Published in final edited form as:

Otol Neurotol. 2014 June ; 35(5): 815–820. doi:10.1097/MAO.0000000000000327.

Long-term Use of Cochlear Implants in Older Adults: Results from a Large Consecutive Case Series

Janet S. Choi, BS¹, Kevin J. Contrera, BS¹, Joshua F. Betz, MS², Caitlin R. Blake, MSPH³, John K. Niparko, MD⁴, and Frank R. Lin, MD, PhD^{3,5}

¹Johns Hopkins University School of Medicine, Baltimore, Maryland ²Department of Biostatistics, Johns Hopkins University Bloomberg School of Public Health, Baltimore, Maryland ³Center on Aging and Health, Johns Hopkins Medical Institutions, Baltimore, Maryland ⁴Department of Otolaryngology-Head & Neck Surgery, Keck School of Medicine of University of Southern California, Los Angeles, California ⁵Departments of Otolaryngology-Head & Neck Surgery, Geriatric Medicine, Mental Health and Epidemiology, Johns Hopkins University, Baltimore, Maryland

INTRODUCTION

Hearing loss is prevalent in one in three people over the age of 50, and two-thirds of those older than 70 years.¹ Hearing loss in older adults impairs verbal communication, contributes to social isolation,² and has been independently associated with poorer cognitive functioning³⁻⁵ and incident dementia.⁶⁻⁷ While hearing aids improve audibility for most individuals with mild to moderate hearing loss, those who suffer from severe to profound hearing loss generally may acquire greater benefit from electrical hearing provided by a cochlear implant (CI).⁸

Currently, the number of older adults in the United States who would potentially meet audiologic criteria for a CI is approximately 150,000,¹ but less than 5% of these older adults are likely to have received a CI System.⁹ Many factors could potentially account for the low rate of CI use in older adults, such as a general perception of hearing loss being an inconsequential part of aging and poor awareness of and access to cochlear implantation. Additionally, there are concerns about whether older adults could practically benefit from CI on a daily basis. Older adults can consistently acquire improved speech perception scores after CI in the clinical setting,¹⁰ but patterns of CI use by older adults has received little review. Previous studies have reported results only in small cohorts of older adults with limited durations of follow-up.¹¹⁻¹⁸ The purpose of our study was to investigate long-term rates of CI use in a consecutive case series of older adults (≥ 60 years) who received their first CI from 1999-2011.

Address correspondence, reprint requests, and proofs to: Frank R. Lin Johns Hopkins Center on Aging & Health 2024 Monument St, Suite 2-700 Baltimore, MD 21287 Telephone: (443) 287-6509 Fax: (410) 614-9444 flin1@jhmi.edu.

Disclosures: Dr. Lin reports being a consultant to Cochlear, on the scientific advisory board for Autifony and Pfizer, and a speaker for Med El and Amplifon

MATERIALS AND METHODS

STUDY COHORT

We queried the Johns Hopkins Listening Center database to retrieve all patients ≥ 60 years who received a first CI from 1999 to June 2011 (n = 447). The purpose of this study was to investigate rates of CI use in older adults which is generally defined by the United Nations as adults ≥ 60 years.³³ Of these patients, we were able to successfully obtain follow-up information from the patient or a proxy respondent for 397 individuals (89%) from June to August 2012, and these individuals comprise our analytic cohort. Characteristics of “responders” (n = 397) and “non-responders” (n = 50) did not differ significantly by age of implantation, onset of hearing loss, side of implantation, or manufacturer (data not shown). Non-responders were more likely to have been implanted earlier in the study time period than responders (p < .001). Of the 50 non-responders, 27 (54%) had died based on Social Security Death Index records. For these deceased non-responders, we were unable to obtain proxy information on their CI use at the time of death due to unavailable contact information for surviving family members. This study was approved by Johns Hopkins Institutional Review Board.

DATA COLLECTION ON CI USE

As part of a quality assurance initiative at the Johns Hopkins Listening Center, we contacted all CI patients and their families to survey their daily CI use. Postal and email surveys were sent with a standardized questionnaire, and patients who did not respond to postal or email survey were contacted via phone calls using a standardized semi-structured interview template. We gathered data on number of hours of CI use per day averaged over the past four weeks.

