ISSN: 3032-3134 (ONLINE)
InaJBCS Indonesian Journal of Biomedicine and Clinical Sciences

Factors influencing auditory verbal therapy outcome among children with cochlear implant

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https://doi.org/10.22146/inajbcs.v57i1.12244

Submitted: 2024-02-18
Accepted : 2024-10-16

ABSTRACT

Early intervention with cochlear implants and habilitation with auditory-verbal therapy (AVT) methods can promote better development later in childhood. A previous study reported that communication methods, educational methods, duration of communication, frequency of therapy, and type of therapy influencing the effectiveness of amplification in children based on observations from parents. The AVT assessment uses several assessments that can help determine a child's hearing skill level, one of which is the early learning accomplishment profile (E-LAP). The study aimed to assess the factors influencing auditory–verbal therapy (AVT) outcomes among children with cochlear implants. It was an analytical observational study with a cross-sectional design in several home therapy. The assessment was using E-LAP. Chi-square test and multivariate logistic regression were used to measure the association between categorical variables. From 52 subjects, there were 32.7% who had received their cochlear implants <3 yr, 67.3% ≥3 yr, 51.9% ≥3 yr using cochlear implant, 53.8% good family participation, 51.9% had undergraduate parents, 71.2% had a profound hearing before implant, 86.5% underwent routine therapy, and 55.8% had a good outcome in AVT. This study showed age of implantation (p= 0.043), optimal family participation (p=0.006), and frequency of AVT (p= 0.002) were related to the outcomes of AVT. From multivariate logistic regression the duration of implant use was the most related (p=0.008). In conclusion, age of implantation, duration of implant use, family participation, and frequency of AVT are related to the outcomes of AVT.

ABSTRACT

Habilitasi kurang dengar pada anak pengguna implan koklear (IK) dilakukan dengan metode *auditory-verbal therapy* (AVT) diharapkan dapat meningkatkan perkembangan bahasa dan wicara. Penelitian yang telah dilakukan menyatakan bahwa metode komunikasi, metode pendidikan, durasi komunikasi, frekuensi terapi, dan jenis terapi yang dilakukan berpengaruh pada keberhasilan AVT. Keberhasilan AVT dapat dinilai dengan *early learning accomplishment profile* (E-LAP) untuk menentukan tingkat keterampilan pendengaran anak. Penelitian ini bertujuan mengetahui faktor yang berhubungan dengan keberhasilan AVT pada pengguna implan koklear. Penelitian observasional analitik dengan rancangan potong lintang di beberapa rumah terapi, menggunakan penilaian E-LAP. Analisis data dengan menggunakan Chi-Square test, regresi logistik multivariat. Hasil penelitian menunjukkan terdapat 52 subjek pada penilitian ini, terdiri dari 32,7% pengguna implan koklear sebelum usia 3 tahun, 67,3% usia ≥3 tahun, 51,9% lama pemakaian implan koklear ≥3 tahun, 53,8% dengan partisipasi keluarga baik, 51,9% orangtua berpendidikan tinggi, 71,2% pengguna IK terdiagnosis kurang dengar sangat berat, 86,5% menjalani terapi AVT rutin, 55,8% dengan hasil evaluasi AVT sesuai usia. Usia implantasi (p=0,043), lama pemakaian (p=0,054), partisipasi keluarga optimal (p=0,006), dan frekuensi AVT (p=0,002) berhubungan dengan keberhasilan AVT, Uji regresi multivariat didapatkan lama pemakaian IK yang paling berhubungan (p=0,008). Simpulan, usia implantasi dan lama pemakaian IK, partisipasi orangtua, dan frekuensi terapi berhubungan dengan keberhasilan AVT.

