Patient-Related Factors Do Not Predict Use of Computer-Based Auditory Training by New Adult Cochlear Implant Recipients

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Objective: The use of computer-based auditory training (CBAT) after cochlear implantation is associated with improved speech recognition and real-world functional abilities. However, patient-related factors associated with CBAT use remain unknown. This study seeks to identify such factors and recognize those at risk for not implementing CBAT.
Study Design: Prospective natural experiment.
Setting: Tertiary academic center.
Patients: A total of 117 new adult cochlear implant (CI) recipients with bilateral moderate-to-profound hearing loss.
Interventions/Main Outcome Measures: Patient demographic and lifestyle information, preimplantation aided speech recognition scores, Cochlear Implant Quality of Life (CIQOL) domain and global scores, CIQOL-Expectations scores, and CBAT use in the first 3 months after activation. Patient-related variables included age, sex, race, duration of hearing loss before implantation, hours of CI use per day, hearing-aid use before implantation, living arrangements/marital status, annual household income, employment, technology use, and education.
Results: Overall, 33 new CI users (28.2%) used CBAT in the first 3 months after activation. On bivariate analysis of the pre-CI CIQOL scores, CIQOL-Expectations score, aided speech recognition scores, and demographic/lifestyle factors examined, regular use of smartphone, tablet, or computer technology was significantly associated with an increased likelihood of CBAT use (odds ratio, 9.354 [1.198-73.020]), whereas higher CIQOL-Expectations emotional domain scores were associated with a lower likelihood of CBAT use ($d = -0.69$ [-1.34 to -0.05]). However, using multivariable analysis to control for potential confounding factors revealed no significant associations between CBAT use in the first 3 months after cochlear implantation and any examined factor.
Conclusions: No associations between patient demographic, lifestyle, or pre-CI speech recognition and patient-reported outcome measures and CBAT use were identified. Therefore, discussions with all patients after implantation on the availability of CBAT and its potential benefits are warranted. In addition, given the limited overall use of CBAT and its association with improved CI outcomes, future studies are needed to investigate facilitators and barriers to CBAT use.
Key Words: Auditory training—Cochlear implantation—Computer-based auditory training.

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INTRODUCTION

Currently, cochlear implantation is widely accepted as the standard of care for severe to profound sensorineural hearing loss for both children and adults (1). After cochlear implant (CI) activation, adaptation to this new form of hearing can be difficult for many. Although improvements in speech recognition and quality of life after implantation are apparent, deficits remain (2–5). This is in part due to limitations of CIs in replicating human speech and other sounds, which requires patients to learn to hear and understand based on degraded signals from their CI. For some, adaptation to identifying and enjoying sounds using their CI requires more effort than for others, with average peak CI speech recognition not occurring until 1 to 2 years after implantation (6–8). Post-CI auditory training may improve or hasten this learning process (9–14), and a majority of audiologists consider it a necessary component of CI hearing rehabilitation (14).

In general, auditory training focuses on exposing CI users to a variety of speech and environmental sounds so that they can adapt to their new form of hearing and develop new listening skills with their CI. These skills may be improved for some patients either through face-to-face interaction with an audiologist or speech-language pathologist, use of passive home-based training, or use of computer-based auditory training (CBAT), or a combination of approaches. Preliminary evidence has demonstrated a trend toward a benefit of face-to-face interaction and CBAT over passive learning (9,12,15), with a new study suggesting the most consistent improvements in speech recognition and CI-specific quality of life with CBAT, even

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after controlling for common demographic variables (16). Unfortunately, CBAT use remains low (9,16). Therefore, knowledge of which patients might be at risk of not pursuing what may be an effective intervention is critical. However, to date, no specific factors have been identified that are associated with CBAT use, and thus, it is not possible to predict which patients are more or less likely to use CBAT (9). Thus, the goal of this study was to identify patient-related factors associated with CBAT use in new adult CI patients during the first 3 months after CI activation, with a goal of identifying which patients might be at risk of not using CBAT and therefore may need special attention, encouragement, and additional resources.

