Determinants of Cochlear Implant Satisfaction and Decisional Regret in Adult Cochlear Implant Users

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Objective: Determine associations expected and actual cochlear implant (CI) outcomes, decisional regret, and satisfaction in experienced adult CI users.
Study Design: Cross-sectional cohort study.
Setting: Tertiary medical center.
Patients: Thirty-nine adult CI users meeting traditional bilateral hearing loss indications with ≥12 months CI experience.
Interventions/Main Outcome Measures: Patients completed the validated Satisfaction with Amplification in Daily Living and Decisional Regret instruments. Pre- and post-CI outcomes (CI Quality of Life [CIQOL]-Expectations; CIQOL-35 Profile; CNC words, AzBio Sentences) were obtained from a prospectively maintained clinical database.
Results: Using established cutoff scores, 29% of patients reported a substantial degree of post-CI decisional regret. For each CIQOL domain, patients without decisional regret obtained post-CI outcome scores closer to pre-CI expectations compared with patients with decisional regret (d = 0.34 to 0.91); similar results were observed with higher CI user satisfaction (d = 0.17–0.83). Notably, the degree of pre- to post-CI improvement in CNC or AzBio scores did not differ between patients with and without decisional regret or with lower and higher satisfaction. Finally, greater pre-/postimprovement in CIQOL-35 Profile domain scores demonstrated far stronger associations with lower decisional regret and higher satisfaction than changes in speech recognition scores.
Conclusions: Patients with better alignment of their pre-CI expectations and post-CI outcomes and greater pre-/post-CIQOL improvement had lower decisional regret and higher satisfaction. This emphasizes the importance of evidence-based pre-CI counseling regarding real-world CI benefits and caution against assuming that improvements in speech recognition are related to patient satisfaction.
Key Words: Adult—Cochlear implant—Decisional regret—Patient-reported outcome measures—Quality of life—Satisfaction.

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INTRODUCTION

Globally, it is estimated that over 430 million people have hearing loss that requires rehabilitation (1). For adults with moderate to profound sensorineural hearing loss who no longer obtain benefit from hearing aids, cochlear implants (CIs) have been the standard of care since their Food and Drug Administration approval in 1984 (2). As of December 2019, approximately 736,900 registered devices have been implanted worldwide, and an analysis of the US Medicare population found a nearly 125% increase in the number of new CIs between 2007 and 2016 (3,4). Over this same period, the pre-CI evaluation process has remained relatively consistent, involving a battery of tests including audiometry, speech recognition testing, medical examination, and imaging (5). A substantial component of the pre-CI evaluation process is typically focused on counseling, which is intended to inform potential CI recipients about the possible benefits they may experience if they elect to proceed with implantation, with the benefits primarily focused on improved speech recognition.

For adults with postlingual hearing loss, the vast majority experience improvements in speech recognition scores compared with their pre-CI scores, with improvements of 35% or more common for both words in quiet and sentences in quiet testing (6,7). Similarly, functional abilities assessed with patient-reported outcome measures (PROMs) have consistently shown significant improvement for patients across multiple domains compared with pre-CI abilities (8–10). Despite these clear pre- to post-CI improvements in both speech recognition ability and broad-based functional abilities for most users, clinicians lack insight into the determinants of CI user satisfaction as well as what factors govern patients' overall attitude toward their decision to undergo implantation. This presents the opportunity to better understand possible determinants of both patient levels of satisfaction with their device as well as their decision to undergo implantation. There is a general assumption that improvement in speech recognition

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scores directly correlates with self-reported patient satisfaction, but this association is not unequivocally supported. Determinants of CI patient satisfaction as well as potential regret surrounding the decision to undergo implantation are likely complex. Therefore, further examination of factors that individuals consider when assessing their decision to undergo implantation as well as their level of satisfaction with their devices is needed. For example, alignment between a patient's expectations of what an intervention will accomplish and the actual realized outcome has been previously associated with the degree of satisfaction after a medical procedure (11), so the inclusion of expectations in the current study is warranted.