Keywords:
cochlear implants;
auditory-verbal therapy;
E-LAP;
hearing loss;
risk factors

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INTRODUCTION

Hearing loss in newborn can be caused by prenatal, perinatal, and postnatal factors due to genetic or environmental factors.[1] The hearing loss affects children's growth and developmental, have an impact on communication, impaired social interaction, opportunities for education and employment.[2]

Basic Health Research (*Riset Kesehatan Dasar*/Riskesdas) 2018 reported that the incidence of hearing loss since birth of children aged 24-59 mo in Indonesia is 0.11%.[3] Early diagnosis and intervention can promote better development in childhood.[4] Early intervention or habilitation in hearing-impaired children with the use of hearing aids and speech therapy methods such as auditory verbal therapy (AVT). Cochlear implants (CI) have developed into the standard surgical intervention for children with severe hearing loss.

Auditory verbal therapy is a listening and speech therapy with hearing aid modality. The goal of the habilitation for children with hearing loss is to function in the same way as children without hearing loss in their age. The quality of interventions provided after early diagnosis, will be related to children's communication.[5] The role of parents or caregivers and coaches is routinely and consistently needed to facilitate children to hear and speak.[6]

Research that has been conducted states that communication methods, educational methods, duration of communication, frequency of therapy, and type of therapy carried out have an effect on the effectiveness of amplification in children with observations from parents.[7] Other studies stated that early intervention after early detection of hearing loss can help in achieving better speech and language skills. The minimum usage required to have more than 60% speech discrimination score is 8.3 hr/d.[8]

The success of AVT can be assessed by using several instruments that can help determine the level of hearing skills of children, one of which is the early learning accomplishment profile (E-LAP) for ages under 36 mo and early learning accomplishment profile (LAP) for ages after 36 mo. Research about factors influencing AVT outcomes in children with cochlear implant has not been conducted in Semarang, Central Java. This study aimed to assess the factors influencing AVT outcomes in children with cochlear implant. The results obtained are expected to optimize AVT and as educational material and further action.

MATERIAL AND METHODS

Subject and design

It was an analytic observational study with a cross-sectional design. The sample was 52 cochlear implant users. The sample obtained from the Department of Medical Rehabilitation, Dr. Kariadi Central General Hospital, Semarang and the Clinical Therapy in Semarang region.

Procedures

The inclusion criteria for this study were being diagnosed with congenital hearing loss, using CI, undergoing AVT, duration of CI usage ≤6 yr, willing to take part in the study. The exclusion criteria in this study were children with cerebal palsy, down syndromes, autism or other syndromes, the presence of otorea symptoms, a history of granulation on the electrodes, a history of cochlear implant migration, a history of re-cochlear implant surgery. The independent variables are age of CI implantation, duration of CI usage, parental

participation, socioeconomic, parental education, frequency of therapy (1x/wk), degree of hearing impairment, while the dependent variable is the success of AVT. Parental participation assessment was assessed using the family involvement rating scale to assess the quality of family participation and involvement in the intervention. The success of AVT were evaluated using E-LAP/LAP. Evaluation of success if abilities have been achieved according to hearing age based on this form.

The E-LAP/LAP is a scoring system that refers to classic criteria for evaluating children aged 0 to 72 mo. It is used to examine six domains of child development including gross motor, fine motor, cognitive, language, self-help, and social emotional. Each domain can be used to assess the child's developmental age in various aspects. The evaluation were made by researcher.

Statistical analysis

The relationship between variables was analyzed using Chi square and Fischer exact tests. The relationship between the two variables used a contingency correlation test. Multivariate logistic regression used to analyze the dominant factors associated with AVT outcomes. This study has been approved by the Health Research Ethics Commission of Dr. Kariadi Central General Hospital, Semarang with number 1470/EC/KEPK-RSDK/2023.

RESULTS

This study involved 52 CI users with sample characteristics as shown in TABLE 1.

The analysis was carried out on several variables, such as the age of CI implantation, duration of CI usage, participation of parents/caregivers, education of parents/caregivers, degree of hearing loss, frequency of AVT therapy, and they were analyzed towards AVT's outcome (TABLE 2).

