Published in final edited form as:

Otol Neurotol. 2018 June ; 39(5): e307–e313. doi:10.1097/MAO.0000000000001777.

Barriers to Rehabilitation Care in Pediatric Cochlear Implant Recipients

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Abstract

Objective—The purpose of this study was to assess barriers to rehabilitation care for pediatric cochlear implant (CI) recipients.

Study Design—Cross-sectional questionnaire study.

Setting—Tertiary medical center.

Patients—Parents of children who received a CI from October 1996 to June 2013.

Main Outcome Measure(s)—Factors related to access to and barriers in audiology and speech therapy services, factors related to CI use, and performance with CI using the Parents' Evaluation of Aural/Oral Performance of Children (PEACH).

Results—35 parents participated in the study (21 rural residents and 14 urban residents). Distance was a significant barrier to audiology services for rural participants compared to urban participants ($p=0.01$). Consistent CI use was complicated by mechanical complications or malfunction in 70% of rural children compared with 33% of urban children ($p=0.05$). Only 10% of rural children were able to access speech therapy services at diagnosis compared with 42% of urban children ($p=0.04$). Low socioeconomic (SES) status and Medicaid insurance were associated with a lack of local speech therapists and medical/mechanical CI complications. Higher parental educational attainment was associated with higher PEACH scores in quiet conditions compared to families with lower parental education ($p=0.04$).

Conclusions—Rural children are often delayed in receipt of cochlear implant rehabilitation services. Multiple barriers including low SES, insurance type, and parental education can affect utilization of these services and may impact the recipient language development. Close follow-up and efforts to expand access to care is needed to maximize cochlear implant benefit.

Keywords

Rural Health; Pediatric hearing loss; Cochlear implantation

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Conflicts of Interest: The authors have no other financial relationships or conflicts of interest to disclose pertaining to the manuscript.

Presented at the CI2016 International Cochlear Implant Meeting, Toronto, Ontario, Canada, May 13, 2016.

Introduction

Cochlear implants (CI) have the potential to change the social and educational direction of the recipient and improve spoken language outcomes of young children who are deaf and hard of hearing (DHH). Speech and language outcomes for CI recipients are highly variable, with some children exhibiting significant delays.¹ The age of implantation is associated with language development outcomes; however, many factors, such as socioeconomic status, family environment,² enrollment in speech therapy, adherence to audiology recommendations, and attendance in mainstream school, play a role in rehabilitation after implantation.³ As the number and diversity of CI recipients increases, post-implant rehabilitation services must adapt to better meet the needs of a diverse population.⁴ Recent trends in delivery of auditory rehabilitation has shifted the focus onto extending services from central CI centers into local centers where families may be able to engage in needed services.⁵

Hearing healthcare barriers for deaf and hard of hearing (D/HH) children include rural residence, low level of parental education, low socioeconomic status, and public insurance.⁶⁻⁸ There is significant burden of responsibility on parents in the rehabilitation of a DHH child, and parent-related factors affect outcomes. Geers et al found that family income and education level played a role in a child's language skills.⁹ This sentiment is also supported by the results of a national survey of pediatric CI audiologists conducted by Kirkham,¹⁰ who almost universally (93%) named parental factors as important predictors of CI rehabilitation outcomes. Specifically, concerns were emphasized that indicated that parents of low socioeconomic status (SES) may lack communication skills, preventing advocacy for their child in a complex healthcare environment.¹⁰ The survey also addressed the perception that compliance rates were lower among low SES families: disadvantaged children who do receive implants are less likely to derive full benefits from them.¹⁰ Further work by Suskind et al addresses the language disparity in the homes of low SES families with deaf and hard of hearing children and the need for interventions to improve the language development outcomes of these children as they undergo rehabilitation.¹¹

A lack of hearing healthcare services, as seen in rural areas, has been linked to delays in hearing loss diagnosis.¹² Additionally, insurance coverage, or lack thereof, can influence CI referral patterns,⁴ thus limiting access to hearing rehabilitation services. It is essential to mitigate access to care barriers in a timely manner and improve adherence to treatment recommendations, as it is clear that age of implantation and duration of cochlear implant use are significant predictors of these long-term language development outcomes.¹³ There is a gap in the literature regarding barriers to audiology and speech therapy services for pediatric cochlear implant recipients. The purpose of this study was to assess barriers to audiology speech and language rehabilitation care for pediatric CI recipients.