Fortunately, validated instruments have been developed to investigate these topics. The Satisfaction with Amplification in Daily Living (SADL) is a well-established PROM used to measure satisfaction in patients who use hearing devices (12,13). Although initially developed for use in hearing aid users, it has since been validated for assessing satisfaction in CI users (14). The Decisional Regret Scale (DRS) is a validated instrument used to measure "distress or remorse after a healthcare decision." (15) It has been used in many other fields of medicine (16–18) but has not been routinely applied to CI patients. Using these instruments, the purpose of the current study was to determine levels of device satisfaction and decisional regret in patients who elected to undergo cochlear implantation. Next, we sought to determine the association between CI user outcomes and patient satisfaction and attitude surrounding their decision to undergo implantation. Together, the overall goal of this study was to identify factors that could be addressed during counseling in the pre-CI evaluation process to enhance satisfaction and minimize decisional regret in adult CI users.

MATERIALS AND METHODS

Patients

The present study was approved by our institutional review board. Patients were retrospectively identified from our institution's prospectively maintained database for adults undergoing cochlear implantation. Inclusion criteria were history of postlingual onset of hearing loss, age of 18 years or greater at time of implantation, completed pre-CI Quality of Life (CIQOL)-Expectations (19), pre-CI and 6 months post-CI (or greater) CIQOL-35 Profile (20), and pre-CI and 6-month post-CI (or greater) speech recognition scores. Exclusion criteria were patients undergoing CI revision surgery, patients with known retro-cochlear pathology on the implanted side, patients with single-sided deafness, and patients with a documented cognitive disorder.

For patients meeting inclusion/exclusion criteria, the following data were extracted from our institution's CI database: age at time of implantation, sex, race (self-identified), listening modality (bilateral CI, CI + hearing aid, or CI without hearing aid), preoperative CIQOL-Expectation scores, CIQOL-35 scores, and pre-/post-CI speech recognition scores. Speech recognition scores were measured using consonant-nucleus-consonant word test (CNC word) and AzBio sentences in quiet (AzBio Quiet, Arizona State University, Tempe, Arizona, USA) (21,22). These are henceforth referred to as word recognition and sentence recognition scores. Further information about testing methods can be found in the Supplemental Digital Content, http://links.lww.com/MAO/B753.

Data Collection

Ultimately, 128 patients met our inclusion/exclusion criteria and were sent SADL and DRS questionnaires via an individualized REDCap invitation. SADL is a 15-item validated instrument that measures a patient's level of satisfaction on a 1–7 Likert scale for four domains: Positive Effect, Service and Cost, Negative Features, and Personal Image, which are summed to provide a Global score. A score of 1 is considered complete dissatisfaction with a hearing device, whereas a 7 represents maximal satisfaction. For the current study, we used the version of the SADL validated for use in CI patients (14). We specifically looked at the Positive Effect domain in our analysis because it focuses on aspects of the CI experience such as improved communication ability, improved localization, and natural sound quality, which are elements most focused on functionality (12). We also considered the Global score, which takes into account components such as cost burden and aesthetic appeal for a broader view of what factors can be attributed to an overall higher level of satisfaction. For the three additional subdomains, individual analyses were not performed because the items they include are less pertinent to functional CI outcomes. For our study, a score of 5 or below was considered low for both domains, which was determined from the overall average of the study cohort as standardized cutoffs have not been set.

The DRS is a 5-item validated instrument that measures a patient's level of regret in decision-making, which in this case is the decision to undergo cochlear implantation. It includes prompts that the user responds to using a standard 5-point Likert scale where 1 represents "strongly agree" and 5 represents "strongly disagree." DRS outcomes are scored on a 0–100 scale, with 0 corresponding with no regret and 100 maximal regret. A score of 20 or higher was considered "significant regret" based on previously reported data for other types of patient cohorts (15). This instrument was selected because it provides a means to analyze which patient-related outcomes may be correlated with a CI user's level of regret with their decision to undergo implantation.

Statistical Analysis

Full description of statistical methods can be found in the Supplemental Digital Content, http://links.lww.com/MAO/B753. All data analyses were performed with SPSS 28.0.1.0 (IBM Corp., Armonk, NY). Outcome measures included pre-CI/post-CI implantation word and sentence recognition, CIQOL-Expectations, pre-/postimplantation CIQOL-35, SADL, and DRS. Cohen's *d* effect sizes and 95% confidence intervals were calculated for all analyses. An effect size of 0.2 to 0.49 is considered small, 0.5 to 0.79 medium, 0.8 to 1.29 large, and above 1.3 very large

(23). Pearson correlation coefficients were also calculated to determine associations between two variables. A coefficient of 0.0 to 0.09 is considered negligible, 0.1 to 0.39 weak, 0.4 to 0.69 moderate, 0.7 to 0.89 strong, and 0.9 to 1.0 very strong (24).

