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A cost-utility analysis of adult group audiologic rehabilitation: Are the benefits worth the cost?

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Abstract—The purpose of this study was to conduct a cost-utility analysis comparing two treatment approaches: (1) hearing aid use alone (HA) and (2) hearing aid use with short-term group postfitting audiologic rehabilitation (HA + AR). A total of 105 veterans, 67 males and 38 females, with at least a mild sensorineural hearing loss participated in this study. The SF-36V was administered to each participant before and after treatment. This instrument measures both mental component summary (MCS) scales and physical component summary (PCS) scales of quality of life. As a whole, the participants exhibited a statistically significant improvement in mean MCS scores pre- to postintervention, with average improvements of 1.4 and 3.0 points for the HA and HA + AR groups, respectively. With the use of the MCS scores, the results of a cost-utility analysis revealed that HA treatment cost $60.00 per quality-adjusted life year (QALY) gained, while HA + AR cost only $31.91 per QALY gained, making HA + AR the more cost-effective treatment.

Key words: *costs and cost analysis, hearing aids, hearing loss (sensorineural), outcome assessment, quality of life, rehabilitation of hearing impaired.*

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INTRODUCTION

Of the approximately 34 million Americans who are over the age of 65, 9 million currently are experiencing age-related hearing loss [1,2]. This prevalence makes hearing loss one of the most significant but correctable chronic health conditions among the elderly. In addition, recent data confirm that age-related hearing loss can negatively impact an individual's overall functioning and health-related quality of life [2].

The primary intervention for age-related hearing loss is the use of hearing aids. As reviewed by Weinstein, research has established many beneficial outcomes from hearing aid use [3]. For example, in a group of adults with hearing impairment, Crandall found significant decreases in functional and psychosocial health difficulties after only 3 months of hearing aid use [4]. Similarly, in a randomized clinical trial with older veterans, Mulrow et al. found that 3 months of monaural hearing aid use was effective in reversing the social, emotional, and communication dysfunction that accompany hearing loss [5]. In addition, hearing aid intervention was found to be quite cost-effective. Cost-effectiveness was determined by calculating cost of treatment for hearing-related quality-adjusted life years (QALYs) gained, a concept derived from health economics. QALY is used to place the cost of an intervention protocol in relationship to a universal standard that allows comparison between divergent procedures and interventions and accounts for the varying quality of life that can result from certain interventions.

QALY attempts to measure more than years of life gained or lost; it attempts to adjust for health-related quality-of-life changes too. Using outcome data from the administration of the Hearing Handicap Inventory for the Elderly (HHIE) and an estimated total cost of $1000 for providing one hearing aid, Mulrow et al. projected that the cost of intervention was equivalent to only $200 for each hearing-related QALY gained [5,6].

Although hearing aid use appears to be a relatively inexpensive means of improving hearing and the associated quality of life in older persons with hearing loss, only one-fourth of those individuals who could benefit from amplification are projected to actually use hearing aids [7]. Furthermore, recent reports indicate that only an estimated 54 percent of individuals are satisfied with the outcomes of hearing aid use [8].

These findings suggest a need to incorporate methods for improving hearing aid use and satisfaction within total healthcare management for older individuals. Indeed Bridges and Bentler, in examining the relationship between successful hearing aid use and a sense of well-being in older adults, found that successful hearing aid users reported higher levels of life satisfaction than unsuccessful hearing aid users [9]. Based on these results, Bridges and Bentler suggested that hearing aid use should be viewed as a necessary part of good healthcare rather than as an elective.

Hearing aid use and outcome satisfaction can be improved through the inclusion of post-hearing aid fitting audiologic rehabilitation (AR) programs [10,11]. Typically, AR programs are designed to provide a "support group" atmosphere in which older adults with hearing loss and their families can discuss information about hearing loss, hearing aids, and effective communication strategies [12]. The effectiveness of AR programs is supported through a recent large-scale study of new hearing aid users by Northern and Beyer [13]. They found that the percentage of patients who returned their hearing aids because of dissatisfaction was 3 percent among 3,080 individuals who attended at least one postfitting AR group session. In contrast, the hearing aid return rate among the 7,187 individuals who did not attend any postfitting sessions was 9 percent.