Materials and Methods

Institutional review board approval was obtained prior to initiation of the study protocol (11-0872-P3H). Inclusion criteria included the parents/guardians of congenital prelingual

deaf and hard of hearing children who received a cochlear implant(s) from a tertiary medical center. Potential candidates were obtained from a cochlear implant recipient database spanning from October 1996 to June 2013. There were 92 potential study candidates. Potential candidates were contacted via telephone through which informed consent was obtained. 42 parents refused participation over the phone. Once participants consented to be involved in the study, an interview was completed over the phone utilizing the questionnaire. Multiple attempts were made to contact subjects who were not initially reached. There were 22 subjects for whom no valid phone number existed; these subjects were mailed the consent form and the questionnaire. If no response was obtained, the study documents were mailed a second time to the potential participant. Additional measures were taken to contact potential participants by working with their audiologists and/or speech language pathologist. The questionnaire included 2 components: a validated objective measure of hearing and communication development, the Parents' Evaluation of Aural/Oral Performance of Children (PEACH) survey (Appendix 1), and a newly developed questionnaire that assessed sociodemographics, barriers to rehabilitation care, factors related to CI use, and utilization of audiology and speech therapy services (Appendix 2). The questionnaire was piloted with a group of parents of children with cochlear implants prior to use in this study. The questions involved fill-in-the-blank, open-ended, multiple choice, yes/no and 5-point graded-scale questions.

The objective measure of CI function, the PEACH survey, was developed and validated by Ching and Hill.¹⁴ It was developed to test the effectiveness of auditory rehabilitation in everyday life, as traditional language testing in a structured environment may not reflect a child's real world ability.¹⁵ The PEACH survey has been correlated with the Preschool Language Scale (PLS-4), Peabody Picture Vocabulary Test (PPVT), Diagnostic Evaluation of Articulation and Phonology (DEAP), and Child Development Inventory (CDI),¹⁶ and has been deemed a reliable measure of parental observations.^{14, 17} This survey requires healthy children that are using a functional implant at the time of survey. This metric was chosen to assess overall listening and language function of pediatric CI in both quiet and noisy settings from a diverse sample of different ages and duration of implant use. Overall percentage and percentages for quiet and noisy conditions were obtained.

Based on the home address and county of residence, we determined the Appalachian residence status of participants based on Appalachian Regional Commission classification.¹⁸ Based on the reported county of residence on the returned questionnaires, we also determined rurality of the participant's county using the US Department of Agriculture Rural-Urban Continuum coding system.¹⁹ Household income at or below \$20,000 was an additional variable used to assess poverty. This income level is the approximate poverty line threshold for a family size of at least 3.²⁰ Data were managed using the REDCap data collection system and was exported into an Excel spreadsheet (Microsoft, Redmond, WA, USA), and statistical analysis was performed with STATA (StataCorp, College Station, TX, USA). Continuous variables were summarized with descriptive statistics (n, mean, standard deviation) and categorical variables were described with counts and percentages. Demographic characteristic differences between rural and urban participants was assessed initially (Table 1) and these factors included gender of parent providing information, parental marital status, single child household, parental educational level, household income,

insurance status. Similarly, we compared characteristics for rural and urban pediatric CI recipients and these factors included gender, age, school type, and timing of initiation of speech therapy services. Comparison between dichotomous variables was assessed with Chi Square analysis. A p-value ≤ 0.05 was considered statistically significant. Next, we assessed the association between rehabilitation barriers (travel distance to speech services, early initiation of speech therapy services, mechanical/maintenance problems with the cochlear implant, and location of speech therapy services) and sociodemographic factors (household income, parental educational attainment, Medicaid insurance, and rural residence) using univariate/multivariate logistic regression analysis (Tables 2–4). These variables were selected because they have been implicated as barriers to healthcare and rehabilitation in other areas of research. We also assessed for associations between PEACH score performance over 50% in both quiet and noisy situations with variables such as the lack of local speech therapists as well as the level of parental education.