RESULTS

A total of 38 patients completed both questionnaires, with one additional patient completing only SADL (N = 39). The average age of respondents was 71.4 years (SD, 12.0; range, 31–93) and included 20 male patients (51.3%). Devices from all three CI companies were represented in the cohort. Characteristics of the patient population are summarized in Table 1. Prior hearing aid use refers to patients who used hearing aids immediately before receiving a CI.

Satisfaction with Amplification in Daily Living

For the Positive Effect domain of the SADL, 15 patients (39%) met the criterion for low Positive Effect (3.1 ± 1.0) and 24 met the criterion for high Positive Effect (6.1 ± 0.6; Table 2). We examined the relationship between Positive Effect and the degree to which CI users' post-CI functional abilities met their pre-CI expectations, as measured using the CIQOL-35 and the CIQOL-Expectations instruments. A negative value was obtained if the CIQOL-Expectations score was larger than the CIQOL-35 score, which represents a patient's post-CI functional abilities not meeting their pre-CI expectations. Looking at the relationship between Positive Effect and how closely CIQOL-35 outcomes met patient expectations, all domains and the Global score demonstrated at least a medium effect size (d = 0.53–0.63) with the environment domain demonstrating a large effect size (d = 0.83). This demonstrates that, overall, patients had higher levels of perceived Positive Effect when their pre-CI expectations more closely met their post-CI outcomes. In addition, a consistent pattern of increased Positive Effect was observed for all domains and the Global score when examining the change in pre-CI to post-CI CIQOL-35 scores, which represents improvement in real-world functional ability, although none of the effect sizes were large (d = 0.22–0.63). In contrast, pre-CI to post-CI change in word or sentence recognition scores was not associated with higher Positive Effect (d = 0.01–0.07).

TABLE 1. *Demographics of patients included in analysis*

Patient Demographics (N = 39)	Mean (SD)
Age (yr)	71.4 (12.0)
	N (%)
Sex	
Male	20 (51.3)
Female	19 (48.7)
Race	
White	39 (100)
Ethnicity	
Not Hispanic or Latinx	39 (100)
Prior hearing aid use	
Yes	27 (69.2)
No	12 (30.8)
Duration of CI use (yr)	2.2 (1.0)
Hearing device configuration	
Bilateral CI	8 (20.5)
Single CI, contralateral hearing aid	8 (20.5)
Single CI, no contralateral device	23 (59.0)

SD indicates standard deviation; CI, cochlear implant.

For the SADL Global score, 17 patients (44%) met the criterion for low satisfaction (3.9 ± 0.7) and 22 patients (56%) met the criterion for high satisfaction (5.8 ± 0.5). When looking at the SADL Global score and alignment of pre-CI CIQOL-Expectations and post-CI CIQOL-35 scores, no domain demonstrated more than a small effect size (d = 0.08–0.49). Regarding change from pre-CI to post-CI CIQOL-35 scores, representing functional improvement, all domains exhibited a pattern of an increased CIQOL score and increased satisfaction, but only the environment domain had a large effect size (d = 0.83). All other domains and global score demonstrated medium effect (d = 0.51–0.70), and the emotional domain demonstrated small effect (d = 0.22). No association was found between pre-CI to post-CI change in either the word or sentence recognition score and the SADL Global score (d = 0.11–0.12). There was a small effect size observed between older age and an increased SADL Global score (d = 0.29), suggesting older patients are more satisfied with their CIs than younger patients; this association was not observed for SADL Positive Effect.

