to complete the activities and practices recommended by professionals as part of his rehabilitation.



### 3.2.4. End of interventions

The IFR ends once the criteria below have been met.<sup>9-10</sup>

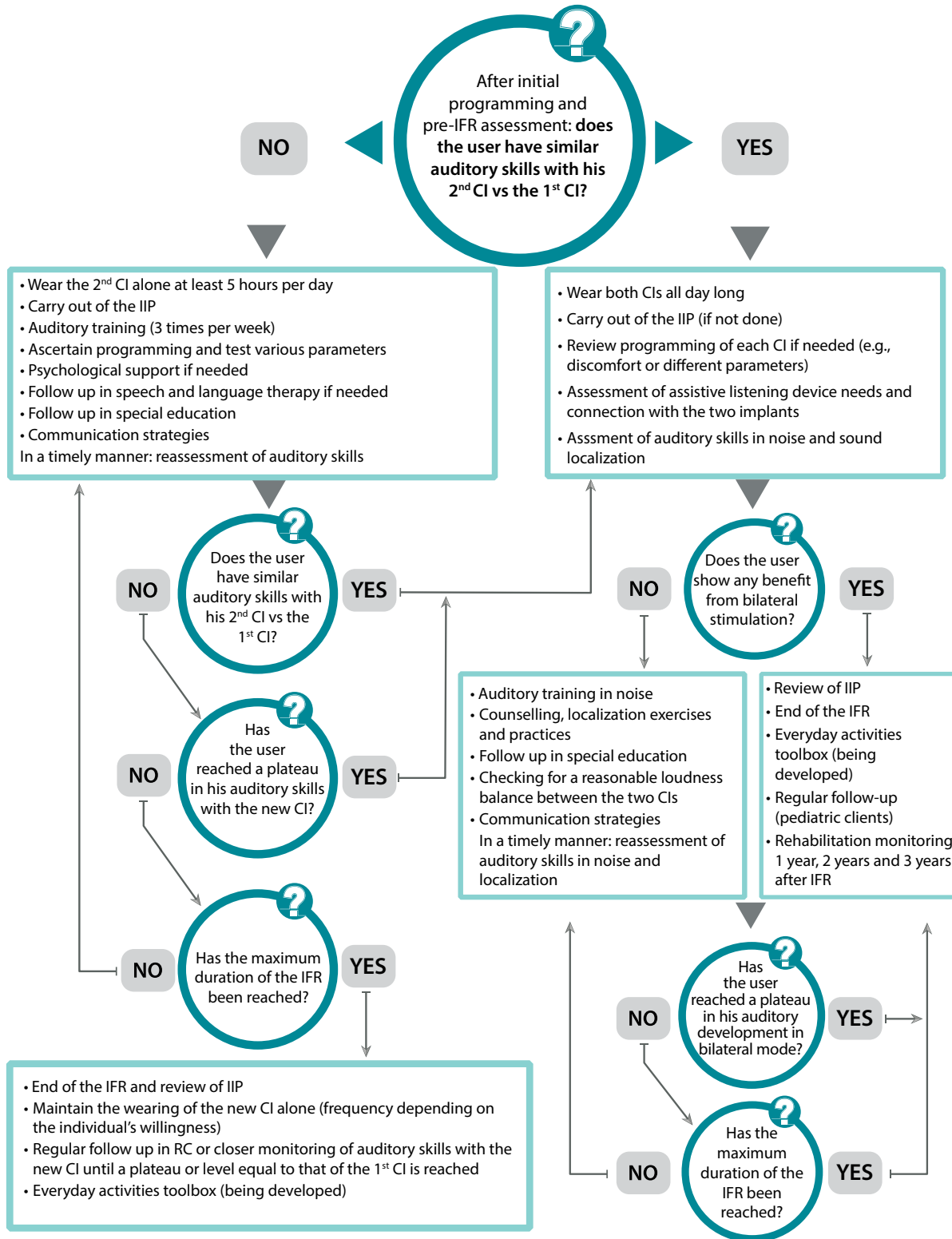


<sup>9</sup> It is possible that there will be no binaural advantages after the IFR, because these benefits generally develop over a longer period. It is therefore important to reassess them at each follow-up session after the IFR.

<sup>10</sup> As needed, a user can receive additional interventions following the IFR if he has not met all the objectives during his rehabilitation process. These additional interventions are part of the rehabilitation service offering and are not included in the MSSS funding for cochlear implantation.



### 3.2.5. Progression of clients





### 3.2. Additional information by discipline

This section aims to provide specific information by discipline that could be useful during interventions with clients.

#### AUDIOLOGY

##### Details for wearing CIs

The user needs to wear his second CI alone for most of the day.



**Very young children who are awake for limited periods (e.g., two naps per day)**



Wearing the second CI alone for five hours per day (e.g., from waking to lunch inclusively) is recommended. For the remainder of the day, it is recommended that both CIs be worn.



