Title: Enhancing Use of Remote Microphones Among Adult Cochlear Implant Users and Their Frequent Communication Partners

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Abstract:

Remote microphones serve as assistive devices with the potential to enhance speech perception and sound quality for cochlear implant (CI) users in challenging listening environments. However, the extent to which adult CI users and their communication partners perceive these benefits remains uncertain. To address this question, we organized support groups for adult CI recipients implanted at the University of Iowa Hospitals and Clinics and their partners residing. The primary objectives of these support groups were twofold: firstly, to provide comprehensive education on the benefits of utilizing remote microphones, and secondly, to facilitate discussions on pertinent topics, including troubleshooting device-related issues. This study focuses on identifying and addressing the barriers encountered by adult CI users and their communication partners in effectively utilizing remote microphones, while simultaneously promoting their proper use through education and guidance. During the support group sessions, we engaged in discussions focused on strategies for optimizing remote microphone utilization among CI users and their frequent communication partners. These strategies encompassed comprehensive education and training, technical assistance, addressing concerns and potential stigma, and involving family members and caregivers in the process. Following participation in the support group sessions, all attendees completed questionnaires indicating an increased motivation to utilize remote microphones effectively. This finding underscores the critical role of education and support in promoting the efficient use of assistive devices and ultimately enhancing communication outcomes for both CI recipients and their communication partners. Because the need for education and support is so great, educational materials about remote microphones for adult CI users and their frequent communication partners were created to aid in this need (shown in Appendix A). In summary, this project indicates the potential advantages of incorporating remote microphones into the lives of adult CI recipients and their communication partners. It underscores the imperative need for robust education and support mechanisms to ensure the optimal utilization of remote microphone systems.

Introduction

Cochlear implants (CIs) are groundbreaking devices in auditory rehabilitation, providing individuals with severe-to-profound hearing loss the chance to restore their access to sound and spoken language. These innovative devices function by directly stimulating the auditory nerve, bypassing damaged or nonfunctioning inner ear components. Although CIs have demonstrated remarkable efficacy in restoring auditory perception in quiet environments, the real-world listening challenges encountered by adult CI recipients, particularly when grappling with speech comprehension in noisy and acoustically complex surroundings, remain a formidable obstacle.

In addressing this challenge, remote microphone technologies offer a promising solution. These supplementary devices capture and transmit audio signals directly to the CI processor, resulting in a substantial enhancement of the signal-to-noise ratio (SNR). This reduction in the impact of ambient noise leads to improved speech clarity and more precise speech recognition, providing substantial benefits to CI users (Dorman and Gifford, 2017).

However, while the benefits of remote microphone technologies have been extensively documented for specific demographics, such as in hard-of-hearing children who use hearing aids, a knowledge gap remains regarding their utility and impact on adult CI recipients. This study aims to address this gap by investigating the benefits, usage patterns, and perceived barriers associated with remote microphones among adult CI users and their frequent communication partners (FCPs).

The purposes of this study are:

- To identify the specific challenges and barriers that adult cochlear implant (CI) recipients and their communication partners encounter when using remote microphones.
- To develop educational materials aimed at facilitating the effective and efficient use of remote microphones by adult CI recipients and their communication partners.

Through this research, we aim to provide valuable insights that can contribute to the enhancement of communication experiences in challenging listening conditions for adult CI users and their communication partners.