Decisional Regret

Overall, 11 patients (29%) met the criteria for significant decisional regret (mean score, 42.7 ± 23.4) and 27 patients (71%) did not (2.2 ± 4.2; Table 3). When examining the relationship between decisional regret and the degree to which CI users' post-CI functional abilities met their pre-CI expectations, CI users had lower decisional regret when their post-CI functional abilities were better aligned with their pre-CI expectations. This effect was large for communication and environment domains and the global measure (d = 0.81–0.91) and medium for the emotional and listening effort domains (d = 0.56–0.75). In addition, greater pre-CI to post-CI improvement in all CIQOL-35 domains demonstrated more consistent and stronger associations with less decisional regret. The entertainment domain demonstrated a large effect size (d = 0.87), whereas the communication, environment, and social domains as well as the global score all had medium effect sizes (d = 0.64–0.79). In contrast, when comparing word and sentence recognition outcomes between the groups with and without significant decisional regret, there was a trend for increased improvement from pre-CI to post-CI scores to be associated with less decisional regret for both word recognition (d = 0.31) and sentence recognition (d = 0.28); however, this effect was very small and nonsignificant. From a demographic standpoint, older age was found to have a small effect on less decisional regret (d = 0.29), meaning older individuals tended to have less regret about their decision to undergo implantation than younger individuals.

Overall, a weak correlation (r = −0.14) was found between decisional regret and satisfaction, meaning as level of decisional regret increased, there was a small correlative decrease

TABLE 2. *Patient change in pre-CI/post-CI speech recognition scores, change in pre-CI/post-CI CIQOL-35 scores, and difference in pre-CI CIQOL-Expectations and 6 months or greater post-CI CIQOL-35 scores stratified by high and low Positive Effect and Global Score of SADL*

	High SADL Positive Effect (N = 24)	Low SADL Positive Effect (N = 15)	Effect Size (95% Confidence Interval)	High SADL Global (N = 22)	Low SADL Global (N = 17)	Effect Size (95% Confidence Interval)
Age (yr)	71.9 (SD, 9.8)	70.5 (SD, 15.1)	0.12 (−0.53–0.77)	72.9 (SD, 8.9)	69.4 (SD, 15.1)	0.29 (−0.34–0.93)
ΔCNC words	49.3 (26.7)	49.5 (15.1)	0.01 (−0.72–0.74)	50.5 (24.1)	47.9 (22.6)	0.11 (−0.59–0.81)
ΔAzBio sentences quiet	61.2 (28.6)	63.3 (30.7)	0.07 (−0.65–0.79)	60.4 (29.5)	64.1 (28.9)	0.12 (−0.56–0.81)
ΔCIQOL-35 domain and global scores						
Communication	20.0 (23.7)	7.2 (13.2)	0.61 (−0.06–1.29)	21.4 (23.8)	7.0 (13.7)	0.70 (0.04–1.37)
Emotional	20.8 (25.9)	9.5 (18.8)	0.47 (−0.19–1.14)	21.1 (26.4)	10.4 (19.0)	0.45 (−0.20–1.10)
Entertainment	23.3 (29.64)	10.4 (23.8)	0.46 (−0.21–1.13)	24.8 (29.0)	9.9 (25.0)	0.53 (−0.11–1.20)
Environment	27.9 (25.9)	11.0 (29.2)	0.61 (−0.06–1.29)	31.1 (26.8)	8.9 (25.1)	**0.83 (0.17–1.52)**
Listening Effort	19.3 (22.1)	8.2 (18.1)	0.52 (−0.14–1.20)	19.7 (22.6)	9.0 (17.9)	0.51 (−0.14–1.17)
Social	18.9 (29.7)	13.1 (14.7)	0.22 (−0.43–0.89)	22.4 (28.4)	8.8 (17.9)	0.54 (−0.11–1.21)
Global	17.3 (19.5)	6.0 (13.3)	0.63 (−0.03–1.32)	18.1 (19.7)	6.3 (13.5)	0.66 (0.01–1.34)
Difference in CIQOL-Expectations and Post-CI CIQOL-35 domain and global scores						
Communication	−8.6 (22.6)	−21.1 (13.8)	0.63 (−0.09–1.39)	−11.5 (22.8)	−16.8 (16.5)	0.26 (−0.46–0.98)
Emotional	4.6 (20.4)	−8.4 (20.6)	0.62 (−0.11–1.37)	1.9 (19.6)	−4.4 (23.2)	0.28 (−0.43–1.01)
Entertainment	−3.9 (29.6)	−22.4 (28.6)	0.62 (−0.11–1.37)	−8.6 (29.1)	−15.6 (32.0)	0.22 (−0.49–0.95)
Environment	−4.0 (23.8)	−26.3 (28.9)	**0.83 (0.09–1.60)**	−7.2 (24.1)	−21.1 (31.1)	0.49 (−0.23–1.23)
Listening Effort	−12.6 (22.3)	−24.4 (15.6)	0.58 (−0.15–1.33)	−16.9 (21.4)	−18.5 (19.7)	0.08 (−0.64–0.80)
Social	3.1 (23.6)	−8.8 (19.7)	0.53 (−0.20–1.27)	1.5 (24.8)	−6.1 (19.5)	0.33 (−0.39–1.06)
Global	−5.3 (18.8)	−15.9 (13.9)	0.61 (−0.12–1.36)	−8.4 (19.6)	−11.5 (15.0)	0.17 (−0.54–0.89)