**Older children and adults**



Wearing the second CI alone over a longer period (e.g., from waking to supper) is recommended. For the remainder of the day, it is recommended that both CIs be worn.

If, following the IFR, the user has not developed similar auditory skills with the second CI as with the first CI, there are two possibilities that could be discussed with the user:

- Maintain the wearing of the second CI alone for a few hours per day or per week to improve auditory skills on that side. It is important to assess the user's auditory skills after a few months to document whether or not there has been progress. Based on clinical experience, this is the option that provides the best chances of improving auditory skills with the second CI.
- Continue wearing both CIs for every waking hour. For some users, auditory skills with the second implant have continued to progress in this situation, but it is generally a less effective option.



## Loudness balance <sup>11</sup>

There are various ways to ensure that sounds are perceived at an equivalent intensity with each CI.

### For soft sounds

} Detection thresholds should be measured in a booth with each implant.

### For medium-intensity sounds

} Have the user listen to sounds at a 60 dB HL in a booth (Ling sounds, environmental sounds, continuous warble sounds or narrow-band sounds), facing the speaker, and ask him to compare the perceived intensity with each CI while removing one antenna at a time.

Or

} Have the user sit in front of the audiologist, outside the booth, and ask him to compare the intensity of the sounds.

If the loudness does not seem similar between the two CIs, it is recommended that the user be referred to the audiologist in charge of programming. Note that depending on the time period between the two implants, changes can be seen in the first weeks, months or even years with the second CI. In addition, the pitch perceived per frequency (or per electrode in programming) could vary between ears: in the beginning, the pitch will generally seem higher in the second CI and lower in the first CI. Based on our observations, it is possible that the pitch perceived per frequency between the two CIs will gradually become closer over time. It is also possible that the pitch will always remain distinct, and this could depend on several factors: a different history between the two ears, such as the duration of hearing loss, different technology in the two implants, a different depth of insertion for the two electrode arrays, etc.

In programming, comfort level adjustments can be made to help sound localization. Although the person is not expected to be able to localize sounds for some time, we believe that a programming that is well balanced between the two CIs can help with localization learning. CIs must first be adjusted individually: take one ear at a time and ensure that the comfort levels are well balanced on each electrode. Next, try to balance the two CIs with voice, either by having both CIs turned on or by comparing one CI at a time. When both CIs are well adjusted and the user believes he is hearing voices equally on both sides, it is possible to fine tune adjustments if the user collaborates well and the technology permits it (e.g., two CIs from the same company with the same number of electrodes). It should then be possible to have pairs of electrode triggered at the comfort level, either the same electrode on each ear simultaneously or alternately (e.g., first electrodes on each ear, then the second electrodes on each ear, and so on), in order to compare loudness and thus adjust the comfort level of the second CI in reference to the first CI.

<sup>11</sup> Lamothe, J. (2016), La balance de sonie, document de travail, CHU de Québec - UL, L'Hôtel-Dieu de Québec.



### Localization exercises for children

A document suggesting listening exercises to develop sound localization in children is available in French for audiologists in the “Intervenants” (professionals) section of the website.

 [www.implantcochleaire.ca/professionnels/pdf/activit%C3%A9s\\_localisation\\_enfant.pdf](http://www.implantcochleaire.ca/professionnels/pdf/activit%C3%A9s_localisation_enfant.pdf)

This document also lists the prerequisites that should be considered before starting sound localization exercises.

### Minimum expected developmental milestones

Minimum expected developmental milestones following bilateral cochlear implantation in children are available on the website of the Centre québécois d’expertise en implant cochléaire (special section for professionals; authentication is required).

 [www.implantcochleaire.ca/professionnels/pdf/balises\\_developpement\\_attendu\\_bil\\_enfant.pdf](http://www.implantcochleaire.ca/professionnels/pdf/balises_developpement_attendu_bil_enfant.pdf)

### Framework of specific objectives

A framework of specific objectives in audiology is available on the website of the Centre québécois d’expertise en implant cochléaire (special section for professionals; authentication is required).

 [www.implantcochleaire.ca/professionnels/readaptation\\_pro.html](http://www.implantcochleaire.ca/professionnels/readaptation_pro.html)

### Presence of tinnitus, vertigo or balance disorders

Significant tinnitus, vertigo or balance disorders can disrupt the IFR follow-up process. Depending on the problem experienced by the user, intervention could be re-oriented or include a follow-up on this issue. The user should be referred to an otorhinolaryngologist (ENT) if this aspect has not already been addressed with an ENT. In some cases, referral to vestibular physiotherapy could be indicated.





## SPEECH AND LANGUAGE THERAPY

### Assessment

Regarding assessment (start of the IFR): it is recommended that both CIs be worn. No tests are required at the end of the IFR (see Section 3.2).

### Intervention

Interventions are adjusted according to the user's age and condition.