MATERIALS AND METHODS

Patient Sample and Data Collection

This study was approved by our university's Institutional Review Board. Data were prospectively collected from patients undergoing cochlear implantation from September 2018 to October 2021 in a single CI center. Inclusion criteria were CI candidacy for bilateral sensorineural hearing loss and age at least 18 years. Patients undergoing revision implantation, second-sided cochlear implantation, or implantation for unilateral deafness were excluded.

Operations were performed by one of four attending neurotologists at an academic, tertiary referral hospital. Three CI audiologists at the same CI center performed all intraoperative device testing, postimplantation programming, and speech recognition testing. Patients meeting the study criteria were identified by study personnel when they presented for routine programming visits with the CI audiologist. At their 3-month post-CI appointment, patients completed surveys on auditory training use and common living arrangements/lifestyle factors, which were recorded in a REDCap database (17). Patient demographic data and data logs of CI use were also collected at this time. Aided speech recognition and patient-reported outcomes, detailed hereinafter, were obtained before cochlear implantation.

Auditory Training Interventions

Upon CI activation, the CI audiologists provided patients with a list of at-home auditory training resources and websites to access CBAT programs. The list of recommended resources was identical for all patients at our institution and was not modified for this study. Per our CI center's standard of care, patients were encouraged at the time of CI activation and during each follow-up visit to use auditory training resources as much as possible. The CBAT resources used in this study included programs developed by Advanced Bionics (Valencia, CA) and Cochlear Americas (Englewood, CO), and Listening and Communication Enhancement (LACE) (18) and Angel Sound (19).

All CBAT forms used in this study were developed for CI users except for LACE, which was developed for adults with hearing loss regardless of whether they use hearing aids or CIs. Most of these resources use a similar structure (20), which involves a series of progressively more difficult sound and speech recognition tasks. These tasks may then progress to topical or script-based exercises to allow CI users to practice speech recognition within a conversation or area of discussion. Practice materials are similar across programs, and use of practice and progression through the tasks are at the patient's discretion. Tracking of performance over time is available in all programs (18,19). All programs also make use of some form of visual correct-response feedback and are available for use on computers or mobile devices.

The primary difference between programs is in user interface and access (18,19). All CBAT resources used in this study were available for free except LACE, which requires a fee. Programs developed by implant companies require creating an account for access to their materials. Angel Sound offers some environmental sound and music training, which is not available in programs developed by implant companies. Advanced Bionics offers advanced customization of individual practice materials with optional video of speakers and options for differing accents and background noise.

As detailed previously, patients completed a comprehensive questionnaire regarding the frequency and duration of listening activities (including CBAT) at the 3 months after CI activation clinic visit. For this study, CBAT users are those who indicated they used this resource at any time in the first 3 months after CI activation.

Speech Recognition Testing

Preimplantation speech recognition measures used in this study were consonant-nucleus-consonant (CNC) phonemes, CNC words (21), and AzBio sentences in quiet (AzBio Quiet) (22). Preimplantation speech recognition was measured with hearing aids (personal or stock) fitted to National Acoustics Laboratory–revised linear targets (23). Ears were tested independently. Patients scoring higher than 50% on AzBio Quiet were tested at +10 dB signal-to-noise ratio. Insufficient data for AzBio sentences in noise were available for analyses in the current study.

Patient-Reported Outcome Measures

Patient-reported functional abilities were obtained using the Cochlear Implant Quality of Life-35 (CIQOL-35) Profile instrument during preimplantation CI evaluations (24,25). The CIQOL-35 Profile is a patient-reported outcome measure that assesses the functional abilities of adult CI recipients within 6 domains: communication, assessing communication ability in different circumstances; emotional, assessing the impact of hearing on emotional well-being; entertainment, assessing the ability to enjoy TV, radio, and music; environmental, assessing the ability to distinguish and localize environmental sounds; listening effort, assessing effort and fatigue associated with receptive communication; and social, assessing the ability to interact and enjoy interactions with groups. A global score is also calculated providing a general assessment of CI-specific QOL. Scores were calculated for each domain and ranged from 0 (lowest) to 100 (highest) (24,25). Also, during the CI evaluation, patients' expectations for their functional abilities after implantation were assessed using the validated CIQOL-Expectations instrument. Like the CIQOL-35 Profile, scores ranged from 0 (lowest expectations) to 100 (highest expectations). Expectation scores were reported for the same six domains, in addition to a global score.

