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ORIGINAL STUDY

# Assessment of the main factors involved in the auditory-verbal rehabilitation process in children with cochlear implants

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## ABSTRACT

**BACKGROUND.** Children's communication with the family and the environmental surroundings begins immediately after birth and development continues throughout life. Impairment of hearing due to the presence of congenital hypoacusis results in severe language development disorders. The purpose of the study was to identify the main factors involved in the auditory-verbal rehabilitation process of children with hearing impairment.

**MATERIAL AND METHODS.** A descriptive, observational study was conducted on a group of 35 carers of hearing-impaired children proposed for auditory-verbal rehabilitation through cochlear implantation. The study carried out was based on the parents' statements, analyzing the essential factors that can influence the quality of life of parents with hearing-impaired children: the child's age at the time of the positive diagnosis, the child's communication skills before implantation, the time elapsed from the intervention to implant activation, participation in auditory-verbal rehabilitation sessions with a speech therapist, parental commitment during the immediate pre- and post-implant period, the parent's level of education.

**RESULTS.** The dominance of the female gender can be noted - 91.43%. 60% of adult participants were college graduates, 20% discontinued their education after completing high school, 17.14% graduated from a post-secondary school. 57.14% of the parents reported being employed in some form of work during the period before and immediately after the cochlear implantation of their children. 82.85% reported the diagnosis of their child's hypoacusis in the pre-kindergarten group. Out of the total number of children, 68.57% were recipients of bilateral cochlear implants, 31.43% had unilateral implants. The periods during which children benefited from post-implantation speech therapy were between 1 and 6 months (5.71%), 1 and 2 years (2.86%), >2 years (17.14%). In 71.43% of cases, families were in the rehabilitation phase with speech therapy at the time of filling out the form.

**CONCLUSION.** In the auditory-verbal rehabilitation process of a hearing-impaired child, there are a number of factors and conditions that must be considered in a specific manner for each individual patient.

**KEYWORDS:** auditory-verbal rehabilitation, cochlear implant, communication, speech therapy treatment.

## INTRODUCTION

An individual's language is constantly developing throughout their entire life. However, a newborn is not inherently prepared for this. Children learn to communicate depending on many factors, including the attention provided by parents/caregivers, along with the surrounding environment. Consequently, each child develops their communication skills at their own pace, but within a general framework of language development.

At the age of only 2 months, the child without hearing disorders begins to coo and, in terms of social integration, starts smiling at people in whose presence he feels secure. This social smile transforms into laughter at about 4 months, at which point the baby should be able to successfully localize sounds around them. At 6 months, attachment to parents becomes evident and anxiety towards strangers appears. Simple cooing starts to transform into syllables. The first words typically form around 9 months of age. By the age of 1, the vocabulary includes 5-10 words, which should expand (10-50

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words) by 1 and a half years to begin forming simple two-word sentences. At 2 years old, a vocabulary of 50-75 words and three-word sentences are expected, while at 4 years old, 250+ words and 4-word sentences.

About 9% of children experience difficulties in acquiring intelligible speech, despite typical sensory, neuro-motor and cognitive functions. Speech and language pathologies are based on descriptions of children's speech errors[1].

Language represents the tool for expressing one's personality. The vocabulary of a healthy adult typically ranges between 20,000 and 35,000 words. A study conducted in the United States in the 1990s concluded that children from higher-income families were exposed to 32 million more words than those from lower-income families[2]. This substantial difference in vocabulary exposure resulted in better social integration for children with more developed vocabularies, both in kindergarten and school.

In the specialized literature, no differences were found between the first and the second child in the language development, in families with several children[3].

Hearing impairment from birth significantly influences the number of words found in the vocabulary of these patients. Congenital hearing loss, present at birth, is one of the most widespread chronic conditions in children. In most developed countries, neonatal hearing screening programs allow for early detection. Early intervention will prevent delays in speech and language development and has long-lasting beneficial effects on social and emotional development and quality of life. Universal screening has been supported by most national child health organizations due to the ease of conducting screening tests and the ability to identify children who may need early auditory rehabilitation[4,5].

A hearing-impaired child encounters difficulties in most of the key points previously mentioned. An infant with profound hearing loss may not start cooing at 2 months, and social smiling is rarely observed. The lack of response to surrounding sounds most often draws parents' attention in undiagnosed cases up to the age of 4 months. Anxiety towards strangers from the age of 6 months is much more pronounced than in children without a deficit. The underdevelopment of vocabulary poses a significant obstacle to social integration. These patients often struggle to engage in play with other children, partly due to lack of communication and partly due to discrimination from the community. Hearing impairment during personality development represents a genuine handicap in terms of social integration.