#### Children aged 5 and under

Two separate therapy sessions per week are generally recommended. It is important to take into account that when the child wears only the second CI in the beginning of IFR, his auditory skills will be less than with the first CI. Since comprehension of spoken language is more difficult when wearing the second CI alone, professionals must be vigilant regarding communication breakdowns and educate parents. Lip reading and/or gestural methods become important tools to optimize communication when only the second CI is worn.



#### School-aged children

If the child has a speech and/or language delay related to hearing loss:

- Provide one to two therapy sessions per week as needed.

If the child does not have any language delay:

- Intervene in the area of communication strategies (follow-up frequency and duration are determined based on needs). The context in which the child wears the second CI alone could reveal shortcomings with regard to the use of communication strategies. Interventions are also needed with parents so that they are aware of communication breakdowns and can make adjustments to improve interactions.



#### Adultes

If a referral has been made by an audiologist, a follow-up regarding communication strategies is offered.



## PSYCHOLOGY AND SOCIAL SERVICES

Apart from the initial meeting with a psychologist, which is planned systematically, other appointments with a psychologist and/or a social worker are possible if:

- Acute problems are noted (e.g., anxiety attacks, depressive symptoms, opposition, disorganization and intense disappointments);
- The user and/or his friends and family are discouraged during the IFR due to, among other things, progress that is sometimes slower, short-term regression as a result of wearing the new implant alone and the disappointment that can crop up in the first few weeks;
- Note that adolescent clients are particularly at risk of losing motivation in the beginning of the IFR for the second CI. Support may be needed for professionals, the child and his family.

Follow-up can be stopped once the user is adapting better to the situation relating to the second CI and/or once they know and apply the various strategies taught to facilitate adaptation.

## SPECIAL EDUCATION AND PSYCHOEDUCATION

### Communication in noisy environments

To facilitate communication in noisy environments, several modalities of intervention are possible depending on a user's needs, such as:

- Counselling regarding the person's positioning to reduce the impact of the noise;
- Outings in noisy environments to experiment and apply clinical recommendations;
- Practices in noise during auditory training.

### User motivation

To encourage user motivation, material could be adapted based on his interests (e.g., popular musical groups, sports played by the young person).

### Adequate use of both CIs

To make adequate use of both CIs, the user may need support (e.g., wearing each CI with the appropriate programming and volume settings, maintenance and batteries recharging, practices for connecting ALDs).



### Strategies for taking part in everyday activities

In addition to the reference guide, an everyday activities kit is being developed. This kit will incorporate several tools including:

- An everyday activities observation grid for professionals;
- A table and a quick reference checklist on strategies for optimizing customizable everyday activities depending on the user's situation;
- Document templates adapted for users with special needs.

## Conclusion

This reference guide is an initial milestone to support IFR teams in their interventions with clients who have undergone a bilateral cochlear implantation. This emerging clientele has prompted rehabilitation professionals at the Centre québécois d'expertise en implant cochléaire to adapt their practices to meet specific needs. One of the main strengths of this service offering is the synergy of scientific and implicit knowledge. This service offering was presented at the 14th International Conference on Cochlear Implants and Other Implantable Technologies in May 2016.

The contents of this reference guide highlight the relevance of the service offering to meet client needs, the coherence between the objectives, methods and resources, the synergy of interdisciplinary work and the flexibility of professionals to adapt their clinical practices. Its effectiveness will be partially addressed as part of a research project.

This document is an initial version and, accordingly, rehabilitation professionals at the Centre québécois d'expertise en implant cochléaire expect to produce updates taking into account new scientific data, experiential knowledge from users, enrichment of clinical experiences, and comments from other rehabilitation settings.

Finally, a supplementary intervention kit on everyday activities will be developed and made available soon. The development of this clinical tool is an illustration of a culture of continuous improvement and innovation.