Bold represents a large effect size. Δ indicates pre- to post-CI change; CNC words, consonant-nucleus-consonant word scores; AzBio, sentence recognition in quiet; SADL, Satisfaction with Amplification in Daily Life.

TABLE 3. *Patient pre-CI/post-CI change in speech recognition scores, change in pre-CI/post-CI CIQOL-35 scores, and difference in CIQOL-Expectations and 6 months or greater post-CI CIQOL-35 scores stratified by high and low Decisional Regret*

	Minimal to No Decisional Regret (N = 27)	Significant Decisional Regret(N = 11)	Effect Size (*d*) (95% Confidence Interval)
Age mean (SD)	72.3 (9.4)	68.7 (17.4)	0.29 (−0.41–1.00)
ΔCNC words	51.0 (22.8)	43.5 (27.3)	0.31 (−0.50–1.12)
ΔAzBio sentences quiet	65.3 (28.6)	57.3 (25.3)	0.28 (−0.48–1.06)
ΔCIQOL-35 domain and global scores			
Communication	19.3 (23.1)	5.0 (12.9)	0.68 (−0.04–1.42)
Emotional	20.0 (24.8)	8.4 (21.8)	0.47 (−0.24–1.20)
Entertainment	24.8 (25.3)	1.3 (28.6)	**0.87 (0.15–1.63)**
Environment	27.0 (27.6)	6.9 (24.9)	0.73 (0.01–1.47)
Listening Effort	18.5 (22.9)	8.9 (16.5)	0.44 (−0.27–1.17)
Social	21.1 (27.17)	4.9 (17.2)	0.64 (−0.07–1.38)
Global	17.1 (19.2)	3.2 (12.0)	0.79 (0.06–1.53)
Difference in CIQOL-Expectations and Post-CI CIQOL-35 domain and global scores			
Communication	−8.2 (21.5)	−25.5 (9.5)	**0.91 (0.13–1.72)**
Emotional	3.0 (20.4)	−9.01 (21.59)	0.56 (−0.20–1.34)
Entertainment	−7.3 (29.6)	−21.0 (30.7)	0.44 (−0.32–1.22)
Environment	−6.1 (25.1)	−28.9 (28.4)	**0.85 (0.07–1.65)**
Listening Effort	−12.7 (22.7)	−27.6 (8.9)	0.75 (−0.02–1.55)
Social	0.6 (19.4)	−7.3 (27.9)	0.34 (−0.42–1.11)
Global	−5.3 (18.3)	−19.0 (11.4)	**0.81 (0.04–1.62)**

Bold represents a large effect size. Δ indicates pre- to post-CI change; CNC words, consonant-nucleus-consonant word scores; AzBio, sentence recognition in quiet.

in level of satisfaction. Table 4 presents an overview of each included variable and its overall effect on decisional regret, Global satisfaction, and Positive Effect. Fig. 1 shows the difference between pre-CI expectations and post-CI outcomes in those with decisional regret and those without, as well as the change in speech recognition scores for each group. In Fig. 1A, CIQOL domains that demonstrated the greatest effect sizes are displayed to demonstrate alignment between expectations and realized outcomes in those with and without decisional regret. A score closer to 0 means greater alignment. Fig. 1B shows the change in speech recognition scores for those with and without decisional regret. A more positive score means greater improvement. As seen, patients with decisional regret had far worse alignment between pre-CI expectations and post-CI outcomes than those without decisional regret, but similar speech recognition improvement. In addition, the waterfall plots in Fig. 2 show these results at the individual level. For each CI user, the relationship between their satisfaction and decisional regret are plotted against the difference between their pre-CI CIQOL-Expectations and post-CI CIQOL-35 communication domain score, pre-CI to post-CI change in CIQOL-35 communication domain score, and pre-CI to post-CI change in word and sentence recognition scores. Red bars signify patients who experienced significant decisional regret or low satisfaction.