Results

A total of 35 parents participated in the study (38% overall participation). From a total of 92 implant potential study candidates, 28 participants agreed to participate and complete phone interviews were conducted. 22 surveys were mailed to potential participants who could not be reached by phone. Seven of the mailed surveys were completed, bringing number of study participants to 35. Table 1 details the demographic data of the parents who completed the surveys with comparison between urban and rural participants. Sixty six percent were female, and the average age was 40.8 (SD 10.97 year) years old.

Overall, 21 of recipients lived in rural communities and 14 in urban communities and 41% of families reside in rural Appalachia. The rural and urban participants did not differ significantly in marital status, number of children in the home, level of education, annual household income, insurance type, age of hearing amplification, or age of child's cochlear implantation. Univariate and multivariate logistic regression revealed differences between the rural and urban groups in relation to cochlear implant function and audiology access (Table 2). Overall, distance was a significant barrier to audiology services as 71% of rural participants reported over 1 hour driving time to their CI audiologist compared with 23% of urban participants ($p=0.01$). This rural distance disparity was significant when controlling for household income, parental education, and Medicaid insurance ($p=0.02$, OR 16.5, 95% CI 1.69 – 162). Furthermore, consistent CI use was complicated by mechanical complications or malfunction in 70% of rural children compared with 33% of urban children ($p=0.05$). This rural complication disparity was significant when controlling for household income, parental education, and Medicaid insurance ($p=0.05$, OR 5.02, 95% CI 0.989 – 25.51). There was also a disparity in rural speech therapy access and utilization. Only 10% of congenitally deaf rural children were able to access speech therapy services at or shortly after diagnosis compared with 42% of urban children ($p=0.04$). This rural speech therapy disparity was significant when controlling for household income, parental education, and Medicaid insurance ($p=0.03$, OR 0.09, 95% CI 0.01 – 0.787). School-based speech therapy was the only available source for speech therapy for 86% of rural children compared with 50% of urban children, who had access to speech services through other means (speech and hearing center, tertiary medical center, home-based therapy, private practice speech

therapist) ($p=0.04$). This difference in therapy options was significant when controlling for parental education and Medicaid insurance ($p=0.05$, OR 5.89, 95% CI 1.04 – 33.3). There was no significant difference when including household income in the multivariate analysis. Univariate and multivariate analysis revealed no significant difference in overall PEACH scores or quiet/noisy condition scores of these participants based on rural residence. The majority of children attended mainstream school; however, there was a trend toward higher percentage of rural children attending deaf school compared with urban children (29% v. 7%, $p=0.06$).

Parental education was examined through univariate and multivariate analysis and was found to be an independent factor in access to rehabilitation services and listening/language outcomes (Table 3). Educational attainment of no more than a high school degree was associated with low household socioeconomic status (less than \$20,000 per year) ($p=0.03$) and Medicaid coverage for the deaf and hard of hearing child in the family ($p=0.002$). The association between parental education and Medicaid insurance was significant when controlling for rural residence and household income ($p=0.01$, OR 0.07, 95% CI 0.01 – 0.52). Approximately 50% of those with low educational attainment reported no access to local speech therapists compared with 14% of those who obtained education beyond high school ($p=0.04$). The association between parental education and lack of local therapists was significant when controlling for rural residence ($p=0.05$, OR 0.16, 95% CI 0.03 – 1.01). There was a non-statistically significant trend toward low speech therapy utilization (less than one therapy session per week) for those with low educational attainment compared with those with those with higher attainment (22% versus 0%, $p=0.06$). Higher parental educational attainment was associated with PEACH scores above 50% in the quiet condition (better performance) compared to those families with lower parental education (93% versus 61%, $p=0.04$). The association was significant when controlling for rural residence ($p=0.05$, OR 10.04, 95% CI 0.978 – 103.25) but was non-significant when household income and Medicaid insurance were added to the multivariate model. There was no difference in overall PEACH scores or noisy condition PEACH scores based on parental education. Using chi-square analysis, there was association between lack of local speech therapists and PEACH score performance below 50% in quiet ($p=0.05$). This association was not seen on multivariate analysis.