Patient-Related Factors

In addition to preimplantation aided speech recognition scores, CIQOL-35 Profile, and CIQOL-Expectations scores, we examined the following: age at implantation, sex, race, duration of hearing loss before implantation, preimplantation hearing-aid use, CI use modality, data logs of CI use in the first 3 months after activation, and patient responses to questions related their living arrangements/lifestyle. These questions included marital status, cohabitation and number of children younger than 18 years in the home, annual household income, education, current employment status, and use of technology (regular uses of computers, smartphones, or tablets).

CI Use

Data logs for CI use were collected during post-CI follow-up audiologic visits. Data were collected using each implant company's proprietary data logging software. Data presented here represent the average daily hours of use from CI activation to 3 months after activation. Data were collected for hours of overall use per day and hours of use per day in noisy environments.

Statistical Analyses

All statistical analyses were performed using SPSS version 25 (IBM Corporation, Armonk, NY). Cohen's d effect sizes (95% confidence intervals [CIs], denoted as "d [lower CI, upper CI]," were calculated where appropriate. Effect sizes were interpreted as follows per Cohen's conventions: ≥0.2 and <0.5, small effect; ≥0.5 and <0.8, medium effect; and ≥0.8, large effect (26).

Correlation and multivariable regression analyses were performed using clinically relevant variables to model CBAT use. Bivariate correlation was initially performed to find factors of any kind associated with CBAT in the first 3 months after activation. Multivariable regression was then performed to identify significant independent associations between patient-related factors and CBAT use while controlling for confounding variables. Threshold to include variables in multivariable analysis were

TABLE 1. *Association of demographic and lifestyle factors with computer-based auditory training use in the first 3 months after activation*