The restoration of hearing is possible through multiple methods thanks to advanced technology available today. Thus, depending on the etiology and severity of the hearing impairment, a child can benefit from a wide range of therapies, ranging from simple non-invasive hearing aids to more complex and invasive procedures of surgical implantation of various auditory devices. The cochlear implant is a hearing device that directly stimulates the nerve endings of the acoustic nerve, causing auditory sensations. It is recommended for children with severe or profound sensorineural hearing loss, whether unilateral or bilateral, congenital or acquired[4,5].

Speech and language delay in children is associated with increased difficulties in reading, writing, attention and socialization. Doctors must be directly involved in recognizing the parents' concerns and identifying potential deficiencies in the children's rehabilitation process. In order to perform a cochlear implant in a child, all aspects related to recovery after surgery must be considered, which requires the involvement of a multidisciplinary team. The cooperation between the child, parents, audiologist, ENT surgeon, speech therapist, psychologist and teaching staff ensures not only an accurate diagnosis and a correct decision regarding the treatment plan, but also provides an environment conducive to auditory-verbal rehabilitation. The audiologist plays a crucial role in the path towards a positive diagnosis. Compared to the compliant and understanding adult, few children understand the purpose of the tests to which they are subjected. Cooperating and maintaining a connection with the same audiologist for subsequent adjustments can reduce both the child's anxiety and the parents' stress through the familiarity and trust already invested. The specialized pediatric psychologist assists hearing-impaired children and their parents in facilitating acceptance of the diagnosis and adaptation to the new lifestyle. The most crucial role, however, is played by the parent. Of all the previously mentioned roles, the parent is the closest to the child. Positive support and optimism from parents are the first steps towards the child's auditory recovery. A study conducted in India, involving 23 parents with cochlear-implanted children showed that their expectations regarding post-implant social integration are high[6].

The objectives of auditory-verbal rehabilitation include the detection, discrimination and identification of the ambient sound, ensuring auditory perception and speech understanding, the development of receptive and expressive language and engaging in interactive conversations[7]. The auditory-verbal method requires integrating training into everyday life and focuses on the initial development of hearing independently of lip-reading. The 8 stages of auditory rehabilitation are: detection, attention, orientation, memory, discrimination, selection, feedback and auditory conception[8]. For children under the age of 3, the ideal rehabilitation is represented by emphasizing the auditory-verbal method with a focus on the listening aspect. The person who is with the child throughout the entire process of implantation and auditory-verbal rehabilitation is the parent. Therefore, it is absolutely necessary to maintain the mental and physical health of the parents so that they can make all the necessary decisions regarding the child's health. Studies that analyzed the psychological stress of parents of children with cochlear implants, concluded that, in general, these parents are more susceptible to high psychological stress compared to parents of children without hearing impairment[9,10]. The psychological state of the parent can influence their behaviour towards the child. It has been proven that mothers experiencing

**Table 1. Individual completion form that was the basis of the study.**

| | |
|---|---|
| Gender of the parent | ❑ Female<br>❑ Male |
| Last school completed by the parent | ❑ General school<br>❑ High school<br>❑ Post-secondary school<br>❑ Faculty |
| Parent's employment status in the pre- and immediate post-implant period | ❑ Employed<br>❑ Unemployed |
| Undergoing surgery through the national program for hearing impairment treatment with implantable prostheses or self-funded | ❑ Yes<br>❑ No |
| The age of the child at the time of cochlear implantation and, respectively, the age at the time of diagnosis | ❑ <3 years<br>❑ 3-6 years<br>❑ 6-10 years<br>❑ 10-14 years<br>❑ 14-18 years |
| The number of implants the child has received | ❑ Unilateral<br>❑ Bilateral |
| The period when the first cochlear implant trial took place | Number of months _____ |
| The duration of time during which the child benefited from sessions with a speech therapist | ❑ Still benefiting<br>❑ Between 1 and 6 months<br>❑ Between 6 months and 1 year<br>❑ Between 1 and 2 years<br>❑ >2 years<br>❑ Did not benefit at all |
| The child's communication skills before implantation | ❑ Did not ommunicate at all<br>❑ Communicated through sounds, without words<br>❑ Used words, unclearly pronounced<br>❑ Communicated normally |
| Observing the improvement related to the child's communication skills after the rehabilitation period | ❑ Yes<br>❑ No |

stress are less sensitive to the child's needs, thereby affecting their socio-emotional development[11]. Additionally, it has been discovered that the mothers' psychological state at the time of the diagnosis of the child's hearing loss and at the time of the first cochlear implant trial were significantly correlated with linguistic reintegration, post-implant communication and auditory-verbal rehabilitation. The psychological stress experienced by parents of hearing-impaired children receiving a cochlear implant is a topic of the few studies published in the literature.