Additional access and utilization variables that were examined included SES and Medicaid insurance (Table 4). Participants with higher SES were less likely to report no local speech services compared with families with lower SES (22% versus 67%, $p=0.02$). This association was significant when controlling for rural residence ($p=0.03$, OR 0.12, 95% CI 0.02 – 0.79) but was non-significant when parental education and Medicaid insurance were added to the multivariate model. Those participants with Medicaid insurance had a higher percentage of co-morbid disabilities in their child with hearing loss than those with private insurance (40% versus 0%, $p=0.01$). This association was not seen on multivariate analysis. Additionally, those with Medicaid insurance had a higher incidence of medical complications with their child's cochlear implant requiring treatment (25% versus 0%) ($p=0.05$). This association was not seen on multivariate analysis. There was a higher incidence of broken CI components requiring maintenance among those with Medicaid insurance (80% versus 42%) ($p=0.03$) than those with private insurance. This association was

significant when controlling for rural residence ($p=0.04$, OR 5.9, 95% CI 1.12 – 30.95) but was non-significant when parental education and Medicaid insurance were added to the multivariate model. Neither low SES or Medicaid insurance status were significantly associated with PEACH scores.

Discussion

In the Healthy People 2020 report produced by the Department of Health and Human Services, increasing access to rehabilitative services for CI recipients is listed as a developmental goal, recognizing the fact that current disparities exist in access to care, and that these disparities have a measureable effect on patient outcomes.²¹ There is evidence that children from vulnerable populations, such as those with low SES or rural residence, who are deaf and hard of hearing are delayed in diagnosis, hearing aid amplification, and cochlear implantation.^{22–24} This study sought to investigate the barriers that cochlear implant families face in obtaining rehabilitation services and the factors that may influence access to care. Rural children are less likely to initiate speech therapy around the time of diagnosis and may face barriers to accessing rehabilitation care due to lack of local providers with the difficulty of increased cost and travel.

Low socioeconomic status and insurance status can affect hearing rehabilitation. Approximately 29% of all participants in this study reported an annual household income of less than \$20,000, and this was associated with a lack of local speech services. Interestingly, household income may be a confounding factor within this study for access to rehabilitation services as there was a loss of statistical significance when assessing multivariate associations with rehabilitation factors such as lack of local speech therapists and speech rehabilitation available only within the school system. Furthermore, the addition of household income in the multivariate analysis model resulted in a loss of statistical significance in the association between Medicaid insurance and the necessity for cochlear implant maintenance. A majority of participants (63%) reported Medicaid insurance. In a national electronic survey of pediatric CI audiologists, low SES was identified as a contributing factor to decreased speech and language outcomes by 78% of responders.¹⁰ The audiologists noted qualitatively that CI users with Medicaid seemed to have higher incidence of CI processor malfunction.¹⁰ Chang et al found a disparity in the number of Medicaid patients that received implants.²⁵ This study indicates that Medicaid pediatric CI patients have a higher incidence of medical complications related to their implant as well as a higher incidence of malfunctioning equipment requiring maintenance.