## References

- Association des établissements de réadaptation en déficience physique du Québec (2007). **Cadre structurant les services spécialisés de réadaptation relatifs à l'implant cochléaire**. February 2007. [[http://aerdpq.reseaut.net/fichiers/publications/implant\\_cochleaire.pdf](http://aerdpq.reseaut.net/fichiers/publications/implant_cochleaire.pdf)]. Accessed on June 14, 2016.
- Bond, M., Mealing, S., Anderson, R., Elston, J., Weiner, G., Taylor, R., Stein, K. (2009). **The effectiveness and cost-effectiveness of cochlear implants for severe to profound deafness in children and adults: a systematic review and economic model**. *Health Technol Assess.* 13 (44): 1-330.
- Dowell, R.C., Galvin, K., Dettman, S., Leigh, J., Hughes, K., van Hoesel, R. (2011). Bilateral cochlear implants in children. **Seminars in Hearing**, 32: 53–72[1b].
- Fu, Q.J., Galvin, J.J., 3rd. (2008). Maximizing cochlear implant patients' performance with advanced speech training procedures. **Hear Res.** 242(1-2): 198–208.
- Galvin, K.L., Hughes, K.C., Mok, M. (2010). Can adolescents and young adults with prelingual hearing loss benefit from a second, sequential cochlear implant? **International Journal of Audiology.** 49: 368–377[4b].
- Gil, D., Lorio, M.C. (2010). **Formal auditory training in adult hearing aid users**. *Clinics (Sao Paulo)*. 65(2): 165–174.
- Kuhn-Inacker, H., Shehata-Dieler, W., Muller, J., Helms, J. (2004). Bilateral cochlear implants: a way to optimize auditory perception abilities in deaf children? **International Journal of Pediatric Otorhinolaryngology**, 68: 1257–1266[4b].
- Lavoie, J., Plaisance, A., Tremblay, G., Champagne, C. (2014). **Évaluation des tests et des modalités d'interventions dans le cadre de la réadaptation fonctionnelle intensive pour la clientèle ayant reçu un implant cochléaire bilatéral suivie à l'IRDPO**. Summary report. Institut de réadaptation en déficience physique de Québec. May.
- Litovsky, R., Parkinson, A., Arcaroli, J., Sammeth, C. (2006). **Simultaneous bilateral cochlear implantation in adults: a multicenter clinical study. (Comparative Study Multicenter Study Research Support, non-U.S. GOv't)**. *Ear Hear.* 27(6): 714–731. Doi:10.1097/01.aud.0000246816.50820.42
- Maclver-Lux, K. (2009). **Intervention for children with cochlear implants: maximizing auditory benefits of bilateral hearing**. **Perspectives on Hearing and Hearing Disorders in Childhood.** 19(2): 85–97. doi : 10.1044/hhdc19.2.85
- Ministère de la Santé et des Services sociaux (MSSS) (2010). **Cadre de référence pour la désignation universitaire des établissements du secteur des services sociaux: mission, principes et critères**. Québec.
- Sparreboom, M., Leeuw, A.R., Snik, A.F., Mylanus, E.A. (2012). Sequential bilateral cochlear implantation in children: parents' perspective and device use. **Int J Pediatr Otorhinolaryngol.** 76(3): 339–344. Doi:10.1016/j.ijporl.2011.12.004

Sweetow, R.W., Sabes, J.H. (2010). Auditory training and challenges associated with participation and compliance. *J Am Acad Audiol.* 21(9): 586–593.

Tremblay, G., Champagne, C., Bergeron, F. (2016). **Bénéfices d'un programme d'entraînement pour la reconnaissance de la parole dans le bruit chez des personnes ayant reçu un implant cochléaire bilatéral.** Research project as part of the Programme de libération d'intervenants de l'IRD PQ. Institut de réadaptation en déficience physique de Québec, Université Laval and Centre interdisciplinaire de recherche en réadaptation et intégration sociale.

Tremblay, G., Champagne, C., Bergeron, F., Lamothe, J., Bussièrès, R., Lavoie, J., Rochefort, A., Côté, M., Philippon, D. (2016). **Rehabilitation model for bilateral cochlear implant users. Poster presented at the 14th International Conference on Cochlear Implants and Other Implantable Technologies,** Toronto, May.

Unité d'évaluation des technologies et des modes d'intervention en santé et en services sociaux (UETMISSS). **Pratiques d'entraînement pour la localisation des sons et la perception de la parole dans le bruit chez des personnes ayant bénéficié d'une implantation cochléaire bilatérale séquentielle. Note brève.** Rapport préparé par Désirée Nsanzabera M.A.P., M.A., et Normand Boucher, Ph. D. Québec : Institut de réadaptation en déficience physique de Québec. [www.ciuss-capitalnationale.gouv.qc.ca/pratiques-dentrainement-pour-la-localisation-des-sons-et-la-perception-de-la-parole-dans-le-bruit](http://www.ciuss-capitalnationale.gouv.qc.ca/pratiques-dentrainement-pour-la-localisation-des-sons-et-la-perception-de-la-parole-dans-le-bruit). Site consulté le 8 décembre 2016.



# Appendices



## **Appendix 1**

Tests and indicators for Francophone clients according to age group (sequential bilateral implantation)

## **Appendix 2**

Tests and indicators for Anglophone clients according to age group (sequential bilateral implantation)

## **Appendix 3**

Indications for the use of clinical tests in audiology: Francophone clients

## **Appendix 4**

Indications for the use of clinical tests in audiology: Anglophone clients







## Appendix 1: Tests and indicators for Francophone clients according to age group (sequential bilateral implantation)

Indications for the use of these tests can be found in Appendix 3 (Francophone clients) and Appendix 4 (Anglophone clients). It is also possible to click on the hyperlinks associated with each test.