	All Patients	CBAT Users	Nonusers	Effect Size, d (95% Confidence Interval)
N	117	33	84	
Age, mean (SD), yr	66.3 (16.2)	62.4 (15.2)	67.9 (16.2)	−0.34 (−0.77 to 0.08)
Duration of hearing loss, mean (SD), yr	24.0 (15.4)	26.0 (17.2)	21.3 (14.4)	0.30 (−0.33 to 0.92)
Average hours of daily CI use, mean (SD)	11.4 (3.4)	11.5 (3.1)	11.7 (3.3)	−0.04 (−0.52 to 0.44)
Average hours of daily CI use in noise, mean (SD)	1.7 (1.3)	1.8 (1.2)	1.7 (1.4)	0.06 (−0.42 to 0.54)
	All Patients	**CBAT Users**	**Nonusers**	**Odds Ratio (95% Confidence Interval)**
Sex				1.063 (0.475 to 2.378)
Female, n (%)	59 (50.4)	17 (51.5)	42 (50.0)	
Male, n (%)	58 (49.6)	16 (48.5)	42 (50.0)	
Race				1.122 (0.292 to 4.608)
White, n (%)	79 (84.9)	19 (86.4)	60 (84.5)	
Non-White, n (%)[a]	14 (15.1)	3 (13.6)	11 (15.5)	
Unknown/did not respond	24	11	13	
Preimplant hearing aid use				1.399 (0.617 to 3.173)
Yes, n (%)	30 (43.5)	11 (44.0)	19 (43.2)	
No, n (%)	39 (56.5)	14 (56.0)	25 (56.8)	
Unknown/did not respond	48	8	40	
Modality of cochlear implant use				1.034 (0.384 to 2.781)
Use cochlear implant with hearing aid	64 (54.7)	20 (60.6)	44 (52.4)	
Use cochlear implant only	53 (45.3)	13 (39.4)	40 (47.6)	
Marital status				1.638 (0.540 to 4.968)
Married	48 (69.6)	19 (76.0)	29 (65.9)	
Single or separated	21 (30.4)	6 (24.0)	15 (34.1)	
Unknown/did not respond	48	8	40	
Cohabitate with friends/family				3.398 (0.729 to 15.841)
Yes, n (%)	93 (84.5)	29 (93.5)	64 (81.0)	
No, n (%)	17 (15.5)	2 (6.5)	15 (19.0)	
Unknown/did not respond	7	2	5	
Live with children <18 yr				1.496 (0.459 to 4.879)
Yes, n (%)	14 (12.7)	5 (16.1)	9 (11.4)	
No, n (%)	96 (87.3)	26 (83.9)	70 (88.6)	
Unknown/did not respond	7	2	5	
Completed college				0.993 (0.428 to 2.302)
Yes, n (%)	48 (45.3)	14 (45.2)	34 (45.3)	
No, n (%)	58 (54.7)	17 (54.8)	41 (54.7)	
Unknown/did not respond	11	2	9	
Currently employed full or part-time				0.792 (0.297 to 2.108)
Yes, n (%)	28 (25.7)	7 (22.6)	21 (26.9)	
No, n (%)	81 (74.3)	24 (77.4)	57 (73.1)	
Unknown/did not respond	8	3	6	
Annual household income >$50,000				2.235 (0.898 to 5.562)
Yes, n (%)	57 (58.2)	22 (71.0)	35 (52.2)	
No, n (%)	41 (41.8)	9 (29.0)	32 (47.8)	
Unknown/did not respond	19	2	17	
Regular use of technology				**9.354 (1.198 to 73.020)**
Yes, n (%)	97 (83.1)	32 (97.0)	65 (77.6)	
No, n (%)	20 (16.9)	1 (3.0)	19 (22.4)	

Bolded text denotes a significant association.
[a]Non-White cohort includes African American (93%) and Hispanic patients.
CBAT indicates computer-based auditory training; SD, standard deviation.

clinical interest and $p < 0.10$ on bivariate analysis. For the multivariable analysis, missing data for some variables for some patients were dealt with using multiple imputation. β Values and associated 95% CIs are presented.

RESULTS

Patterns of CBAT Use

Data from 117 CI patients were included in this study. Of these, 33 patients (28.2%) used CBAT in the first 3 months after activation. Analysis of the 33 CBAT users was undertaken to determine patterns of CBAT use and the impact of various patient-specific factors on those patterns. The CBAT format used by most patients was Angel Sound, used by 16 (48.5%). Regarding other forms of CBAT, 6 (18.2%) patients used the "Listening Room" by Advanced Bionics, 10 (30.3%) used "Sound Success" by Advanced Bionics, 9 (27.3%) used "The Communication Corner" by Cochlear, and 1 (3%) used LACE. Of these patients, 9 (27.3%) used multiple forms of CBAT. In this group, 19 (57.6%) also reported using some form of passive at-home rehabilitation such as listening to an audiobook or radio, but few (n = 3; 9.1%) took part in at least one in-person rehabilitation session. Regarding patterns of use, we found that CI patients used CBAT on average for 4.1 ± 2.3 days per week for a cumulative average of 8.8 ± 14.3 hours per week. We also found that most common modalities for using CBAT were through a loudspeaker from a computer or cellphone used by 13 (39.4%) patients, and Bluetooth streaming directly to the CI used by 8 (24.2%). Because of insufficient power, no statistical analyses were undertaken.

Patient-Related Factors

Patient demographics and lifestyle factors are detailed in Table 1. For all patients, average age at implantation was 66.3 ± 16.2 years, with an average duration of hearing loss before implantation of 24.0 ± 15.4 years. Fifty-nine (50.4%) of patients were female, and 79 (84.9% of those who reported race) were White.