In addition to decreasing return rates, participation in postfitting AR programs is known to be efficacious in addressing the adjustment and communication needs of many hearing aid users, as well as increasing hearing aid use and satisfaction [10,11,14,15]. Given these findings, it seems disappointing that postfitting AR programs are reportedly not a standard component of hearing healthcare management [16,17].

Although the reasons for lack of routine inclusion of postfitting AR programs are not completely known and despite Northern and Beyer's data, many audiologists may possibly perceive that they lack the time and financial resources to offer such programs [13,16]. Weinstein pointed out that a need existed for data demonstrating that the clinical benefits obtained through a postfitting AR program outweighed the financial burdens associated with its provision [18]. While the hearing aid return rate data of Northern and Beyer may be interpreted to support AR programs from a business perspective, the cost of services relative to the clinical outcomes was not determined [13]. Thus, the need for cost-effectiveness analyses of postfitting group AR programs remains.

Three techniques are available to compare treatment alternatives and examine the issue of costs versus benefits. These techniques include cost-effectiveness analysis (CEA), cost-benefit analysis (CBA), and cost-utility analysis (CUA) [19]. In the economic evaluation of healthcare services, the costs of treatment, both direct and indirect, are compared to the measured outcomes resulting from the treatment. The three methods (CEA, CBA, and CUA) differ in the way outcomes are evaluated. CEAs measure outcomes as specific increments of clinical effects, such as percent correct for word recognition tasks when various hearing aids are compared. CBAs measure outcome by comparing the money spent against the money gained or saved. Thus, costs and benefits must be assigned in monetary units. In CUAs, the costs of treatment are measured in dollars and then standardized by the life expectancy adjusted for quality of life, which is measured by a valid health-related quality-of-life instrument [20]. Thus, all three techniques facilitate resource allocation decision making:

- CBA compares return on investment when the outcomes are diverse.
- CEA captures the return on investment relationship when outcomes are similar or alike.
- CUA captures the cost invested for the expected life span of the outcome, accounting for quality-of-life differences between the alternative interventions using a health-related quality-of-life assessment tool.

Although the Audiology and Speech-Language Pathology Service at the Department of Veterans Affairs (VA) Medical Center in Bay Pines, Florida, routinely

offered post-hearing aid fitting AR programs, we believed the cost-effectiveness of this intervention approach needed to be examined. In this era of shrinking healthcare resources and increased accountability, it is important to demonstrate that any service provided is economically, as well as clinically, sound. Thus, the purpose of this work was to conduct a CUA comparing two treatment approaches: (1) hearing aid use alone (HA) and (2) hearing aid use along with short-term group postfitting AR (HA + AR).

METHODS

Participants

A total of 105 veterans, 67 males and 38 females, with acquired hearing loss who were eligible to receive hearing aids through outpatient services participated in this study. Participants exhibited at least a mild sensorineural hearing loss (four-frequency pure tone average (PTA) of ≥30 dB hearing level (HL) or more at 500, 1,000, 2,000, and 4,000 Hz) in the better ear and had no previous experience with hearing aid use. All participants passed the Mini-Mental State Exam and exhibited no more than mild depression on the Beck Depression Inventory [21,22]. Participants had no known neurological, neuromuscular, psychiatric, or visual disorders that could impact on their ability to independently use a hearing aid.

Participants were randomly assigned to receive intervention through either HA (n = 52) or HA + AR (n = 53) program. There were 36 men and 16 women in the HA group with a mean age of 73.0 years (SD [standard deviation] = 7.6) and 31 men and 22 women in the HA + AR group with a mean age of 74.5 years (SD = 6.9). Mean four-frequency PTAs for the HA participants were 34.5 dB HL (SD = 12.3) and 32.1 dB HL (SD = 12.0) for the right and left ears, respectively. For the HA + AR participants, these averages were 35.1 dB HL (SD = 11.8) and 35.7 dB HL (SD = 11.5) for right and left ears, respectively. Independent t-tests revealed no statistically significant differences in ages or hearing thresholds in either ear between the intervention groups.