### Children under 3 years old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
EARS (if the child is able to do this test) <a href="#">?</a>	X	X	X	X
IRDPQ scale <a href="#">?</a>	X	X	X	X
Sound lateralization <a href="#">?</a>		X	X	X
LittIEARS questionnaire <a href="#">?</a>	X	X	X	
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
Inventaire MacArthur-Bates du développement de la communication (IMBDC): “version mots et gestes” for 8 to 16 month-olds and “version mots et énoncés” for 16 to 30 month-olds, to be completed by the parent	X		X	
Phonemic inventory (up to 11 years 11 months old)	X		X	X



### Children between 3 years and under 6 years old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
EARS <a href="#">?</a> ou HINT for Children <a href="#">?</a>	X	X	X	X
IRDPQ scale <a href="#">?</a>	X	X	X	X
Sound lateralization/localization <a href="#">?</a>		X	X	X
LittIEARS questionnaire <a href="#">?</a>	X	X	X	
Multimedia tests: administered exclusively by the Centre québécois d'expertise en implant cochléaire	X	X	X	X
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
EOWPVT-R (5 years to 7 years 11 months old) Québec French adaptation or EOWPVT-2000 or EOWPVT-4 (3 years to 4 years 11 months old) for those who do not have the 2000 version	X		X	X
EVIP (3 years to 17 years 11 months)	X		X	X
Phonemic inventory (up to 11 years 11 months old)	X		X	X



## Appendix 1: Tests and indicators for Francophone clients according to age group (sequential bilateral implantation)



### Children between 6 years and under 12 years old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
EARS <sup>?</sup> (if the child cannot do the HINT) or HINT for Children <sup>?</sup>	X	X	X	X
IRD PQ scale <sup>?</sup>	X	X	X	X
Sound lateralization/localization <sup>?</sup>		X	X	X
Multimedia tests: administered exclusively by the Centre québécois d'expertise en implant cochléaire	X	X	X	X
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
EOWPVT-R (5 years to 7 years 11 months old) Québec French adaptation or EOWPVT-2000 or EOWPVT-4 for those who do not have the 2000 version (8 years to 17 years 11 months old)	X		X	X
EVIP (3 years to 17 years 11 months old)	X		X	X
Phonemic inventory (up to 11 years 11 months old)	X		X	X



### Users between 12 years and under 18 year old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
HINT for Adults (or HINT for Children depending on level of language) <sup>?</sup>	X	X	X	X
IRD PQ scale <sup>?</sup>	X	X	X	X
Sound localization (test being developed) <sup>?</sup>		X	X	X
Multimedia tests: administered exclusively by the Centre québécois d'expertise en implant cochléaire	X	X	X	X
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
CELFCDN-F sentence repetition test (ages 12 and up)	X		X	X
EOWPVT-2000 or EOWPVT-4 for those who do not have the 2000 version (8 years to 17 years 11 months old)	X		X	X
EVIP (3 years to 17 years 11 months old)	X		X	X



## Appendix 1: Tests and indicators for Francophone clients according to age group (sequential bilateral implantation)



### Adult users

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	<i>Start of IFR</i>	<i>End of IFR</i>	<i>1 year and 2 years after IFR</i>	<i>3 years after IFR</i>
<b>Audiology</b>				
HINT for Adults <sup>?</sup>	X	X	X (1 year)	
IRDPO scale <sup>?</sup>	X	X	X (1 year)	
Sound localization (tool being developed) <sup>?</sup>		X	X (1 year)	
Multimedia tests: administered exclusively by the Centre québécois d'expertise en implant cochléaire	X	X	X (1 year)	

Only the measurement time “1 year after IFR” is mandatory for all tests. The “2 years and 3 years after IFR” measurements should be taken if deemed necessary by the RC audiologist (e.g., significant progress is noted during the “1 year after IFR” assessment or the user reports a deterioration in his auditory functioning).



## Appendix 2: Tests and indicators for Anglophone clients according to age group (sequential bilateral implantation)

Indications for the use of these tests can be found in Appendix 3 (Francophone clients) and Appendix 4 (Anglophone clients). It is also possible to click on the hyperlinks associated with each test.



### Children under 3 years old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
ESP Spondees (if the child is able to do this test) <a href="#">?</a>	X	X	X	X
IRDPO scale <a href="#">?</a>	X	X	X	X
Sound lateralization <a href="#">?</a>		X	X	X
LittIEARS questionnaire <a href="#">?</a>	X	X	X	
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
MacArthur-Bates Communicative Development Inventories (MBCDIs): Words and Gestures form for 8 to 16 month-olds and Words and Sentences form for 16 to 30 month-olds, to be completed by the parent	X		X	
Goldman-Fristoe Test (ages 2 and up)	X		X	X
Phonemic inventory (up to 11 years 11 months old)	X		X	X



### Children between 3 years and under 6 years old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
ESP Spondees <a href="#">?</a> or HINT for Children <a href="#">?</a>	X	X	X	X
IRDPO scale <a href="#">?</a>	X	X	X	X
Sound lateralization/localization <a href="#">?</a>		X	X	X
LittIEARS questionnaire <a href="#">?</a>	X	X	X	
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
Goldman-Fristoe Test (2 years to 11 years 11 months old)	X		X	X
EOWPVT-4 (3 years to 17 years 11 months old)	X		X	X
ROWPVT-4 (3 years to 17 years 11 months old)	X		X	X
Phonemic inventory (up to 11 years 11 months old)	X		X	X