DISCUSSION

In the current study, improvements in CIQOL-35 scores from pre-CI to post-CI, which represent real-world functional ability improvements across multiple domains, were consistently associated with more satisfaction and less decisional regret. This trend demonstrates the importance of measuring functional abilities, beyond speech recognition, through validated PROMs as a key component of monitoring post-CI outcomes and providing pre-CI counseling. Prior evidence has demonstrated that most CI users experience improvement in speech recognition after implantation (6,7); however, evidence describing the association between pre-/post-CI improvement in speech recognition scores and patient satisfaction is limited. In the current study, there was a minimal effect from either word or sentence recognition improvement on CI satisfaction. There was a small, nonsignificant effect from improvement in speech recognition and lower decisional regret. These minimal effects of pre-CI to post-CI improvement in speech recognition on satisfaction and decisional regret are especially compelling given most CI research and clinical care up to this point has focused on speech recognition scores as the primary metric of CI outcome success (25). Although clinicians generally look to improvements in speech recognition as a measure of CI success, the results of the current experiment strongly suggest a need to broaden metrics used when defining CI success.

Moreover, the results for speech recognition scores in the current study support multiple previously published studies that show absent to weak associations between CI users' speech recognition ability and self-reported functional abilities (8,9). In addition, the results from external outcome measures in this study (SADL and DRS), which focus on different outcome constructs, provide additional support of these previously demonstrated weak associations (8). These findings further support 1) a critical reexamination of our current paradigm of utilizing only speech recognition scores as a measure of success in CI users (25–27) and 2) the integration of PROMs into routine clinical CI care, in pre-CI counseling, and as primary outcome measures in CI research protocols and clinical trials. These views are

based on our results that demonstrated that CIQOL outcomes are more strongly associated with patient satisfaction and decisional regret than speech recognition scores. Examination of individual CI user data in Fig. 2 provides specific examples of these relationships. For example, patients 25 and 26 both had large pre-/post-CI improvements in their CIQOL-35 communication scores but modest improvements in their word recognition scores. Yet, both patients had positive satisfaction and minimal decision regret. In contrast, patients 4, 5, and 6 had low levels of satisfaction and significant decisional regret despite large pre-/post-CI improvements in word recognition scores. Notably, these patients had much smaller pre-/post-CI improvements in CIQOL-35 communication scores and had pre-CI expectations that exceeded their actual post-CI abilities.

The current study also demonstrated that a smaller difference between patients' pre-CI CIQOL-Expectations and post-CI CIQOL-35 scores, representing greater congruency between expected and actual post-CI functional abilities, was associated with higher satisfaction and lower decisional regret. These results suggest a need to improve the pre-CI evaluation to include evidence-based counseling so that potential CI users can develop realistic expectations of their post-CI functional abilities. Although precise predictions of post-CI patient outcomes are not currently possible, modifications of patient expectations by providers during the pre-CI counseling process can be attempted to ensure expectations are realistic and achievable (10,28), with the long-term goal of improved patient satisfaction and reduced regret with the decision to undergo cochlear implantation. Both audiologists and surgeons should assess how reasonable a patient's expectations are, based on available normative data (28), and subsequently provide resources such as the opportunity to speak with a current CI user so patients have a better understanding of their post-CI outcomes. Moreover, these results are supported by previously published research that CI users prefer their potential outcomes be discussed using real-world examples, represented by validated clinical vignettes associated with specific levels of improvement in each domain of the CIQOL-35, as opposed to speech recognition scores (10,29,30).