Regular CI use was defined as using the CI for ≥ 8 hours per day *a priori* based on what the authors generally considered to be indicative of successful CI use. Eight hours correspond to the average working day and > 50% of waking hours (assuming 16 hours/day). For patients or proxy respondents reporting < 8 hours of use per day, we also asked for the estimated month and year of when the individuals began to stop using the implant for ≥ 8 hours per day and the reasons for doing so. We recorded the number of hours as 16 hours for patients or proxy respondents who answered “all waking hours” or “all day”. If a range of hours was given (e.g., 12-16 hours), we took the average of the values as the reported number of hours of daily use (i.e., 14 hours).

For deceased patients, surviving family members were asked for the date of the patient's death and the estimated month/year that the patients stopped using the CI for ≥ 8 hours/day. Deceased patients whose proxy respondents reported that they used the CI ≥ 8 hours/day until the time of death were censored at the time of death. If proxy respondents reported that deceased patient stopped using the CI ≥ 8 hours/day within 6 months of death, we also censored them at the time of discontinuing regular use rather than classifying them as non-users since the proximity to the death likely implied limited use due to non-CI related health issues (e.g., from hospitalization, inability to update processor settings with CI audiology programming, and etc.).

STATISTICAL METHODOLOGY

We used chi-squared test and Fisher's exact test to compare categorical variables, and 2-sample t-test for the continuous variables associated with regular CI use. Kaplan-Meier method was used to estimate rates of regular CI use as a function of time from implantation. Cox proportional hazard models were used to analyze the association of age at implantation with the rate of discontinuing regular CI use. The assumption of proportional hazards was evaluated and confirmed using the correlation coefficient between transformed survival time and the scaled Schoenfeld residuals. The linear relationship between the log of hazard ratio and age of implantation was checked using penalized splines. Statistical significance was accepted at a two-sided $p < 0.05$ level. STATA 12 (StataCorp, College Station, TX) and R version 2.15²² using the Survival package²³ were used for all statistical computations.

RESULTS

We were able to obtain follow up data on 397 of the 447 individuals (89%) who received their first CI from 1999-2011 (mean duration of follow-up, 5.2 years [range 0 -13.5]). Of these 397 individuals, 366 (92%) reported using their CI for ≥ 8 hours per day and 31 (8%) reported using CI < 8 hours per day. Cohort demographics and CI characteristics of the 397 older adults are presented in **Table 1**. The mean age at initial CI was 72.5 years [range 60 -94.9 years]. Characteristics of regular users (≥ 8 hours/day) and non-users (< 8 hours/day) did not differ significantly by sex, year of implantation, onset of hearing loss, side implanted, or manufacturer.

Reasons for reporting CI use < 8 hours per day among the 31 non-users are specified in **Table 2**. The most common reasons include poor hearing benefit ($n = 14$, 45%) followed by reported pain or discomfort ($n = 7$, 23%) and lack of needing to hear on a daily basis ($n = 7$, 23%).

Of the 397 older adults, 354 were living at the time of data collection and reported their number of hours of CI use per day averaged over the past four weeks (**Figure 1**). Proxy respondents for deceased individuals ($n = 43$) were unable to estimate the actual number of hours the deceased patient used the CI at time of death but were able to usually recall if and when the patient discontinued regular CI use. The mean duration of CI use among individuals living at the time of data collection was 13.6 hours per day (S.D. = 4.0 h, **Figure 1**). Among regular CI users, 50% ($n = 177$) reported using their CI for all waking hours or more (≥ 16 hours per day). Among the 25 non-users using CI < 8 hours/day, 12 were still using their CI at least 1 hour per day, and 13 individuals reported complete non-use.

We investigated the duration of time between the date of CI implantation and when individuals or proxy respondents discontinued regular CI use. The proportion reporting CI use for ≥ 8 hours/day as a function of duration of follow-up is provided in **Figure 2**. At 5 years of follow-up, 93.2% (95% CI: 89.9-95.4%) of all patients continued to use their CI for ≥ 8 hours per day. At 13.5 years of follow-up, 82.6% (95% CI, 72.5-89.3%) still continued to be regular users. We investigated if age at implantation, 60-74 years ($n = 251$) vs. ≥ 75 years ($n = 146$), was associated with rates of discontinuing regular CI use and found that these Kaplan-Meier time-to-event functions were significantly different (log-rank, $p = .001$).