## Appendix 2: Tests and indicators for Anglophone clients according to age group (sequential bilateral implantation)



### Children between 6 years and under 12 years old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
ESP Spondees <sup>?</sup> (if the child cannot do the HINT) or HINT for Children <sup>?</sup>	X	X	X	X
Monosyllables <sup>?</sup>	X	X	X	X
IRDPO scale <sup>?</sup>	X	X	X	X
Sound lateralization/localization <sup>?</sup>		X	X	X
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
Goldman-Fristoe Test (2 years to 11 years 11 months old)	X		X	X
EOWPVT-4 (3 years to 17 years 11 months old)	X		X	X
ROWPVT-4 (3 years to 17 years 11 months old)	X		X	X
Phonemic inventory (up to 11 years 11 months old)	X		X	X



### Users between 12 years and under 18 years old

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	Start of IFR	End of IFR	1 year and 2 years after IFR	3 years after IFR
<b>Audiology</b>				
HINT for Adults (or HINT for Children depending on level of language) <sup>?</sup>	X	X	X	X
Monosyllables <sup>?</sup>	X	X	X	X
IRDPO scale <sup>?</sup>	X	X	X	X
Sound localization (test being developed) <sup>?</sup>		X	X	X
<b>Speech and language therapy at each measurement time; all tests are to be done with both CIs worn</b>				
CELF-4 "Recalling Sentences" evaluation (ages 12 and up)	X		X	X
EOWPVT-4 (3 years to 17 years 11 months old)	X		X	X
ROWPVT-4 (3 years to 17 years 11 months old)	X		X	X



## Appendix 2: Tests and indicators for Anglophone clients according to age group (sequential bilateral implantation)



### Adult users

TESTS ADMINISTERED AND INDICATIONS	MEASUREMENT TIME			
	<i>Start of IFR</i>	<i>End of IFR</i>	<i>1 year and 2 years after IFR</i>	<i>3 years after IFR</i>
<b>Audiology</b>				
HINT for adult <sup>?</sup>	X	X	X (1 an)	
Monosyllables <sup>?</sup>	X	X	X (1 an)	
IRDPO scale <sup>?</sup>	X	X	X (1 an)	
Sound localization (tool being developed) <sup>?</sup>		X	X (1 an)	

Only the measurement time “1 year after IFR” is mandatory for all tests. The “2 years and 3 years after IFR” measurements should be taken if deemed necessary by the RC audiologist (e.g., significant progress is noted during the “1 year after IFR” assessment or the user reports a deterioration in their auditory functioning).



## Appendix 3: Indications for the use of clinical tests in audiology: Francophone clients

### TEST : HINT

CLIENTELE	INDICATIONS
<b>6 to 12 years old</b> (or older with language limitations)	<ul style="list-style-type: none"> <li>HINT for Children (1 list of 10 sentences/test).</li> </ul>
<b>Ages 13 and up</b>	<ul style="list-style-type: none"> <li>HINT for Adults (1 list of 20 sentences/test).</li> <li>For adults, the measurement times “2 years and 3 years after IFR” are not mandatory.</li> </ul>
<b>All clients</b>	<ul style="list-style-type: none"> <li>Recorded version, level set at 63 dBA, speech facing client.</li> <li>Start of IFR, 2nd CI alone; same protocol as for unilateral implantation, i.e.:             <ul style="list-style-type: none"> <li>In quiet.</li> <li>In noise (speech and noise in front) if result &gt; 30% in quiet. Increase duration of noise to 5 seconds before introducing speech:                 <ol style="list-style-type: none"> <li>Signal-to-noise ratio of +10 dB.</li> <li>If result &gt; 30% at a signal-to-noise ratio of +10 dB, test at a ratio of +5 dB.</li> <li>If result &gt; 30% at a ratio of +5 dB, test at a ratio of 0 dB.</li> </ol> </li> </ul> </li> <li>All other measurement times:             <ul style="list-style-type: none"> <li>In quiet : 1st CI alone, 2nd CI alone and both CIs together.</li> <li>In noise (speech and noise in front) if result &gt; 30% in quiet with both CIs. Increase the duration of noise to 5 seconds before introducing speech.                 <ol style="list-style-type: none"> <li>First test with both CIs at a signal-to-noise ratio of +10 dB.</li> <li>If result &gt; 30% with both CIs at a signal-to-noise ratio of +10 dB, test at a ratio of +5 dB with both CIs.</li> <li>If result &gt; 30% with both CIs at a ratio of +5 dB, test at a ratio of 0 dB with both CIs.</li> <li>Test the 1st CI alone and the 2nd CI alone at the lowest signal-to-noise ratio where the result with both CIs together is roughly 50%.</li> </ol> </li> </ul> </li> </ul>