A useful measure of hearing rehabilitation is the attendance of the child in mainstream education. The majority of CI recipients surveyed attended mainstream schools. Rural participants were more likely to utilize the school as the only means to speech therapy services while urban children had broader access to these services due to increase number of providers. Therefore, the delivery of speech therapy tailored to the needs of pediatric CI recipients becomes critical. Many rural school districts and speech language pathologists within those school systems may lack the experience and expertise in caring for these children. This study also demonstrated that rural children were less likely to initiate speech therapy near the time of diagnosis.

The family-centered model of hearing rehabilitation is the currently accepted paradigm among hearing specialists, and therefore requires knowledge of the environment and culture in which the family exists.³ It has been speculated that parental education levels influence their awareness of rehabilitation services and ability to support their hearing-impaired child in the home.²⁶ The results of this study indicate that parental educational level is associated with a lack of local speech therapists and a trend toward lower utilization of speech services. Furthermore, lower parental educational attainment was associated with lower language scores in quiet conditions. Cultural differences in homes with lower parental education and/or lower SES could affect healthcare engagement; thereby, influencing rehabilitation following cochlear implantation. The fact that parental involvement is the strongest contributor to improved language outcomes in CI recipients,²⁷ along with the variability in aural/oral function among CI recipients suggests that differential parental involvement may be the culprit. Holt echoed this sentiment by stating “variability in cochlear implantation outcomes is related to specific aspects of the family environment.”² Further research into how family dynamics influence CI rehabilitation will lead to innovative strategies that benefit all types of families.

This study is limited by a low response rate, which may introduce bias into the results. The non-probability sampling of this study may lead to a lack of generalizable conclusions regarding vulnerable rural, low education, and low SES populations. Research in vulnerable populations is plagued with low recruitment due to communication challenges and the transient residence of some of these families. Research in lower socioeconomic and rural populations is often complicated by limited phone connectivity and temporary residence. Based on the findings of this study, future research efforts involving rural populations should include mixed methodology conducted more locally, which would involve quantitative and qualitative data collection regarding barriers to hearing healthcare. Furthermore, the use of a non-validated survey instrument is a limitation of this study. Further research is warranted to develop instruments that can efficiently and effectively gather information simultaneously regarding healthcare access barriers and outcomes from cochlear implantation. Another limitation of this study includes the inherent recall bias associated with a questionnaire study design. Additionally, the cohort is not age-matched, thus comparison of speech outcomes was not feasible. This was the driving factor in utilization of the PEACH survey, to allow assessment of functional CI use without requiring age-matched controls or CI duration-matched controls. Furthermore, the quality of rehabilitation services likely ranged significantly between the various practices and this study did not incorporate an objective assessment of these services.

Conclusion

This study demonstrates a delay in the initiation of speech therapy in rural cochlear implant recipients. For children with cochlear implants from homes with low SES, Medicaid insurance, and low parental education, multiple barriers exist. Addressing access barriers deserves further research in order to maximize speech and language outcomes in CI recipients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Source of Funding: This work was supported by the National Institute of Deafness and Other Communication Disorders (1K23DC014074)(MLB). MLB is a consultant for MED-EL and Oticon Medical and receives research funding from Advanced Bionics.