Responses related to living arrangements and lifestyle, and data on CI use are also detailed in Table 1. Of patients who responded, 30 (43.5%) reported using hearing aids before implantation. Data logging showed an average of 11.37 ± 3.4 hours per day of CI use, with 1.68 ± 1.3 hours of this in noisy environments. Regarding modality of CI usage, 64 (54.7%) reported using a hearing aid in the same or contralateral ear. Regarding living arrangements, 48 (69.6%) were married, 93 (84.5%) lived with friends or family, and 14 (12.7%) lived with children younger than 18 years. Concerning education and employment, 48 (45.3%) had completed college, 28 (25.7%) were employed at least part-time, and 57 (58.2%) reported an annual household income greater than $50,000. Regarding familiarity with technology, 98 (83.1%) regularly used computers, smartphones, or tablets.

Preimplantation aided speech recognition, CIQOL Profile-35, and CIQOL-Expectations scores are detailed in Table 2. Mean preimplantation aided speech recognition scores were 15.4 ± 17.1% for CNC word, 28.4 ± 25.2% for CNC phoneme, and 20.4 ± 24.4% for AzBio Quiet for the implanted ear. Average preimplantation CIQOL global score was 35.5 ± 9.9, and average CIQOL-Expectations global score was 61.8 ± 14.6.

Univariate Analysis

Comparisons were made between CBAT users and nonusers regarding the aforementioned patient factors (Tables 1 and 2). Regular use of technology was significantly associated with increased CBAT use (odds ratio, 9.354

TABLE 2. *Association of preimplantation aided speech recognition and patient-reported outcomes measures with computer-based auditory training use in the first 3 months after activation*

	All Patients	CBAT Users	Nonusers	Effect Size d (95% Confidence Interval)
Aided speech recognition score in the ear to be implanted, percent correct (SD)				
CNC-W	15.4 (17.1)	15.2 (18.7)	15.2 (16.2)	0.001 (−0.47 to 0.47)
CNC-P	28.4 (25.2)	29.0 (26.8)	27.5 (24.8)	0.06 (−0.41. 0.53)
AzBio Quiet	20.4 (24.4)	20.1 (26.8)	20.2 (23.4)	0.003 (−0.47 to 0.46)
CIQOL-35 profile domain and global scores (SD)				
Global	35.5 (10.0)	37.6 (9.8)	35.0 (10.1)	0.26 (−0.41 to 0.93)
Communication	28.1 (12.3)	34.5 (8.9)	26.5 (12.7)	0.66 (−0.02 to 1.31)
Emotional	42.3 (16.5)	42.1 (16.0)	42.4 (16.8)	−0.02 (−0.68 to 0.65)
Entertainment	36.7 (14.5)	40.4 (13.9)	35.9 (14.6)	0.31 (−0.38 to 1.00)
Environment	32.7 (17.6)	39.4 (10.6)	31.1 (18.6)	0.47 (−0.22 to 1.16)
Listening effort	22.2 (14.0)	27.1 (11.4)	20.9 (14.5)	0.44 (−0.23 to 1.11)
Social	45.0 (19.0)	44.6 (15.8)	45.2 (19.9)	−0.03 (−0.70 to 0.64)
CIQOL-Expectations domain and global scores (SD)				
Global	61.8 (14.6)	57.6 (11.9)	63.3 (17.6)	−0.34 (−1.00 to 0.31)
Communication	63.4 (18.0)	58.9 (17.8)	67.2 (16.9)	−0.48 (−1.11 to 0.16)
Emotional	**65.1 (21.3)**	**55.0 (17.6)**	**69.2 (20.8)**	**−0.69 (−1.34 to −0.05)**
Entertainment	67.4 (19.5)	61.7 (20.5)	72.5 (17.9)	−0.57 (−1.23 to 0.09)
Environment	69.6 (22.60)	69.3 (26.0)	73.4 (20.0)	−0.18 (−0.84 to 0.47)
Listening effort	56.9 (20.3)	50.4 (17.6)	61.7 (19.3)	−0.59 (−1.25 to 0.08)
Social	69.9 (19.3)	64.5 (13.5)	73.3 (20.3)	−0.47 (−1.11 to 0.18)

CBAT indicates computer-based auditory training; CIQOL, Cochlear Implant Quality of Life; CNCp, consonant-nucleus-consonant phoneme; CNCw, consonant-nucleus-consonant word; SD, standard deviation.