At 5 years of follow-up, 95.6% (95% CI, 92.0-97.6%) of patients implanted at 60-74 years were regular users compared with 88.6% (95% CI, 81.2-93.2%) of patients implanted at 75 years. At 13.5 years of follow-up, 91.1% (95% CI, 83.2-95.4%) of patients implanted at 60-74 remained to be regular users compared to 55.7% (95% CI, 24.9-78.1) of patients implanted at 75 years (**Figure 2**). Running a sensitivity analysis excluding deceased patients generated similar results (data not shown).

We further investigated the association between age at CI and rate of discontinuing regular CI use using Cox proportional hazard models (**Figure 3**). We observed that the hazard ratio of discontinuing regular CI use increased, on average, by 7.8% for every incremental year of age at implantation (hazard ratio: 1.08 [95% CI, 1.03-1.13] $p=0.001$).

DISCUSSION

Our results reflect an assessment of the largest consecutive case series of older adult CI recipients to date. We observed that the rate of regular CI use in older adults is 82.6% at 13.5 years of follow-up. We found that age at implantation was strongly associated with the rate of discontinued regular CI use such that for every incremental year of age of implantation, there was a 7.8% increased rate of discontinuing regular CI per annum. Overall, our results support the general notion that earlier cochlear implantation in older adults is a highly useful intervention and likely to be associated with more favorable long-term treatment effects that both support and are reinforced by greater use.

These results are consistent with models of CI performance that implicate in important association of *auditory memory* with clinical outcome.^{20, 27} *Auditory memory* is a construct for the sustained ability to process acoustic-phonemic stimuli to restore speech perception with the electrical hearing from a CI. Thus, two individual candidates, with equivalent (hearing) aided-speech recognition capacity, but with differing hearing histories such that their sensorineural hearing loss progression impaired their speech recognition at different ages, would be expected to have differing outcomes. Such models predict higher CI speech recognition in the individual with a shorter duration of impaired speech recognition, an observation born out in the evaluation of large case series.²⁸⁻³⁰

Previous studies have demonstrated that rates of regular CI use in older adults have ranged from 84% to 100%.¹²⁻¹⁵ However, comparing these rates to results from the current study is difficult as the definition of regular CI use, the number of older adults in the study population, and the length of follow-up vary substantially by report. Our study uses a relatively conservative definition of regular CI use (8 hours per day) compared to previous studies which utilized definitions ranging from > 0 hour per day to 8 hours per day.^{15, 13} Our *a priori* definition of regular use was based on our clinical experiences and discussion with CI audiologists and was consistent with a natural cutpoint that was observed in CI usage at this value (**Figure 1**). Previous studies generally included only a small number of older adult CI patients ranging from sample sizes of 27 to 67 individuals.^{13, 12} The average length of follow-up in previous studies (ranging from 1.8 to 4.2 years)^{12, 14} was also relatively less than in our cohort (mean 5.2 years, range 0-13.5 years). Importantly, we utilized Kaplan-Meier and Cox proportional hazard methods to analyze our data which

allows us to account for censored individuals (e.g, patients who are lost to follow-up, have different durations of follow-up, or who have died). Previous studies have simply calculated the fraction of regular CI users at one time point,¹²⁻¹⁵ and they may have overestimated the rates of regular CI users by excluding individuals who were lost to follow-up due to death or other reasons.

Rates of regular CI use in older adults in the current study exceed 80% at greater than 10 years of follow-up which suggests that the vast majority of older adults continue to obtain practical benefit from the CI on a daily basis. The high rates of long-term CI use in older adults are consistent with the findings from previous studies demonstrating improved speech perception abilities and better health-related quality of life after CI in this population.^{15, 19-21}

We found that earlier age at implantation was associated with a greater rate of regular CI use. These results are consistent with earlier data from our research group demonstrating that earlier intervention was also associated with greater speech perception scores after CI in older adults.¹⁹ Older adults may still have neural plasticity which is an essential component in auditory processing of speech in CI users. However, it is widely known that the factors that contribute towards neural plasticity decline at the cellular level as individuals age.^{24, 25} In addition, older adults with greater age and poorer hearing require additional cognitive effort for successful perception of speech.²⁶ Taken together, these results suggest that younger age at CI is likely to result in better outcomes, possibly from the aforementioned factors related to auditory memory and greater neural and behavioral plasticity in older adults who are younger at implantation.