TABLE 1. Subject characteristic of the studies

Independent variables	Quantity
Gender	
• Male	23 (44.2)
• Female	29 (55.8)
Age of CI implantation (yr)	
• <3	17 (32.7)
• 3-6	35 (67.3)
Duration of CI usage (yr)	
• <3	25 (48.1)
• 3-6	27 (51.9)
Parent/caregiver participation	
• Median	17 (32.7)
• Good	28 (53.8)
• Optimal	7 (13.5)
Socioeconomic	
• Above minimum wage	52 (100.0)
• Under minimum wage	0 (0.0)
Parent/caregiver education	
• Tertiary education	27 (51.9)
• Secondary school	25 (48.1)
Degree of hearing loss	
• Severe	15 (28.8)
• Profound	37 (71.2)
Frequency of AVT therapy	
• Routine	45 (86.5)
• Irregular	7 (13.5)
AVT's outcome	
• Attained	29 (55.8)
• Unachieved	23 (44.2)

TABLE 2. Bivariate analysis with AVT success

Variables	AVT's success [n (%)]			p	PR	95%CI	r
	Attained	Unachieved	Total				
Age of CI implantation (y.o.)							
• <3	14 (82.4)	3 (17.6)	17 (100.0)	0.043	4.94	1.20-20.28	0.30
• 3-6	17 (48.6)	18 (51.4)	35 (100.0)				
Duration of CI usage (y.o.)							
• 3-6	20 (74.1)	7 (25.9)	27 (100.0)	0.054	3.63	1.13-11.69	0.29
• <3	11 (44.0)	14 (56)	25 (100.0)				
Parents participation							
• Optimal	7 (100.0)	0 (0.0)	7 (100.0)	0.006	2.83	1.48-5.39	0.50
• Good	18 (64.3)	10 (35.7)	28 (100.0)	0.114	3.30	0.93-11.63	0.27
• Median	6 (35.3)	11 (64.7)	17 (100.0)	-	-	-	-
Parent education							
• Tertiary education	18 (66.7)	9 (33.3)	27 (100.0)	0.427	1.84	0.60-5.66	0.14
• Secondary school	13 (52.0)	12 (48.0)	25 (100.0)				
Degree of hearing loss							
• Severe	9 (60.0)	6 (40.0)	15 (100.0)	0.970	1.02	0.30-3.477	0.005
• Profound	22 (59.5)	15 (40.5)	37 (100.0)				
Frequency of AVT therapy							
• Routine	31 (68.9)	14 (31.1)	45 (100.0)	0.002	0.31	0.20-0.481	0.432
• Irregular	0 (0.0)	7 (100.0)	7 (100.0)				

TABLE 3. Regression analysis with AVT success

Variables	p	PR	95% CI
Age of CI implantation	0.249	3.990	0.380 - 41.930
Duration of CI usage	0.008	9.734	1.819 - 52.093
Parental participation	0.022	0.205	0.053 - 0.794
Frequency of therapy	0.999	-	-

Regression analysis was used to evaluate the effect of two or more independent variables (age of CI implantation, duration of CI usage, parental participation, frequency of therapy) on the dependent variable (AVT success). Eligible variables included in the analysis were variables that have a significance level (sig.) or p value <0.25 in the bivariate analysis, such as age of CI implantation (p=0.043), duration of CI usage (p= 0.054), optimal parental participation (p=0.006), frequency of therapy (p= 0.002). The results of the regression test (TABLE 3) showed that the duration of CI usage was the most influencing factor with p=0.008. The largest PR value obtained was 9.734 which means that the duration of use of CI has a 9.734 times chance of causing AVT success.