The role of preintervention expectations has been studied for a variety of medical interventions, and in general, fulfillment of patient expectations is associated with better health outcomes and greater levels of satisfaction. Thompson and Suñol (11) formulated a theoretical framework for the relationship between patient expectations and subsequent level of satisfaction. In general, the more congruent a patient's expectations are with their lived experience, the greater the patient satisfaction with treatment. This notion is supported by results of the current study, which demonstrated increased satisfaction and lower decisional regret when pre-CI expectations aligned more closely with post-CI CIQOL outcomes. The converse is true as well, with lower levels of satisfaction and higher decisional regret associated with larger gaps between pre-CI expectations and post-CI outcomes. Such results could ultimately lead to worse CI outcomes, as dissatisfied patients are more likely to not adhere to prescribed treatment regimens and not attend scheduled follow-up appointments (31).

Future studies should focus on the change in patient expectations over the CI evaluation period to determine if this is a modifiable target for future interventions. Moreover, understanding of the factors associated with higher patient expectations, and therefore, those at risk of having greater discrepancy between expectations and outcomes, will allow clinicians to identify patients with the most unrealistic expectations and appropriately counsel these individuals. Finally, future evidence-based counseling tools that use the CIQOL framework have the potential to enhance the pre-CI process and decrease decisional regret and increase overall satisfaction.

Limitations

Although the CIQOL instruments were developed to provide a more comprehensive assessment of CI users'

TABLE 4. *Summarized effects of difference in CIQOL-Expectations and 6 months or greater post-CI CIQOL-35 scores, change in pre-CI/post-CI CIQOL-35 scores, and change in pre-CI/post-CI speech recognition scores on Positive Effect of SADL, Global Score of SADL, and Decisional Regret*

	SADL Positive Effect	SADL Global	Decisional Regret
Difference between CIQOL-Expectations and post-CI CIQOL-35 scores			
Communication Domain	++	+	+++
Emotional Domain	++	+	++
Entertainment Domain	++	+	+
Environment Domain	+++	+	+++
Listening Domain	++	−	++
Social Domain	++	+	+
Global Score	++	−	+++
Change between pre-CI and post-CI CIQOL-35 scores			
Communication Domain	++	++	++
Emotional Domain	+	+	+
Entertainment Domain	+	++	+++
Environment Domain	++	+++	++
Listening Domain	++	++	+
Social Domain	+	++	++
Global Score	++	++	++
Change between pre-CI and post-CI word recognition scores			
CNC word	−	−	+
AzBio Quiet	−	−	+

Groups are compared as previously defined. − indicates minimal effect size; +, small effect size; ++, medium effect size; +++, large effect size.

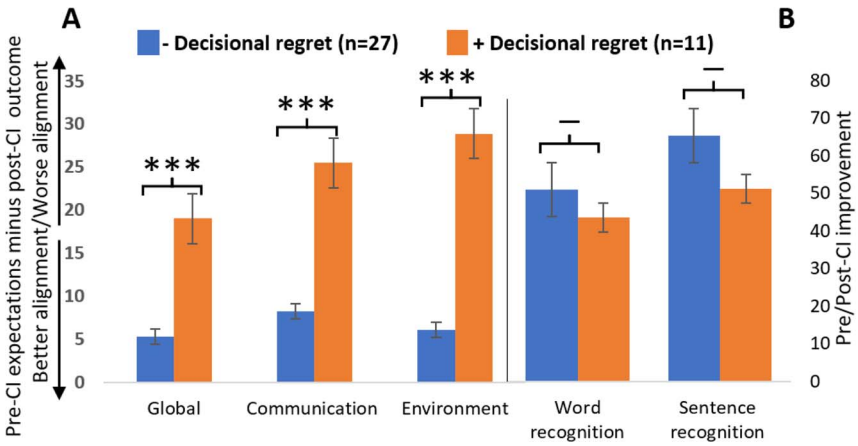

FIG. 1. *A (left)*, The difference in pre-CI expectations and post-CI outcomes for domains of the CIQOL that demonstrated the greatest effect sizes, for patients with decisional regret (+ decisional regret, *orange*) and those without (– decisional regret, *blue*). Lower score indicates better alignment between expectations and realized outcomes. *B (right)*, Pre- to post-CI change in speech recognition scores for patients with decisional regret (+ decisional regret, *orange*) and those without (– decisional regret, *blue*).