Our study has limitations. First, recall bias by patients or proxy respondents may limit the accuracy of the reported results. This bias would likely lead to overestimates of self-reported CI use. However, we note that our findings are generally consistent with previous reports.¹²⁻¹⁵ We made every attempt to limit this potential bias by using the same standardized data report forms for postal and email surveys and a corresponding semi-structured interview template for patients who were contacted by phone. Previous studies investigating the quality of proxy reports suggest that the accuracy of proxy ratings was higher when the information sought was concrete and observable.³¹ We feel that proxy reporting of whether a family member on average used a CI regularly (i.e., 8 hours/day) would be a reasonably concrete measure to report. Our results were also robust to excluding proxy informant data from individuals who were deceased. Future studies incorporating data logging technology in newer CI processors or asking patients to keep daily diaries could be performed to further investigate our findings.

Secondly, our study was based on results from a single tertiary referral center, and hence, our findings may not be generalizable to rates at other CI centers. We also note that we were unable to obtain follow-up data on 50 individuals (11%), and if these individuals were primarily non-users, our results are possibly overestimates of rates of regular CI use. However, we feel that this limitation is unlikely to have substantially biased our results given that the primary reason that most of these individuals could not be contacted is because they had died.

Although our results demonstrate that earlier implantation is associated with greater rate of regular CI use, we note that the individuals implanted earlier (and observed to have greater rates of regular CI use over 13 years in this study) may still experience an accelerated decline in the rate of regular use once they reach an older age. Further studies incorporating longer periods of follow-up will be useful to better understand long-term rates of CI use in older adults. Finally, we note that competing risks³² and informative censoring with mortality is a possible concern when investigating the association of age at CI with rates of long term use. Importantly, such a bias would likely lead to overly *conservative* estimates of the association of greater age at CI with poorer rates of long-term use given that increasing age and likely discontinuation of CI are positively associated with mortality.

In summary, our results are based on the largest consecutive case series of older adult CI recipients to date and demonstrate that long-term rates of regular CI use in older adults exceed 80% and that the rate of sustained use is strongly associated with earlier age at implantation. Clinical strategies and public policies promoting earlier rather than later cochlear implantation in older candidates are likely to lead to more favorable long-term outcomes and cost-effectiveness of cochlear implantation in older adults.

Acknowledgments

Funding: This manuscript was supported in part by NIH K23DC011279, the Eleanor Schwartz Charitable Foundation, a Triological Society/American College of Surgeons Clinician Scientist Award, and an Alpha Omega Alpha Carolyn L. Kuchin Student Research Fellowship.

REFERENCES

1. Lin FR, Niparko JK, Ferrucci L. Hearing Loss Prevalence in the United States. *Arch Intern Med*. 2011; 171(20):1851–1853. doi:10.1001/archinternmed.2011.506. [PubMed: 22083573]
2. Cacioppo JT, Hawkley LC, Norman GJ, Berntson GG. Social isolation. *Ann N Y Acad Sci*. 2011; 1231(1):17–22. [PubMed: 21651565]
3. Lin FR, Ferrucci L, Metter EJ, An Y, Zonderman AB, Resnick SM. Hearing loss and cognition in the Baltimore Longitudinal Study of Aging. *Neuropsychology*. Nov; 2011 25(6):763–770. [PubMed: 21728425]
4. Lin FR. Hearing loss and cognition among older adults in the United States. *J Gerontol A Biol Sci Med Sci*. 2011; 66(10):1131–1136. [PubMed: 21768501]
5. Lin FR, et al. Hearing loss and cognitive decline in older adults. *JAMA Intern Med*. 2013; 173(4):293–9. [PubMed: 23337978]
6. Lin FR, Metter EJ, O'Brien RJ, Resnick SM, Zonderman AB, Ferrucci L. Hearing loss and incident dementia. *Arch Neurol*. Feb; 2011 68(2):214–220. [PubMed: 21320988]
7. Gallacher J, et al. Auditory threshold, phonologic demand, and incident dementia. *Neurology*. 2012; 79(15):1583–90. [PubMed: 23019269]
8. Lustig LR, Niparko JK. *Clinical Neurotology: Diagnosing and Managing Disorders of Hearing, Balance and the Facial Nerve*.
9. Murray, Brendan. Cochlear Europe Limited. Personal Communication. Sep 22, 2012
10. Raman, G.; Lee, J.; Chung, M., et al. Agency for Health-care Research and Quality. U.S. Department of Health & Human Services; Effectiveness of cochlear implants in adults with sensorineural hearing loss: technology assessment report.. <https://www.cms.gov/determination-process/downloads/id80TA.pdf>. Accessed December 15, 2011
11. Proops DW, Donaldson I, Cooper HR, Thomas J, Burrell SP, Stoddart RL, et al. Outcomes from adult implantation, the first 100 patients. *J Laryngol Otol Suppl*. 1999; 24:5–13. [PubMed: 10664722]