References

1. Tait ME, Nikolopoulos TP, Lutman ME. Age at implantation and development of vocal and auditory preverbal skills in implanted deaf children. *Int J Pediatr Otorhinolaryngol*. 2007 Apr; 71(4):603–10. [PubMed: 17239961]
2. Holt R, Beer J, Kronenberger W, Pisoni D. Developmental effects of family environment outcomes in Pediatric Cochlear Implant Recipients. *Otol Neurotol*. 2013; 34(3):388–395. [PubMed: 23151776]
3. Yanbay E, Hickson L, Scarinci N, Constantinescu G, Dettman S. Language outcomes for children with cochlear implants enrolled in different communication programs. *Cochlear Implants Int*. 2014; 15(3):121–135. [PubMed: 24867056]
4. Wiley S, Meinzen-Derr J. Access to cochlear implant candidacy evaluations: Who is not making it to the team evaluations? *Int. J. Audiol*. 2009; 48:74–79. [PubMed: 19219691]
5. Archbold S, O'Donoghue M. Ensuring the long-term use of cochlear implants in children: The importance of engaging local resources and expertise. *Ear Hear*. 2007; 28(Suppl 2):3S–6S. [PubMed: 17496636]
6. Cavalcanti HG, Guerra RO. The role of maternal socioeconomic factors in the commitment to universal newborn hearing screening in the Northeastern region of Brazil. *Int J Pediatr Otorhinolaryngol*. 2012; 76(11):1661–7. [PubMed: 22921603]
7. Liu CL, Farrell J, MacNeil JR, Stone S, Barfield W. Evaluating loss to follow-up in newborn hearing screening in Massachusetts. *Pediatrics*. 2008; 21(2):e335–343.
8. Lester EB, Dawson JD, Gantz BJ, Hansen MR. Barriers to the Early Cochlear Implantation of Deaf Children. *Otol Neurotol*. 2011; 32:406–12. [PubMed: 21221048]
9. Geers A, Nicholas J, Sedey A. Language Skills of Children with Early Cochlear Implantation. *Ear Hear*. 2003; 24:46S–58S. [PubMed: 12612480]
10. Kirkham E, Sacks C, Baroody F, et al. Health Disparities in Pediatric Cochlear Implantation: An Audiologic Perspective. *Ear Hear*. 2009; 30(5):515–525. [PubMed: 19633562]
11. Suskind DL, Graf E, Leffel KR, Hernandez MW, Suskind E, Webber R, Tannenbaum S, Nevins ME. Project ASPIRE: Spoken Language Intervention Curriculum for Parents of Low-socioeconomic Status and Their Deaf and Hard-of-Hearing Children. *Otol Neurotol*. 2016 Feb; 37(2):110–7.
12. Bush M, Hardin B, Rayle C, Lester C, Studts C, Shinn J. Rural Barriers to Early Diagnosis and Treatment of Infant Hearing Loss in Appalachia. *Otology & Neurotology*. 2015; 36(1):93–98. [PubMed: 25325844]
13. Tobey E, Thal D, Niparko J, Eisenberg L, Quittner A, Wang N. Influence Of Implantation Age On School-Age Language Performance In Pediatric Cochlear Implant Users. *Int J Audiol*. 2013; 52(4):219–229. [PubMed: 23448124]
14. Ching T, Hill M. The Parents' Evaluation of Aural/Oral Performance of Children (PEACH) Scale: Normative Data. *J Am Acad Audiol*. 2007; 18:220–235. [PubMed: 17479615]
15. Desjardin J, Doll E, Stika C, et al. Parental Support for Language Development During Joint Book Reading for Young Children With Hearing Loss. *Commun Disord Q*. 2014; 35(3):167–181.
16. Kumar S, Rotu N, Kumar N, Chatterjee I, Selvakumaran H. Performance of Indian Children with Cochlear Implant on PEACH Scale. *ISRN Otolaryngology*. 2013; 565096:1–6.