Bolded text denotes a significant association.

TABLE 3. *Multivariable regression analysis of factors associated with computer-based auditory training use in the first 3 months after activation*

Covariate	Odds Ratio (95% Confidence Interval)
Age	0.989 (0.916–1.068)
Sex	1.249 (0.130–11.998)
Regular use of technology (yes/no)	7.379 (0.895–60.857)
Annual household income >$50,000 (yes/no)	0.089 (0.004–1.982)
CIQOL-Expectations emotional domain score	0.936 (0.871–1.005)

CBAT indicates computer-based auditory training; CIQOL, Cochlear Implant Quality of Life.

Bolded text denotes a significant association.

[1.198-73.020]). No other demographic or lifestyle factor was significantly associated with CBAT usage.

When examining preimplantation aided speech recognition, CIQOL, and CIQOL-Expectations scores, we noted that global expectation scores and all expectation domain scores were negatively associated with CBAT use with small to medium negative effect sizes (d range, −0.69 to −0.18). Notably, the emotional expectations domain scores were significantly and negatively associated with CBAT use with a medium effect size (d = −0.69 [−1.34 to −0.05]). Overall, it seems that as patients' expectations for improvements in their emotional well-being after implantation increased, the likelihood of CBAT use decreased. No other preimplantation aided speech recognition or patient-reported outcomes were significantly associated with CBAT use.

Multivariable Analysis

A multivariable regression was performed to determine the association of CIQOL expectation scores and patient-reported technology use while controlling for common demographic covariables. Variables included age, sex, regular use of technology, household income, and preimplant CIQOL-Expectations emotional domain scores. Variables were included based on clinical interest (age and sex) or $p < 0.10$ on bivariate analysis. Results are detailed in Table 3. After accounting for potential confounders, the use of CBAT was not significantly associated with any patient-related factors.

DISCUSSION

Auditory training is often recommended to adult CI users by audiologists and otologists to help CI users adapt to their new sensory input and improve auditory function (14). Evidence on the effectiveness on specifics forms of auditory training in real-world settings is scarce (9,12,15,16). However, preliminary data in new adult CI recipients have linked CBAT use to improved speech recognition and patient-reported outcomes at 3 months after implantation, with multivariable analysis showing a greater increase in CNC words scores of 33% and CIQOL global scores of 11 points out of 100, in patients who used CBAT compared with those who did not (16). Despite this apparent effectiveness, only a small percentage of CI patients take advantage of these widely available resources—only 28.2% of patients used CBAT in this study and 33.3% in a recent study at our institution (9,16). As such, it is important to identify those factors that might enhance or inhibit CBAT use. In this prospective natural study, we examined the association of patient-related factors and CBAT use in new adult CI recipients and found that no single patient-related variable was a significant predictor of CBAT use.

Comparing these results with the literature, we found limited data on rates of CBAT use in adult CI patients, with most reports primarily focused on results of laboratory efficacy rather than real-world effectiveness (9,12,15). Even more scarce is literature on factors that might influence or predict CBAT use. Harris et al. (9) reported on auditory training use by a cohort of 23 experienced CI users. Similar to our results, only a small percentage of patients, roughly one-third, used CBAT. The study by Harris et al. used thematic analysis of open-set questionnaires and interviews to identify central themes related to postimplantation use of auditory training. Although the results did not directly identify any specific factors associated with increased use of CBAT, themes of strong social support and appropriate expectations about the amount of work needed after implantation were reported to be related to higher performing CI patients who often used auditory training, such as CBAT. Because this exploratory pilot study incorporated a qualitative research design, it did not examine associations between specific patient-reported factors, as in the current study, nor did it focus specifically on CBAT use.