Methods

Cochlear implant users were recruited through the Wendell Johnson Speech and Hearing Center at the University of Iowa with a phone call invitation to participate in a cochlear implant support group session. The cochlear implant users consisted of a variety of different sound processor models and remote microphones that were provided with their processor. Three separate support groups were organized, each tailored to cochlear implant recipients based on the manufacturer of their device: Cochlear America, Advanced Bionics, and Med El. Participants were encouraged to join the support group corresponding to their specific cochlear implant manufacturer to ensure relevance and tailored support. For each support group, all participants either brought their own remote microphone systems or used demo devices for hands-on learning experience with remote microphone systems. Representatives from each cochlear implant manufacturer were also invited to facilitate the educational sessions on remote microphone systems, providing valuable insights and support tailored to the specific remote microphone systems offered by each manufacturer. The survey questionnaires were crafted to capture the perceptions of both CI users and their FCPs regarding the benefits and barriers associated with their use of remote microphones following the educational cochlear implant support group session. These questionnaires utilized a variety of question types, including short-answer, multiple-choice, and scale-based questions, offering a comprehensive assessment of remote microphone utilization from the time of the participant's implantation to present. Below are examples of questions from the questionnaires, however the complete questionnaire is available for download on the article webpage:

For CI Users: "How confident do you feel about using a remote microphone with your cochlear implant?"

For FCPs: "What are the reasons for not using a remote microphone with the cochlear implant user?"

These questionnaires were distributed to adult CI users and their FCPs who participated in the adult CI support group sessions. Participation in the questionnaire was voluntary and provided as an option at the end of each support group session. Thus far, the study has included six adult CI users (four aged between 51 and 70, and two aged over 81) and one dedicated FCP (aged over 81), with data collection occurring immediately after the support group sessions.

Results

Based on the responses obtained from the questionnaires, the preliminary data reveals that four adult CI users, spanning the age range of 50 to 80+, reported incorporating remote microphones into their CI usage. However, the frequency and duration of usage exhibited substantial variation among those four participants. Some individuals utilized the device consistently whenever needed, often for several hours a day, while others used it infrequently and for shorter durations.

Most of the participants who used remote microphones expressed a moderate level of confidence in operating the device. They attributed their motivation for its use to various factors, including improved speech comprehension in noisy environments, enhanced hearing at a distance, and better auditory experiences within a car. Nonetheless, participants also encountered barriers and challenges, such as occasionally forgetting to bring the remote microphone or experiencing difficulties with device pairing. They expressed a clear need for more comprehensive information on troubleshooting and maintenance, as well as a desire for additional resources and training related to remote microphone systems.

Notably, communication partners who attended the CI support groups alongside their CI recipients shared similar responses regarding the use of remote microphones. However, a majority of them reported feeling less confident in their ability to use the device, despite acknowledging its positive impact on communication in various settings, particularly within a car. The most common barriers they mentioned were related to their CI recipients not providing them with the remote microphone or forgetting to bring it along. They also expressed a strong desire for more resources and instructional guidance on using the remote microphone effectively.

It is worth highlighting that all respondents, including both CI users and their communication partners, reported an increased motivation to utilize remote microphones following their participation in the support group sessions. Table 1 summarizes the reported benefits and barriers experienced by CI users and FCPs (N = 7).

Table 1. Reported Benefits and Challenges of Remote Microphone Use among CI Users and FCPs

Benefits	Challenges
- Improved listening to TV. - Enhanced communication in a car. - Enhanced speech understanding in noisy environments.	- Inconvenience of carrying the remote microphone (RM). - Discomfort in requesting others to wear or use the RM. - Forgetfulness in bringing or using the RM. - Difficulty in discerning when and how to use the RM. - Challenges related to activating and pairing the RM.

Discussion

This project aimed to address the gaps in the accessibility and utilization of remote microphone systems among adult CI recipients and their frequent communication partners. Analysis of the questionnaire responses revealed significant variability in the use of remote microphones among adult CI recipients and their communication partners. Participants who utilized the remote microphones consistently reported that these devices contributed to improved speech comprehension in noisy environments, enhanced hearing over distances, and more effective communication within a car. These perceived benefits of remote microphone systems by adult CI recipients and their frequent communication partners were consistent with previous research findings (Blamey et al., 2013, Gifford et al.,2018).

However, participants also identified several barriers and challenges associated with using remote microphones. These included instances of forgetting to bring the device, difficulties with unstable device pairing, and a lack of information and resources for troubleshooting and maintenance. The questionnaire results underscored the pressing need for enhanced education and support to encourage the effective utilization of remote microphones and to address any obstacles or challenges that might impede their use.