17. Bagatto M, Scollie S. Validation of the Parents' Evaluation of Aural/Oral Performance of Children (PEACH) Rating Scale. *J Am Acad Audiol*. 2013 Feb; 24(2):121–125. [PubMed: 23357805]
18. [Accessed March 30, 2017] The Appalachian Region. Appalachian regional commission. Available at: http://www.arc.gov/appalachian_region/TheAppalachianRegion.asp
19. Rural-Urban Continuum Codes. [Accessed 3/27/2017] USDA Economic Research Service. United States Department of Agriculture. <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/>
20. Office of the Assistant Secretary for Planning and Evaluation. U.S. Department of Health & Human Services; Poverty Guidelines. <https://aspe.hhs.gov/poverty-guidelines> [Accessed 8/29/17]
21. [Accessed March 27, 2017] Hearing and Other Sensory of Communication Disorders. HealthyPeople.gov. <https://www.healthypeople.gov/2020/topics-objectives/topic/hearing-and-other-sensory-or-communication-disorders/objectives>
22. Bush M, Osetinsky M, Shinn J, Gal T, Fardo D, Schoenberg N. Assessment of Appalachian Region Pediatric Hearing Healthcare Disparities and Delays. *Laryngoscope*. 2014 Jul; 124(7):1713–7. [PubMed: 24402802]
23. Bush M, Bianchi K, Lester C, Shinn J, Gal T, Fardo D, Schoenberg N. Delays in Diagnosis of Congenital Hearing Loss in Rural Children. *J Pediatr*. 2014; 164:393–7. [PubMed: 24183213]
24. Bush M, Burton M, Loan A, Shinn J. Timing Discrepancies of Early Intervention Hearing Services in Urban and Rural Cochlear Implant Recipients. *Otology & Neurotology*. 2013; 34(9):1630–5. [PubMed: 24136305]
25. Chang D, Ko A, Murray G, Arnold J, Megerian C. Lack of Financial Barriers to Pediatric Cochlear Implantation. *Arch Otolaryngol Head Neck Surg*. 2010; 136(7):648–657. [PubMed: 20644058]
26. Yehundai N, Tzach N, Shpak T, Most T, Lutz M. Demographic Factors Influencing Educational Placement of the Hearing-Impaired Child With a Cochlear Implant. *Otol Neurotol*. 2011; 32:943–947. [PubMed: 21512422]
27. Moeller N. Early intervention and language development in children who are deaf and hard of hearing. *Pediatr*. 2000 Sep.106(3):E43.

Table 1

Participant and Pediatric CI Recipient Demographical Data

	Response	Rural	Urban	Total	<i>p</i> value
Characteristics of Parental Participant					
Sample Size (%)		21 (60)	14 (40)	35 (100)	
Gender (%)					0.71
	Female	15 (71)	8 (57)	23 (66)	
	Male	6 (29)	6 (43)	12 (34)	
Marital Status (%)					0.78
	Married/Domestic partner	13 (62)	8 (57)	21 (60)	
	Unmarried/divorced	8 (38)	6 (43)	14 (40)	
Single Child Household (%)					0.35
	More than 1 child	12 (57)	9 (64)	21 (60)	
	Single child	9 (43)	5 (36)	14 (40)	
Education level (%)					0.67
	High school degree or less	12 (57)	7 (50)	19 (54)	
	Education beyond high school	9 (43)	7 (50)	16 (46)	
Household Income (%)					0.89
	\$20,000 or less	6 (29)	4 (31)	10 (29)	
	More than \$20,000	15 (71)	9 (69)	24 (71)	
Insurance (%)					0.89
	Medicaid	13 (62)	9 (64)	22 (63)	
	Private or HMO/PPO	8 (38)	5 (36)	13 (37)	
Characteristics of CI Recipients					
Gender					0.71
	Female	15 (71)	8 (57)	23 (66)	
	Male	6 (29)	6 (43)	12 (34)	
Age at Survey, mean (SD)		11.6 y (5.3)	12.6 y (5.3)		
Age at Diagnosis, mean (SD)		9 mo (10.5)	8.3 mo (11)		
Age at Amplification, mean (SD)		19.5 mo (21.5)	20.7 mo (16.6)		

	Response	Rural	Urban	Total	<i>p value</i>
Age at Implantation, mean (SD)		3.76 y (2.1)	4.45 y (3)		
School type					0.06
	Mainstream	15 (71)	10 (90)	25 (78)	
	Deaf Education	6 (29)	1 (10)	7 (22)	
Initiation of Speech Therapy					<i>*0.04</i>
	Shortly after diagnosis	2 (10)	5 (42)	7 (22)	
	After treatment (HA/CI)	18 (90)	7 (58)	25 (78)	

Univariate and Multivariate analysis of the Effect of Rural Residence on Hearing Rehabilitation. (Additional variables in multivariate model).