DISCUSSION

Hearing loss can occur at any age from birth to old age. Hearing loss has an impact on the development of speech language, social skills, academic development, and emotional behavior. Identification of the cause of hearing loss and early intervention will affect a person's quality of life.[1] The cause of hearing loss is difficult to determine because of the variability of symptoms. Onset of prelingual or postlingual hearing loss, stable or progressive, unilateral or bilateral, conductive or neurosensory, mild or very severe.[1]

The prevalence of hearing loss in newborn varies, more among males (1.8 per 1000 live births) than females (1.2 per 1000 live births).[9] This study showed that there is no significant differences between sexes (p= 0.870). This is in line with previous research showing that both sexes respond well to AVT.[10] Although previous studies in other contexts showing that female perform better than male in auditory and verbal abilities for biological and cultural reasons.

Audio verbal therapy (AVT), which is a method of hearing and speech therapy using parents as the main specific change agent, obtains optimal and efficient oral language developed through hearing.[11] Children who had AVT, achieve better speech recognition skills during the first 3 years after CI activation compared to children who use visual communication methods such as sign language.[12]

Cochlear implants candidates before the age of 3 yr if they use hearing aids regularly and continuously can provide better results.[13] At this age, children can successfully achieve good hearing rehabilitation and can be measured subjectively and objectively for the success.[14] Children who did the CI implantation after the age of 3 yr still experience language delays when compared to normal children. There was a sensitive period of about 2-3 yr in which the development of the central auditory system showed the greatest neural plasticity.[13] This is in accordance with our research which shows the initial age of CI that less than 3 yr is a significantly related factor (p= 0.043) to the success of AVT.

Clinical experience shows that it takes about three years of habilitation to achieve speech and language skills equivalent to those of an auditory companion.[12] The predicted average linguistic score increases with longer duration of CI usage. Children who received CI at 12 to 18 mo of age with the same duration of CI usage, consistently had better language levels than older ages. At more than 30 mo of age, language delays and slower language development rates, even with longer duration of implant use, resulted in CI users not being able to catch up with language.[15] In this study, the duration of CI usage was an unrelated factor (p= 0.054) to the success of AVT. The logistic regression test shows that the duration of CI usage was the most influential factor in the success of AVT when compared to other variables with p=0.008.

Family involvement in the habilitation process is a major prognostic factor for hearing, speech comprehension and language development after CI and overall growth and development.[16,17] The results of this study obtained optimal participation from parents/caregivers related to AVT success (p=0.006). The socio-economic level had no significant impact on success after cochlear implantation. Previous research has shown that the socio-economic level has no effect on the linguistic skills of children enrolled in AVT habilitation programs. Meanwhile, another study found that socio-economic level had little effect on children's language experience.[18] Parental education was an unrelated factor (p= 0.427).

Better residual pre-implanted hearing is associated with superior voice

recognition in cochlear implants.[15] There is a significant decrease in language scores along with an increase in hearing loss. Another study found no significant effect of hearing loss severity on speech outcomes.[19] The results of this study obtained a degree of hearing loss when diagnosed unrelated to the success of AVT (p=0.971).

Routine AVT can improve receptive language skills and good language articulation. Intensity of therapy is not the dominant factor affecting hearing and speech language development post CI, but AVT without intensive interaction with the surrounding environment will produce unsatisfactory results.[7] In this study, the frequency of routine therapy was significantly related to AVT success (p= 0.002).

This study has limitations such as the installation of CI and AVT therapy carried out on-site and different doctors/therapists, there are several variables that were not analyzed in this study, such as the use of hearing aids before implantation, the duration of hearing aids per day, the duration of communication per day, components of CI and operating techniques that can be considered in further research.

CONCLUSION

In conclusion, there is a relationship between age of CI implantation, duration of CI usage, parental participation, and AVT frequency with AVT success. In contrast, there is no relationship between parental education and the degree of hearing impairment with the success of AVT.

ACKNOWLEDGMENTS

We would like to thank all those who helped in the collection and analysis of data until the study is completed. This research did not receive any specific grants from others. The author reports no conflicts of interest in this work.

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