### Appendix 3: Indications for the use of clinical tests in audiology: Francophone clients

#### TEST: EARS

CLIENTELE	INDICATIONS
<p><b>Children under 12 years old</b></p> <p><i>Only if the child cannot do HINT and is able to do this test</i></p>	<ul style="list-style-type: none"> <li>• Closed-set words presented using the CD provided by the Centre québécois d'expertise en implant cochléaire.</li> <li>• Calibration based on the reference signal on the CD.</li> <li>• Presentation level: 60 dB HL.</li> <li>• Speech noise of the audiometer.</li> <li>• Speech and noise are always facing the child.</li> <li>• Start of IFR: 2nd CI alone.</li> <li>• Other measurement times: 1st CI alone, 2nd CI alone and bilateral.                             <ol style="list-style-type: none"> <li>1. In quiet.</li> <li>2. In noise, to determine the appropriate signal-to-noise ratio at which to test each CI alone. Start with both CIs at a signal-to-noise ratio of 0 dB. If the result is 0%, test at a signal-to-noise ratio of +5 dB.</li> </ol> </li> </ul>

#### TEST: IRDPQ SCALE

CLIENTELE	INDICATIONS
<p><b>All clients</b></p>	<ul style="list-style-type: none"> <li>• Administered to young children and to all users who score &lt; 30% on the HINT in quiet.</li> <li>• Use of clinical tools as needed for assessment.</li> <li>• Start of IFR: 2nd CI alone.</li> <li>• End of IFR: 2nd CI alone and both CIs together.</li> <li>• Other measurement times: both CIs together.</li> </ul>





## Appendix 3: Indications for the use of clinical tests in audiology: Francophone clients

### TEST: SOUND LATERALIZATION

CLIENTELE	INDICATIONS
<b>Children under 12 years old</b> <i>(Right-left for children as soon as that is possible)</i>	<ul style="list-style-type: none"> <li>• Two speakers positioned at 45 degrees.</li> <li>• Filtered car horn stimulus on CD provided by the Centre québécois d'expertise en implant cochléaire.</li> <li>• Random presentation 6 times in each speaker at 60 dB HL.</li> <li>• Use of visual reinforcements for children.</li> <li>• End of IFR and other measurements: both CIs.</li> <li>• If <math>\geq 9/12</math> with both CIs, test each CI alone.</li> <li>• Clients ages 12 and up: Test being developed.</li> </ul>

### TEST: LITTLEARS QUESTIONNAIRE

CLIENTELE	INDICATIONS
<b>Children under 6 years old</b>	<ul style="list-style-type: none"> <li>• Questionnaire filled out by the parent.</li> <li>• Start of IFR: 2nd CI alone.</li> <li>• End of IFR: 2nd CI alone.</li> <li>• Other measurement times: both CIs.</li> </ul>

### TEST: MULTIMEDIA TEST

CLIENTELE	INDICATIONS
<b>All clients</b>	<ul style="list-style-type: none"> <li>• Start of IFR: 2nd CI.</li> <li>• Other measurement times: 1st CI alone if deemed relevant, 2nd CI alone and both CIs together.</li> <li>• Administered exclusively by the Centre québécois d'expertise en implant cochléaire.</li> <li>• For adults, the measurement times "2 years and 3 years after IFR" are not mandatory.</li> </ul>



## Appendix 4: Indications for the use of clinical tests in audiology: Anglophone clients

### TEST: HINT

CLIENTELE	INDICATIONS
<b>6 to 12 years old</b> (or older with language limitations)	<ul style="list-style-type: none"> <li>HINT for Children (1 list of 10 sentences/test).</li> </ul>
<b>Ages 13 and up</b>	<ul style="list-style-type: none"> <li>HINT for Adults (1 list of 20 sentences/test).</li> <li>For adults, the measurement times “2 years and 3 years after IFR” are not mandatory.</li> </ul>
<b>All clients</b>	<ul style="list-style-type: none"> <li>Recorded version, level set at 63 dBA, speech facing client.</li> <li>Start of IFR, 2nd CI alone; same protocol as for unilateral implantation, i.e.:                             <ul style="list-style-type: none"> <li>In quiet.</li> <li>In noise (speech and noise in front) if result &gt; 30% in quiet. Increase the duration of noise to 5 seconds before introducing speech:                                     <ol style="list-style-type: none"> <li>Signal-to-noise ratio of +10 dB.</li> <li>If result &gt; 30% at a signal-to-noise ratio of +10 dB, test at a ratio of +5 dB.</li> <li>If result &gt; 30% at a ratio of +5 dB, test at a ratio of 0 dB.</li> </ol> </li> </ul> </li> <li>All other measurement times:                             <ul style="list-style-type: none"> <li>In quiet: 1st CI alone, 2nd CI alone and both CIs together.</li> <li>In noise (speech and noise in front) if result &gt; 30% in quiet with both CIs. Increase the duration of noise to 5 seconds before introducing speech.                                     <ol style="list-style-type: none"> <li>First test with both CIs at a signal-to-noise ratio of +10 dB.</li> <li>If result &gt; 30% with both CIs at a signal-to-noise ratio of +10 dB, test at a ratio of +5 dB with both CIs.</li> <li>If result &gt; 30% with both CIs at a ratio of +5 dB, test at a ratio of 0 dB with both CIs.</li> <li>Test the 1st CI alone and the 2nd CI alone at the lowest signal-to-noise ratio where the result with both CIs together is roughly 50%.</li> </ol> </li> </ul> </li> </ul>