expectations and functional abilities, no PROM is ever going to be fully representative of every individual's values. The use of the CIQOL instruments provides a generalized framework to improve pre-CI counseling, but they should be used in conjunction with personalized discussions to ensure the topics that each CI user values most are discussed. In addition, the current study was limited by the number of patients with post-CI outcomes 6 months or greater as well as responses to both the SADL and DRS, although this set of data provided estimates of effect sizes that can be used for sample size calculations in future prospective studies. Larger sample sizes will allow for confirmation of the suggested trends in the current study and will likely be more representative of the national sample of adult CI users in terms of race, age, sex, and outcomes. Another limitation was the homogeneity of the cohort regarding race and ethnicity. Unfortunately, there are minimal published nationwide data on adult cochlear implantation rates by race and ethnicity (32), and published data consistently demonstrate non-White and Latinx patients are vastly underrepresented in rates of cochlear implantation when compared with US census data (33–36). One final limitation is the fact that not all patients who completed SADL and DRS had also completed pre- and post-CI speech recognition scores, further reducing the power of this component of the analysis. Moreover, the inclusion of outcomes for sentence recognition in noise could provide a more comprehensive understanding of the role of speech recognition in more ecologically valid environments in patient satisfaction and decisional regret. It is also important to note that the current sample includes only

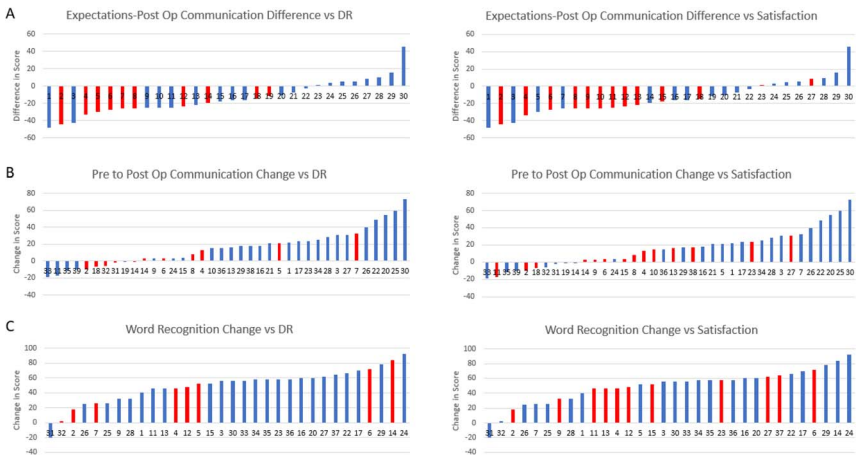

FIG. 2. *A*, Difference in pre-CI expectations and post-CI CIQOL communication scores. *B*, Change in pre-CI to post-CI CIQOL communication score. *C*, Change in pre-CI to post-CI word recognition score. *Red bars* identify patients with either high decisional regret or low satisfaction. *Blue bars* identify patients either with low decisional regret or higher satisfaction. Patient identification numbers are in order of change in pre-CI CIQOL-Expectations communication domain score compared with post-CI CIQOL-35 communication domain score (*A*) and then stay consistent throughout the remainder of the *panels* (*B, C*). A negative score in *panel A* signifies post-CI functional outcomes did not meet pre-CI expectations, a negative score in *panel B* signifies the communication score of the CIQOL-35 was worse post-CI than pre-CI, and a negative score in *panel C* signifies post-CI word recognition score was worse than pre-CI.

patients who elected to get a CI, and future analysis may warrant measuring the decisional regret of patients who made the decision not to proceed with a CI.

CONCLUSION

This study provides preliminary evidence that greater congruence between pre-CI expectations and post-CI functional outcomes of CI users is significantly associated with both higher satisfaction and less regret about the decision to undergo implantation. However, speech recognition scores had minimal effect on levels of CI user satisfaction and decisional regret. These results further demonstrate the importance of clearly addressing patient expectations during pre-CI evidence-based counseling with the goal of informed decision-making. In addition, a larger improvement in CIQOL-35 scores from pre-CI to post-CI, representative of greater functional improvement, is associated with higher satisfaction and less decisional regret. These results challenge the current standard of focusing solely on speech recognition scores for assessing successful CI outcomes (25). Changes in clinical and research protocols, with an increased focus on PROMs in addition to speech recognition, have the potential to improve CI-related outcomes through the application of a patient-centered and shared decision-making approach to CI care.

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