A child's cochlear implant involves a long and challenging journey towards recovery, often resulting in partial recovery. In families with hearing-impaired children, daily activity, quality of life, family relationships and social interactions are affected. All these factors can have negative effects on the overall life, both psychologically and physically.

The primary motivation of this study was to assess potential predictive factors that could induce stress in parents of hearing-impaired children, potential candidates for surgical treatment through cochlear implantation, and to provide parents with the opportunity to express the level of stress experienced throughout the entire auditory rehabilitation process.

## MATERIAL AND METHODS

A descriptive, observational study was conducted on a group of 80 carers of hearing-impaired children proposed for auditory-verbal rehabilitation through cochlear implantation. The study was carried out in the Cochlear Implant Center in Targu Mures, during the period 2022-2023. It is worth noting that this study collected data online through the "Parents of children with cochlear implant" platform, including parents who agreed to participate in the study, their confidentiality data being preserved. The main selection criterion was being a parent.

The conducted study is based on the parents' statements, analyzing the essential factors that can influence the quality of life of parents of hearing-impaired children proposed for cochlear implant surgery. This category includes: the child's age at the time of positive diagnosis, the child's communication abilities before implantation, the time elapsed from the intervention to implant activation, participation in auditory-verbal rehabilitation sessions with a speech therapist, parental commitment during the period immediately pre and post implant, as well as the parent's level of education. The main

selection criterion for the study was being a parent, regardless of gender, parents being approached via online.

Out of the 80 people initially included, 35 were selected who responded affirmatively, providing the necessary data for the study. The assessment of the participants was carried out through an individually completed form using the Google Forms platform. The form comprised 10 general questions regarding the participant's personal information, the child's diagnosis and the surgical intervention. The response options varied depending on the type of question (Table 1).

The questions were formulated to be able to identify possible connections between the information requested and the parents' stress levels. They did not contain any reference to the personal data of parents/children, personal data of the surgeon/hospital where the intervention took place, or any other detail that could lead to the nominal identification of the patients. Consequently, all privacy data has been respected, based on research ethics compliance.

## RESULTS AND DISCUSSIONS

As a result of evaluating the forms, if we refer to the gender of the parents involved, out of a total of 35 parents, the dominance of females is evident, in a percentage of n=32 (91.43%). Only 8.57% (n=3) of the participants are male, indicating a much greater involvement of mothers in everything related to raising the child and the auditory-verbal rehabilitation of the hearing-impaired individuals.

In response to the question regarding the last school completed by the parents, it can be observed that n=21 (60%) of the participants are college graduates, n=7 (20%) discontinued their studies after completing the 12 years of high school, and n=6 (17.14%) chose to continue their education by graduating from a post-secondary school. N=1 (2.86%) dropped out of the educational system after completing the 8 grades of primary school (Figure 1). In this context, the predominance of parents with higher education among children with cochlear implants can be noted, further demonstrating the increased involvement of intellectuals in everything that means the auditory-verbal rehabilitation process of hearing-impaired children.

The employment commitment of parents during the period before and immediately after cochlear implantation of the children (Figure 2) was declared in 57.14% of cases (n=20), with 42.86% (n=15) being unemployed. The difference of 14.28% can be interpreted as not significantly high, indicating that the child' s cochlear implantation did not necessarily lead to giving up employment.

Out of the total cochlear implants analyzed in this descriptive study, in 89.8% of cases, the surgical intervention was carried out within the National Program for the treatment of hearing impairment through implantable prostheses, fully covered, while 10.2% of the evaluated cases bore the costs of the medical device from their own funds.

Referring to the age of hearing impairment diagnosis, in relation to the indications for cochlear implantation, taking into account the medium and long-term results in language development and social integration, the results of our study show that n=29 (82.85%) of the participants – parents – had their child categorized as pre-kindergarten at the time of diagnosis, under 3 years old (Figure 3). The next population category was the age group between 3 and 6 years: n=4 (11.43%). There were only 2 isolated cases outside the majority: 1 patient diagnosed between 6-10 years old and 1 patient diagnosed between 10-14 years old. No participant belonged to the high school age category.