The participants were fitted binaurally with Starkey programmable hearing aids at no cost to the participants. The style and circuits for each instrument were selected on the basis of individual patient need as determined by the examining audiologist. Hearing aid fitting was conducted in accordance with currently accepted clinical practice [23]. Specifically, verification of hearing aid performance was conducted throughout the experimental protocol with the use of real ear instrumentation (Audioscan® RM500 Real Ear Measurement and Hearing Aid Test System, Software Version 2.6). Insertion gain was initially adjusted to achieve a best-fit response in accordance with the NAL-R formula [24]. We calculated closeness of fit using the root-mean-square (rms) difference value described by Byrne [25]. Insertion gain was modified at subsequent visits so that we could maximize perceived speech quality and/or speech intelligibility in accordance with current clinical practice.

Mean root-mean-square differences for the HA participants were 5.6 dB SPL (SD = 2.6) and 5.5 dB SPL (SD = 3.2) for right and left hearing aids, respectively. For the HA + AR participants, the mean values calculated for the right and left hearing aids were 5.8 dB SPL (SD = 2.6) and 5.6 dB SPL (SD = 2.6), respectively. We determined relative equivalency of aided listening ability by examining the speech index as calculated by the Audioscan® system software [26]. The mean speech indices for the HA group were 0.84 (SD = 0.12) and 0.83 (SD = 0.16) for the right and left ears, respectively. For the HA + AR group, the mean speech indices were 0.88 (SD = 0.12) and 0.84 (SD = 0.11) for the right and left ears, respectively. Independent t-tests revealed no statistically significant differences between the groups for either root-mean-square differences or speech indices in either ear.

Quality-of-Life Outcome Measure

The Medical Outcomes Study 36-Item Short-Form Health Survey modified for the veteran population (SF-36V) was used [27,28]. The SF-36V is a multi-item scale that measures eight general health concepts in two major domains: mental and physical functioning. A mental component summary (MCS) scale score is calculated through the responses provided in the health concept areas of vitality, social functioning, role limitations because of emotional problems, and mental health. Responses provided for the health concepts of physical functioning, role limitations because of physical health problems, bodily pain, and general health perceptions are used in the calculation of a physical component summary (PCS) scale score.

Procedure

Data were collected over a 2-year period from May 1999 through December 2001 in 10-week experimental

cycles. We targeted a recruitment of 16 participants for each cycle, with the exception of the final experimental cycle that consisted of 20 participants. All participants were evaluated approximately 3 to 4 weeks preceding the start of a 4-week group AR program; approximately half of whom were randomly assigned to the HA group and half to HA + AR group. While the goal was to have eight participants in each HA + AR group and eight in each HA group within an experimental cycle, the range was five to nine because some dropped out and others (because of scheduling conflicts) were added to groups that already had eight participants. Significant others were also encouraged to attend the AR sessions.

At the first appointment, audiologic evaluations were conducted and the Mini-Mental State Exam was administered. Veterans meeting inclusion and exclusion criteria who were willing to participate completed the SF-36V on the same day that their hearing aids were ordered. Two weeks after the initial visits, all participants were fitted with their hearing aids and provided with a routine hearing aid orientation. Thus, all hearing aids were dispensed within a 2-week period immediately preceding the 4-week AR program. Participants who had been randomly assigned to HA + AR intervention then returned once a week, for 4 weeks, for a 2-hour group meeting. Briefly, the first session provided a general overview of the hearing process and developing communication strategies. The second session focused primarily on improving communication in adverse listening conditions, including a focus on the use of visual cues and listening strategies. The third session included information and practice in the areas of anticipatory strategies, repair strategy usage, and environmental management. The final session focused on telephone communication strategies, the use of assistive technology, and community resources for the hard of hearing. Within a 2-week period following the end of the group AR program, all participants were again seen at the clinic and administered the SF-36V.

RESULTS

To calculate the cost utility of the two treatment approaches, we needed to determine the change in quality of life as a function of intervention for each participant, as well as the cost of all services involved in each treatment approach. We present these results first, followed by the results of the CUA.

Change in Quality of Life: SF-36V Outcomes

Based on review of previous studies [3], hearing aid use, with or without adjunctive AR therapy, was expected to result in a significant change in the mental domain (MCS scores) but have little to no effect on quality of life in the physical domain (PCS scores). **Figures 1** and **2** show the means and standard errors for pre- and postintervention MCS and PCS scores as a function of treatment by HA and HA + AR, respectively. As expected, inspection of **Figure 1** reveals an improvement in mean MCS scores (mean change = 1.4 points) for the HA participants. Somewhat surprising was the finding of a small decrement in mean PCS scores (mean change = –1.6 points). **Figure 2** indicates that participants in the HA + AR treatment group also showed a positive change in MCS scores pre- versus posttreatment (mean change = 3.0 points). There was, however, essentially no change in PCS scores (mean change = 0.3 points) for the HA + AR participants.