12. Horn KL, McMahon NB, McMahon DC, Lewis JS, Barker M, Gherini S. Functional use of the nucleus 22-channel cochlear implant in the elderly. *Laryngoscope*. Mar; 1991 101(3):284–8. [PubMed: 2000016]
13. Shin YJ, Frayssse B, Deguine O, et al. Benefits of cochlear implantation in elderly patients. *Otolaryngol Head Neck Surg*. Apr; 2000 122(4):602–606. [PubMed: 10740189]
14. Kelsall DC, Shallop JK, Burnelli T. Cochlear implantation in the elderly. *Am J Otol*. Sep; 1995 16(5):609–15. [PubMed: 8588665]
15. Orabi AA, Mawman D, Al-Zoubi F, Saeed SR, Ramsden RT. Cochlear implant outcomes and quality of life in the elderly: Manchester experience over 13 years. *Clin Otolaryngol*. Apr; 2006 31(2):116–22. [PubMed: 16620330]
16. Mawman DJ, Bhatt YM, Green KM, O'Driscoll MP, Saeed SR, Ramsden RT. Trends and outcomes in the manchester adult cochlear implant series. *Clin Otolaryngol Allied Sci*. Aug; 2004 29(4):331–9. [PubMed: 15270818]
17. Ray J, Wright T, Fielden C, Cooper H, Donaldson I, Proops DW. Non-users and limited users of cochlear implants. *Cochlear Implants Int*. Mar; 2006 7(1):49–58. [PubMed: 18792374]
18. Bhatt YM, Green KM, Mawman DJ, Aplin Y, O'driscoll MP, Saeed SR, et al. Device nonuse among adult cochlear implant recipients. *Otol Neurotol*. Mar; 2005 26(2):183–7. [PubMed: 15793402]
19. Lin FR, Chien WW, Li L, Clarrett DM, Niparko JK, Francis HW. Cochlear implantation in older adults. *Medicine (Baltimore)*. Sep; 2012 91(5):229–41. [PubMed: 22932787]
20. Francis HW, Chee N, Yeagle J, Cheng A, Niparko JK. Impact of cochlear implants on the functional health status of older adults. *Laryngoscope*. Aug; 2002 112(8 Pt 1):1482–8. [PubMed: 12172266]
21. Vermeire K, Brokx JP, Wuyts FL, Cochet E, Hofkens A, Van de Heyning PH. Quality-of-life benefit from cochlear implantation in the elderly. *Otol Neurotol*. Mar; 2005 26(2):188–95. [PubMed: 15793403]
22. R: A language and environment for statistical computing. [computer program]. R Foundation for Statistical Computing; Vienna, Austria: 2012.
23. A Package for Survival Analysis in S [computer program]. Version R package version 2.36-142012.
24. Fujiki N, Naito Y, Hirano S, et al. Correlation between rCBF and speech perception in cochlear implant users. *Auris Nasus Larynx*. 1999; 26:229–236. [PubMed: 10419029]
25. Dickstein DL, Kabaso D, Rocher AB, et al. Changes in the structural complexity of the aged brain. *Aging Cell*. 2007; 6:275–284. [PubMed: 17465981]
26. Tun PA, McCoy S, Wingfield A. Aging, hearing acuity, and the attentional costs of effortful listening. *Psychol.Aging*. 2009; 24(3):761–766. [PubMed: 19739934]
27. Tyler RS, Summerfield AQ. Cochlear implantation: Relationships with research on auditory deprivation and acclimatization. *Ear Hear*. Jun; 1996 17(3 Suppl):38S–50S. [PubMed: 8807275]
28. Rubinstein JT, Parkinson WS, Tyler RS, Gantz BJ. Residual speech recognition and cochlear implant performance: Effects of implantation criteria. *Am J Otol*. Jul; 1999 20(4):445–52. [PubMed: 10431885]
29. Friedland DR, Venick HS, Niparko JK. Choice of ear for cochlear implantation: The effect of history and residual hearing on predicted postoperative performance. *Otol Neurotol*. Jul; 2003 24(4):582–9. [PubMed: 12851549]
30. Leung J, Wang NY, Yeagle JD, Chinnici J, Bowditch S, Francis HW, et al. Predictive models for cochlear implantation in elderly candidates. *Arch Otolaryngol Head Neck Surg*. Dec; 2005 131(12):1049–54. [PubMed: 16365217]
31. Klinkenberg M, Smit JH, Deeg DJ, Willems DL, Onwuteaka-Philipsen BD, van der Wal G. Proxy reporting in after-death interviews: The use of proxy respondents in retrospective assessment of chronic diseases and symptom burden in the terminal phase of life. *Palliat Med*. Mar; 2003 17(2):191–201. [PubMed: 12701851]
32. Andersen PK, Geskus RB, de Witte T, Putter H. Competing risks in epidemiology: Possibilities and pitfalls. *Int J Epidemiol*. Jun; 2012 41(3):861–70. [PubMed: 22253319]