Out of the total number of children whose parents responded to our invitation for this study, n=24 (68.57%) were recipients of bilateral cochlear implants, n=11 (31.43%) had a unilateral implant, with no information on a potential intervention for the second implant. This further supports the idea of the necessity to expand bilateral implantation among hearing-impaired children in Romania.

The time elapsed from the surgical intervention to implant activation was reported by each parent. The responses were categorized according to the working hypothesis involving this question (Figure 4): 1 month (n=19) 54.29% of the participants, and >1 month (n=16) 45.71% of the partici-

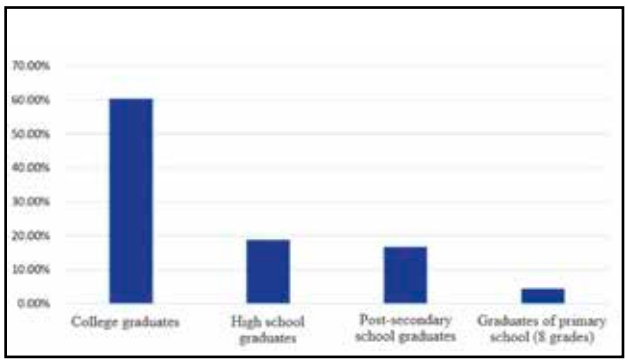



**Figure 1.** Evaluation of the professional training of parents of cochlear-implanted children.

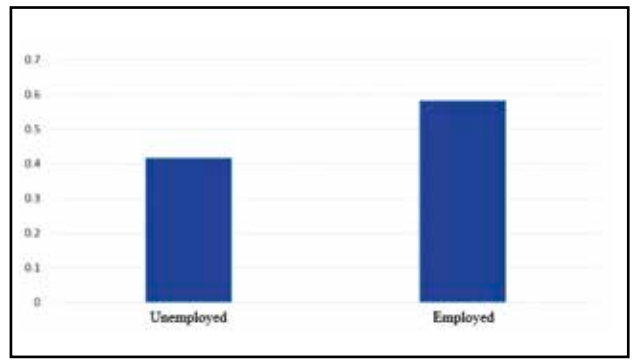



**Figure 2.** The employment commitment of a parent with a hearing-impaired or cochlear-implanted child.

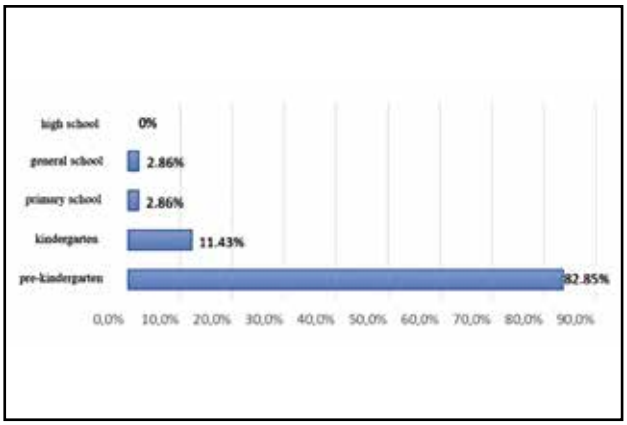



**Figure 3.** Distribution by age groups of children at the time of hearing impairment diagnosis and cochlear implant indication.

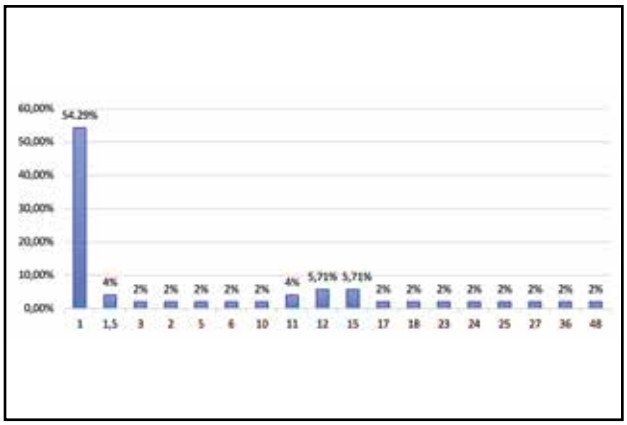



**Figure 4.** The time interval (in months) from the intervention to the activation of the implant.

pants. In the ">1 month" category, n=2 children had their first activation at 12 months and another n=2 at 15 months. Activation at 1 and a half months occurred at the same percentage as activation at 11 months. The following responses (in months) represented 2% each: 2, 3, 5, 6, 10, 17, 18, 23, 25, 27, 36 and 48. It can be noted that the activation of an implant is performed within a maximum of one month after the surgical intervention in most situations, although there are some exceptions that may be related to the patient's condition or the aspect of the surgical wound.