To further examine the predictions, we subjected the SF-36V data to a repeated measures analyses of variance (ANOVA), with one between-subjects variable (treatment group) and two within-subject variables (test time and component scale score). Only two significant findings were found. First, there was a significant main effect of component scale score [$F(1, 103) = 123.5$; $p = 0.00$, MSE = 89.9],

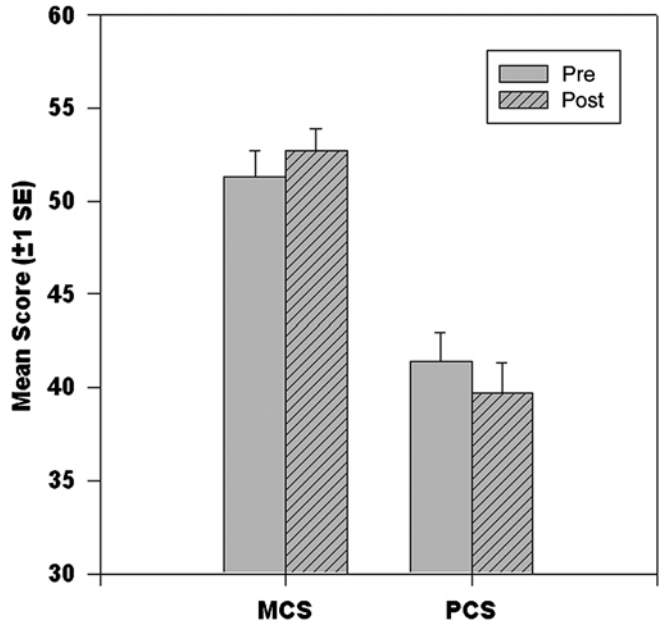

Figure 1.
Means and standard errors (SEs) for pre- versus postintervention SF-36V physical component summary (PCS) and mental component summary (MCS) scale scores for the HA treatment group.

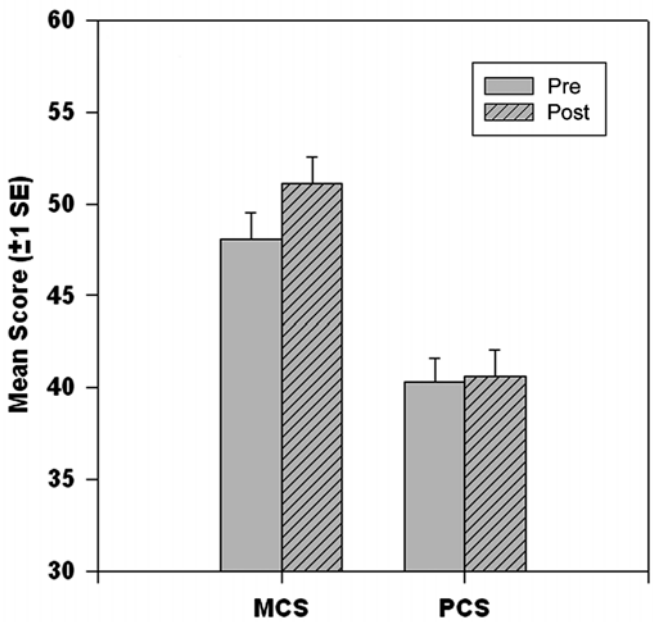

Figure 2.
Means and standard errors (SEs) for pre- versus postintervention SF-36V physical component summary (PCS) and mental component summary (MCS) scale scores for the HA + AR treatment group.