Interestingly, communication partners expressed lower confidence in using remote microphones compared to CI recipients, indicating a potential necessity for additional education and training initiatives. It is noteworthy that all participants reported an increased motivation to utilize remote microphones after participating in the support group sessions, highlighting the critical role of education and support in promoting the effective use of assistive devices and ultimately enhancing communication outcomes for both CI recipients and their communication partners. The reported challenges of remote microphone systems in our study were consistent with previous findings indicating urgent needs for continued education on remote microphone systems among adult cochlear implant users (Scarni et. al., 2022).

This project illuminates the considerable potential benefits of remote microphones for adult CI recipients and their communication partners. It underscores the imperative need for augmented education and support mechanisms to ensure the optimal utilization of assistive devices. We believe that ongoing counseling regarding remote microphone use during subsequent clinical appointments holds promise for educating CI users about the advantages of this technology. Furthermore, group discussions, such as support groups, provide a valuable platform for CI users to exchange insights and experiences related to device use. One limitation of this study is that the results were based on a small amount of completed questionnaires (7). While this work is preliminary and should be considered with caution, this is an interesting avenue of science communication and deserves more investigation.

Additionally, the development of educational materials (shown in **Appendix A**) covering the fundamentals of remote microphone systems could prove highly beneficial to a wide range of CI users. The key ideas that these educational materials share include pairing, streaming, overall usage, and examples of everyday environments where remote microphone technology could be beneficial. These were created with adult cochlear implant users and their frequent communication partners in mind. Because of this, the verbiage used in the materials is catered to individuals who have basic knowledge of cochlear implants and remote microphones. Several images are included in the materials to help provide reinforcement of the information provided in the text. Advanced Bionics, Cochlear Americas, and Med-El were included in the materials, as they are the largest manufacturers of cochlear implants. The materials are color coded based on the manufacturer's logo. These educational materials have not yet been implemented in support groups held at the University of Iowa but have been shared in clinic appointments and with audiologists. By creating and sharing these educational materials, we hope that adult cochlear implant users can gather a deeper understanding of remote microphones and successfully integrate these systems into their daily lives.

References

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Appendix A: Educational Materials for Adult CI Users and Their Frequent Communication Partners

ADVANCED BIONICS

REMOTE MICROPHONE INFORMATION FOR COCHLEAR IMPLANT USERS AND THEIR FREQUENT COMMUNICATION PARTNERS

Phonak, a hearing aid manufacturer, is the sister company to Advanced Bionics. Phonak Roger devices are the compatible remote microphones with Advanced Bionics Cochlear Implants.

PAIRING YOUR DEVICES

Advanced Bionics use a two part remote microphone system. There is the microphone, the Roger On device, and a receiver that is placed on the hearing devices.

Once a compatible receiver is placed on the cochlear implant, the receiver and Roger On must be paired. To do this, turn the hearing device on. Press the connect button on the backside of the Roger On. Hold the Roger On close to the hearing device. If the display has a check mark, the connection has been successful.

RECEIVERS

CONNECT BUTTON

Connect successful

Receiver not compatible

No receiver found, go closer

STREAMING TO YOUR DEVICE

Once your Roger On has been charged, move the switch on the side of the Roger to the "on" position. You are ready to listen!

On/Off Slider

Function Button

ROGER ON

ONE ON ONE VERSUS GROUP USE

One on One: When talking to one person, give them the microphone to either clip to their collar or hold to speak into.

Group: When using in a group, set the microphone down in a central location so the microphone can pick up all the different people in the group.

COCHLEAR AMERICAS

REMOTE MICROPHONE INFORMATION FOR COCHLEAR IMPLANT USERS AND THEIR FREQUENT COMMUNICATION PARTNERS

PAIRING YOUR DEVICES

PAIRING BUTTON

First, you need to pair the Mini Microphone with the cochlear implant (CI) processor. To pair, remove your CI and turn it off by removing the battery. Turn on the mini microphone by holding the on/off button for 2 seconds until the light turns **green**. Next, use a pen to press the pairing button once. Once the light is blinking **yellow**, turn on your CI. It will flash a **blue** light when pairing has been successful.