The periods during which children benefited from post-implantation speech therapy were between 1 and 6 months in n=2 (5.71%), between 1 and 2 years in n=1 (2.86%), and >2 years n=6 (17.14%) (Figure 5). In n=25 (71.43%) cases, families were in the rehabilitation phase, undergoing speech therapy at the time of completing the form. Only one parent, 2.86%, reported the response option "did not benefit at all", indicating that the child relied solely on family support. This underlines the importance of pre- and postoperative speech therapy in the auditory-verbal rehabilitation of hearing-impaired children.

The child's communication abilities before cochlear implantation were divided into 3 variants (Figure 6): "communicated through sounds, without words" n=14 (40%), "used words, unclearly pronounced" n=5 (14.29%) and "did not communicate at all" n=16 (45.71%). The fourth response option ("communicated normally") did not apply to any participant. Out of the 22 children who did not communicate at all before implantation, 20 were diagnosed at ages >3 years and two at ages 3 - 6 years. All parents (100%), whether they received speech therapy or not, reported improvement in their child's communication abilities after the rehabilitation period.

This study has limitations as it relies on subjective statements provided by interviewed parents, taking into account their intellectual capacities and involvement in the study. Additionally, there is a lack of comprehensive data related to the evolution over time of the patients included in the study, especially concerning the subsequent language development. The study is limited only to communication at the time of cochlear implantation, lacking specific post-implantation data.

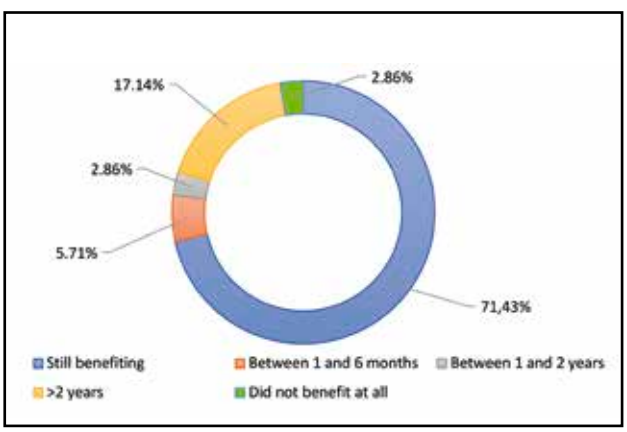



**Figure 5.** The duration of speech therapy treatment that the children subjected to cochlear implantation received.

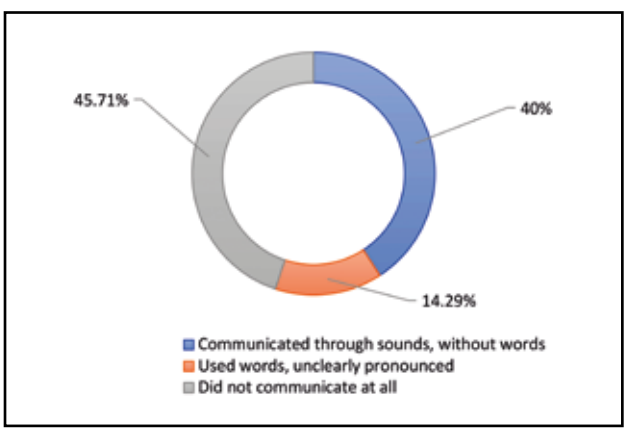



**Figure 6.** Evaluation of children's communication capacity during the pre-implantation period.

## CONCLUSIONS

Having the opportunity to talk with some of the participating parents, we truly realized the importance of the topic addressed by our study. The burden of the diagnosis imposed on the child and on their future often overshadows the impact on the quality of family life, which is a place of safety and comfort for the child. To provide the child with the best chances of recovery, we must offer a supportive, healthy and confident environment for their rehabilitation.

Thus, the first step is represented by the appropriate medical/surgical therapy for the type of hearing impairment, the cochlear implant in the case of this study.

An important role in the auditory-verbal rehabilitation of hearing-impaired children is played by the family, with mothers being more involved in this regard. Additionally, the professional training of parents is a contributing factor, demonstrating that in families with higher professional qualifications, the auditory-verbal rehabilitation has better results. The age of implantation, the time interval from implantation to the activation of the implant and especially the period until the start of speech therapy also play an essential role.

Therefore, it can be stated that in the auditory-verbal rehabilitation process of a hearing-impaired child, there are a number of factors and conditions that must be considered in a specific manner for each patient.

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