33. Definition of an older or elderly person. <http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html>. Accessed 15 Oct, 2013

Figure 1.
Reported number of hours of CI use per day*

All patients

CI at 60-74 versus CI at 75+

Figure 2.

Time from date of CI implantation to reporting non-use of CI (< 8hrs/day) in all patients and in patients implanted at 60-74 years versus 75 years. Shaded gray area indicates 95% confidence interval.

Figure 3. Rate of discontinuing regular use of CI (< 8hrs/day) by age at implantation. Dotted line indicates 95% confidence interval.

Table 1

Cohort demographics and characteristics of adults 60 years old receiving their first CI at Johns Hopkins, 1999-2011, n = 397

Characteristics	Cohort n (%)	Users (≥8hr/day) n (%)	Non-users (<8hr/day) n (%)	P
Sex				
<i>Male</i>	206 (51.9)	186 (50.8)	20 (64.5)	.19
<i>Female</i>	191 (48.1)	180 (49.2)	11 (35.5)	
Age at initial CI, year				
<i>60-74</i>	251 (63.2)	238 (65.0)	13 (41.9)	.018
<i>74+</i>	146 (36.8)	128 (35.0)	18 (58.1)	
<i>Mean age, yr (SD)</i>	72.5 (7.7)	72.3 (7.7)	74.8 (7.7)	.091
<i>[Range]</i>	[60.1-94.9]	[60.1-94.9]	[61.0-91.5]	
Year of Implantation				
<i>1999-2003</i>	86 (21.7)	74 (20.2)	12 (38.7)	.23
<i>2004-2008</i>	186 (46.9)	176 (48.1)	10 (32.3)	
<i>2009-2011</i>	125 (31.5)	116 (31.7)	9 (29.0)	
Onset of Hearing Loss				
<i>Congenital</i>	4 (1.0)	3 (0.8)	1 (3.2)	.15
<i><18 yrs</i>	52 (13.1)	51 (13.9)	1 (3.2)	
<i>18yrs</i>	303 (76.3)	277 (75.7)	26 (83.9)	
<i>Unknown</i>	38 (9.6)	35 (9.6)	3 (9.7)	
Side Implanted				
<i>Right only</i>	206 (51.9)	187 (51.1)	19 (61.3)	.84
<i>Left only</i>	178 (44.8)	167 (45.6)	11 (35.5)	
<i>Bilateral</i>	13 (3.3)	12 (3.3)	1 (3.2)	
Manufacturer				
<i>Advanced Bionics</i>	162 (40.8)	151 (41.3)	11 (35.5)	.11
<i>Cochlear</i>	183 (46.1)	171 (46.7)	12 (38.7)	
<i>MED-EL</i>	52 (13.1)	44 (12.0)	8 (25.8)	

Table 2

Reasons for using a CI < 8hours/day among non-users, n=31

Reason	n (%) [*]
Poor hearing benefit	14 (45)
Pain or discomfort	7 (23)
No need to hear	7 (23)
Comorbid illnesses (dementia, tumor, hip broken)	6 (19)
Device failure or broken	2 (7)
Ear infection	1 (3)
Unknown	1 (3)

* Column does not sum to 31 because patients reported more than 1 reason.