## Appendix 4: Indications for the use of clinical tests in audiology: Anglophone clients

### TEST: ESP SPONDEES

CLIENTELE	INDICATIONS
<p><b>Children under 12 years old</b></p> <p><i>Only if the child cannot do the HINT and is able to do this test</i></p>	<ul style="list-style-type: none"> <li>• Closed-set words presented using the Central Institute for the Deaf CD's.</li> <li>• Calibration based on the reference signal on the CD.</li> <li>• Presentation level: 60 dB HL.</li> <li>• Speech noise of the audiometer.</li> <li>• Speech and noise are always facing the child.</li> <li>• Start of IFR: 2nd CI alone.</li> <li>• Other measurement times: 1st CI alone, 2nd CI alone and both CIs together.               <ol style="list-style-type: none"> <li>1. In quiet.</li> <li>2. In noise, to determine the appropriate signal-to-noise ratio at which to test each CI alone. Start with both CIs at a signal-to-noise ratio of 0 dB. If the result is 0%, test at a signal-to-noise ratio of +5 dB.</li> </ol> </li> </ul>

### TEST: MONOSYLLABLES

CLIENTELE	INDICATIONS
<p>Users ages <b>6 and up</b></p>	<ul style="list-style-type: none"> <li>• Lists of phonetically balanced words for adults (1 list of 50 CNC Test words / test) or children (1 list of 25 PBK words / test), depending on level of language (using CD).</li> <li>• Presentation level: 60 dB HL.</li> <li>• Start of IFR: 2nd CI alone.</li> <li>• Other measurement times: 1st CI alone, 2nd CI alone and both CIs together.</li> <li>• Depending on the calibration of the booth:               <ul style="list-style-type: none"> <li>• Both CIs: words presented facing the user or on the side of the 1st CI.</li> <li>• With each CI alone: words presented facing the user or on the side of the CI being tested.</li> </ul> </li> <li>• For adults, measurement times "2 years and 3 years after IFR" are not mandatory.</li> </ul>

### TEST: IRDPQ SCALE

CLIENTELE	INDICATIONS
<p><b>All clients</b></p>	<ul style="list-style-type: none"> <li>• Administered to young children and to all users who score &lt; 30% on the HINT in quiet.</li> <li>• Use of clinical tools as needed for assessment.</li> <li>• Start of IFR: 2nd CI alone.</li> <li>• End of IFR: 2nd CI alone and both CIs together.</li> <li>• Other measurement times: both CIs together.</li> </ul>



## Appendix 4: Indications for the use of clinical tests in audiology: Anglophone clients

### TEST: SOUND LATERALIZATION

CLIENTELE	INDICATIONS
<p><b>Children under 12 years old</b></p> <p><i>(Right-left for children as soon as that is possible)</i></p>	<ul style="list-style-type: none"> <li>• Two speakers positioned at 45 degrees.</li> <li>• Filtered car horn stimulus on CD provided by the Centre québécois d'expertise en implant cochléaire.</li> <li>• Random presentation 6 times in each speaker at 60 dB HL.</li> <li>• Use of visual reinforcements for children.</li> <li>• End of IFR and other measurements: both CIs.</li> <li>• If <math>\geq 9/12</math> with both CIs together, test each CI alone.</li> <li>• Clients ages 12 and up: Test being developed.</li> </ul>

### TEST: LITTLEARS QUESTIONNAIRE

CLIENTELE	INDICATIONS
<p><b>Children under 6 years old</b></p>	<ul style="list-style-type: none"> <li>• Questionnaire filled out by the parent.</li> <li>• Start of IFR: 2nd CI alone.</li> <li>• End of IFR: 2nd CI alone.</li> <li>• Other measurement times: both CIs.</li> </ul>



ISBN: 978-2-550-80966-1 (PDF)  
(Translation of the French edition 2016)

ISBN : 978-2-550-77308-5 (PDF)  
(Original edition in French 2016)

## Centre québécois d'expertise en implant cochléaire

CIUSSS de la Capitale-Nationale  
site de l'IRDPO  
2975, chemin Saint-Louis  
Québec (Québec) G1W 1P9

CHU de Québec - UL  
site L'Hôtel-Dieu de Québec  
11, côte du Palais  
Québec (Québec) G1R 2J6

*Centre intégré  
universitaire de santé  
et de services sociaux  
de la Capitale-Nationale*

**Québec** 

  
**CHU  
de Québec**  
Université Laval