Although no factor in the current study was associated with CBAT use while controlling for confounders, we noted a significant positive association in univariate analysis between regular use of technology and CBAT use. This is likely related to the fact that CBAT requires a computer, smartphone, or tablet and some basic understanding of these technologies. Related to that, only one CBAT user in the current study did not report regular technology use. However, while controlling for confounding demographics and lifestyle factors, this association was no longer significant. In addition, we noted that CBAT users did not use their CIs for more average hours than nonusers. Thus, different factors may motivate patients to increase their daily use of their CIs than to use CBAT resources, even though both practices are routinely recommended by clinicians.

We also noted a significant negative association between emotional domain CIQOL-Expectations scores and CBAT use, in addition to a nonsignificant negative association between CBAT use and all other CIQOL-Expectations domain and global scores. This trend generally indicates that patients with lower expectations for improvements in their functional abilities after implantation are more likely to use CBAT. This is similar to the results of the thematic analysis by Harris et al. (9) showing the importance of setting appropriate expectations about the amount of work needed after implantation to encourage use of auditory training. It is possible that patients with lower pre-CI expectations about their post-CI abilities will be more likely to pursue any possible interventions, such as CBAT, to maximize their success. Related to this, McRackan et al. (27) showed that lower pre-CI expectations were associated with higher postimplantation CIQOL scores, and Harris et al. (9) showed that patients with both higher postimplantation QOL and word recognition scores often cited a stronger preimplantation understanding of outcome expectations. This highlights the importance of appropriate preimplantation counseling to set realistic goals and expectations related to benefits of CBAT use and the work involved. However, once controlling for confounding demographics and lifestyle factors, the relationship between expectations and CBAT use was no longer significant; as such, expectations cannot be used as an independent predictor of CBAT use.

The results of the current study did not identify any patient-related factors that predicted CBAT use. Given data suggesting benefits of CBAT for CI outcomes related to speech recognition and QOL (9,12,15,16), it is important for clinicians to give special attention to CBAT use in counseling of CI candidates and encourage all patients to pursue CBAT after implantation, while also providing realistic expectations about the work involved. Moreover, if possible, it may also be important to determine reasons for patients' reluctance or barriers to CBAT use, such as limited access to technology or lack of social support. More research with longer follow-up time points is needed to determine the extent to which CBAT use changes with more CI experience. In addition, research is needed to identify specific facilitators and barriers to CBAT use at the patient, clinician, and system levels with the goal of more effectively guiding patients' postactivation behaviors and improved CI outcomes.

Strengths of this study lie in its prospective design, allowing for analysis of a broad range of patient-specific factors. The use of validated CI-specific quality of life instruments (CIQOL-35 Profile and CIQOL-Expectations) to supplement speech recognition measures provides patient-reported real-world functionality and expectations.

The primary limitation of this study is reliance on patient self-report on their CBAT use, which may be unreliable. As a result, patient responses may not perfectly reflect their true CBAT use, and patient reports of time spent on CBAT could not be verified. As such, we could not make meaningful observations on factors that might influence the amount of time spent on CBAT. An additional limitation is the relatively small sample size. Although 117 patients were included in this study, only 33 used CBAT. As such, the current study may have been underpowered to detect true significant relationships. Additionally, the small CBAT cohort precluded any statistical analysis on specific types of CBAT or usage habits.

CONCLUSIONS

No independent patient factors were associated with CBAT use in the first 3 months after activation. Therefore, discussions with all patients on the availability of CBAT and its potential benefits are warranted. Also, given the evidence of limited use of CBAT and the association of CBAT with improved outcomes, future studies are needed to investigate facilitators and barriers to CBAT use to maximize its use after cochlear implantation.

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