STREAMING TO YOUR DEVICE

There are 3 ways to stream from the Mini Microphone to the CI.
1. The button on the CI: Turn on the CI. Turn on the Mini Microphone. Press and hold the button on the sound processor for 2 seconds. The light on the CI will be **blue** when the streaming has begun.
2. The Nucleus Smart App: Turn on the CI. Turn on the Mini Microphone. Start the app. Tap Audio Sources and tap the Mini Mic icon. The light on the CI will be **blue** when streaming has begun.
3. The Remote Control: Turn on the CI. Turn on the Remote Control. Turn on the Mini Microphone. Press and hold the Telecoil button for 2 seconds. The light on the CI will be **blue** when streaming has begun.

On/Off Button

Volume Up Button

Mute Button

Volume Down Button

MINI MICROPHONE

ONE ON ONE VERSUS GROUP USE

One on One: When talking to one person, give them the microphone to either clip to their collar or hold to speak into.

Group: When using in a group, set the microphone down in a central location so the microphone can pick up all the different people in the group.

MED-EL

REMOTE MICROPHONE INFORMATION FOR COCHLEAR IMPLANT USERS AND THEIR FREQUENT COMMUNICATION PARTNERS

PAIRING YOUR DEVICES

First, you need to pair the AudioLink to the cochlear implant (CI) processor. To pair, switch off the CI. Switch on the AudioLink by holding the main button at the top for 2 seconds. The status light in the right corner should be either orange or green. Place the CI coil on the top side of the AudioLink, just over the volume button. Switch the CI on. When the AudioLink and CI are paired, the left and right connection symbols should light up.

STREAMING TO YOUR DEVICE

In order to use the AudioLink as a remote microphone, first begin by turning the AudioLink on by holding the main button at the top for 2 seconds. Next, press the microphone button on the AudioLink to start streaming. The microphone button will be lit up when streaming has begun.
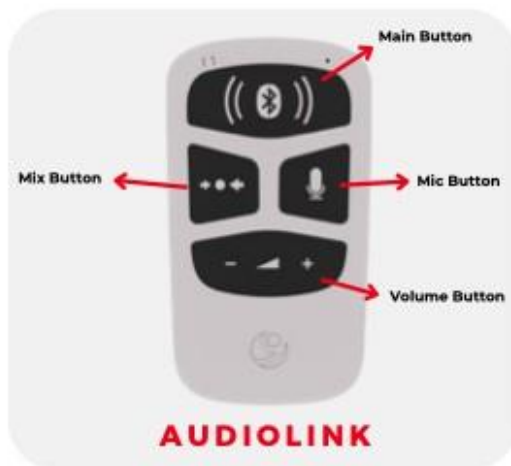
AUDIOLINK

Main Button
Mix Button
Mic Button
Volume Button

ONE ON ONE VERSUS GROUP USE

One on One: When talking to one person, give them the microphone to either clip to their collar or hold to speak into.

Group: When using in a group, set the microphone down in a central location so the microphone can pick up all the different people in the group. AudioLink also comes with a docking station, shown in photos on the next page.

AudioLink User Guide:
https://www.medel.com/docs/default-source/support-downloads/aw40214_20_quick-guide-audiolink-(en-english-us).pdf?auto=format&sfvrsn=49b92040_5

HOW AND WHEN TO USE IT

Remote microphones should be used whenever a cochlear implant user would find benefit. Here are some common examples where remote microphones are used.

🟧 Cochlear Implant User   🟨 Remote Microphone

The Car

Restaurants - 1 on 1

Walking

Game Night

Classes

Appendix B: Links to User Guide Provided by CI Manufacturers

1. **Advanced Bionics**

2. **Cochlear Americas**

3. **Med-El**