Table 2

Effect of Rural Residence on Hearing Rehabilitation					
	Rural – N (%)	Urban – N (%)	P value	Odds Ratio	95% Confidence Interval
Travel Distance over 1 hour	15 (71%)	3 (23%)	0.01	10.5	1.72 – 63.9
Multivariate analysis (Controlling for Household income over \$20,000, Education beyond high school, Medicaid insurance)			0.02	16.5	1.69 – 162
Speech Therapy Before Hearing aid or CI treatment	2 (10%)	7 (42%)	0.04	0.15	0.02 – 0.99
Multivariate analysis (Controlling for Household income over \$20,000, Education beyond high school, Medicaid insurance)			0.03	0.09	0.01 – 0.787
Mechanical Problems with Cochlear Implant	14 (70%)	4 (33%)	0.05	4.67	1.01 – 21.65
Multivariate analysis (Controlling for Household income over \$20,000, Education beyond high school, Medicaid insurance)			0.05	5.02	0.989 – 25.51
Speech Therapy only available at school	18 (86%)	7 (50%)	0.04	5.67	1.07 – 30.08
Multivariate analysis (Controlling for Education beyond high school, Medicaid insurance)			0.05	5.89	1.04 – 33.3
Multivariate analysis (Controlling for Household income over \$20,000, Education beyond high school, Medicaid insurance)			0.07	5.46	0.89 – 33.60

Table 3

Univariate and Multivariate analysis of the Effect of Parental Education on Hearing Rehabilitation. (Additional variables in multivariate model).

Effect of Parental Education Beyond High School on Hearing Rehabilitation					
	Beyond High School - N (%)	High School Degree or Less - N (%)	p value	Odds Ratio	95% Confidence Interval
Medicaid Insurance	4 (28.57%)	16 (90%)	0.002	0.5	0.01 – 0.33
Multivariate analysis (Controlling for Rural residence, Household income over \$20,000)					
PEACH Score Over 50% in Quiet Conditions	13 (93%)	11 (61%)	0.04	8.27	0.877 – 78.01
Multivariate analysis (Controlling for Rural residence)					
Multivariate analysis (Controlling for Rural residence, Household income over \$20,000, Medicaid insurance)					
No Local Speech Therapist	2 (14%)	9 (50%)	0.04	0.17	0.03 – 0.97
Multivariate analysis (Controlling Rural residence)					
Multivariate analysis (Controlling for Rural residence, Household income over \$20,000, Medicaid insurance)					
			0.05	0.16	0.03 – 1.01
			0.31	0.29	0.03 – 3.19

Univariate and Multivariate analysis of the Effect of Household Income and Medicaid Insurance on Hearing Rehabilitation. (Additional variables in multivariate model).

Table 4

Effect of Household Income over \$20,000 on Hearing Rehabilitation					
	Over \$20,000 Household Income – N (%)	Less than \$20,000 Household Income - N (%)	p value	Odds Ratio	95% Confidence Interval
No Local Speech Therapist					
	5 (23%)	6 (67%)	0.02	0.15	0.03 – 0.81
Multivariate analysis (Controlling for Rural residence)					
			0.03	0.12	0.02 – 0.79
Multivariate analysis (Controlling for Rural residence, Education beyond high school, Medicaid insurance)					
			0.10	0.22	0.04 – 1.36
Effect of Medicaid Insurance on Hearing Rehabilitation					
	Insurance Other Than Medicaid % (N)	Medicaid Insurance % (N)	p value	Odds Ratio	95% Confidence Interval
CI Broken Components Requiring Maintenance					
	5 (42%)	16 (80%)	0.03	5.6	1.15 – 27.37
Multivariate analysis (Controlling for Rural residence)					
			0.04	5.9	1.12 – 30.95
Multivariate analysis (Controlling for Rural residence, Education beyond high school)					
			0.05	11.7	0.99 – 139.44
Multivariate analysis (Controlling for Rural residence, Household income over \$20,000, Education beyond high school)					
			0.07	10.1	0.84 – 121.38