with the mean MCS score equal to 50.7 points and the mean PCS score equal to 40.5 points. More important, however, was the significant interaction between test time and component scale score [$F(91, 103) = 6.32$; $p = 0.01$, MSE = 32.3]. Results of Tukey HSD post hoc testing revealed that the mean posttreatment MCS score (51.9 points) was statistically higher than the mean pretreatment MCS score (49.7 points), yielding a mean improvement of 2.2 points. There was not a statistically significant difference, however, between mean pretreatment PCS (40.9 points) and mean posttreatment PCS (40.2) scores. Thus, these data supported the prediction that the use of hearing aids (with or without adjunctive AR therapy) would result in significant improvements in quality of life in the mental health domain. Although the improvement in mean MCS scores for those in the HA + AR group (mean change = 3.0 points) was more than twice that of the mean change for the HA participants (mean change = 1.4 points), the ANOVA failed to reveal any statistically significant differential treatment effects. While a lack of finding statistical significance may at first appear somewhat disappointing, it is important to remember that statistical significance only tells us about the reliability of our results and not necessarily about their practical or clinical importance [29]. One approach to examining practical importance would be to determine, as is done here, the cost utility of each treatment.

Cost of Services

We conducted cost analyses for billable procedures that were a part of each treatment approach and are detailed in **Table 1**. For each procedure, dollar costs included labor (audiologist, receptionist, clerk), supplies and materials (insert earphones, real-ear tubes, hearing aids, etc.), equipment (computer, audiometer, maintenance, etc.), and other (i.e., administration, building maintenance, etc.). The costs for AR included the additional transportation expenses incurred by the AR participants. The average distance traveled by these participants was 20.3 miles round-trip which, at $0.35 per mile, added $28.48 for the four sessions. As **Table 1** shows, the total cost for HA + AR was approximately $62.70 more than for HA.

Cost-Utility Analysis

We calculated cost utility for each treatment approach using the formula

$$\text{Cost Utility} = C/[\Sigma(L^*\Delta M)]/n \ ,$$

where C = the cost of the treatment approach per person taken from **Table 1**, L = life expectancy from gender-specific actuarial tables [30], ΔM = change score on SF-36V mental component summary scale, and n = the number of patients receiving the treatment. The results revealed that HA treatment cost $60.00 per QALY gained, while HA + AR cost only $31.91 per QALY gained, making it the more cost-effective treatment.

DISCUSSION

The findings of this investigation represent the first known evidence that hearing aid use, with or without adjunctive AR, yields significantly positive results on the MCS scale of the SF-36V—a widely used, generic quality-of-life measure. The finding that a change score of 2.2 points on the MCS scale was statistically significant is in keeping with results reported in 24 studies reviewed by Ware and Kosinski [31]. In longitudinal studies examining MCS change scores as a function of a variety of treatments for different disorders, all differences greater than 2 points reached statistical significance. A change score

Table 1.
Cost-analyses data for billable hearing aid dispensing procedures. Figures indicate cost per person.

Procedure	HA + AR	HA Alone
Audiological Assessment	$ 64.01	$ 64.01
Hearing Aid Evaluation	$ 941.65*	$ 941.65*
Hearing Aid Orientation	$ 26.11	$ 26.11
Postfitting Follow-up	$ 24.96	$ 24.96
Aural Rehabilitation	$ 62.70†	$ 00.00
Total	$1,119.43	$1,056.73

HA = hearing aid alone
HA + AR = hearing aid use with short-term group postfitting audiologic rehabilitation
*Includes the cost of binaural digitally programmable analog hearing instruments.
†Calculating the cost was done by multiplying the cost per session ($68.44) by the total number of sessions (4), dividing by the average number of patients per session (8), and adding the total travel costs over the four sessions ($28.48).

of 2.2 points would place the improvement found with audiological intervention between change scores reported for those patients receiving treatment for lower back pain therapy whose mean MCS scale score increased an average of 1.3 points and those patients receiving heart valve replacement whose mean MCS scale score increased by 3.2 points [32,33].

As expected, the PCS scores were insensitive to the effects of amplification. The questions in the physical domain on the SF-36V relate to pain and such activities as lifting, bending, walking, climbing stairs, etc. The questions associated with the MCS, on the other hand, address feelings of nervousness, cheerfulness, levels of energy, fatigue, anxiety, depression, etc. Not a single question, however, specifically addressed hearing loss or, for that matter, any communication function. The finding that audiologic intervention had a significant effect on the MCS scale clearly highlights the importance of improved hearing on these participants' quality of life and overall mental health through audiological intervention.

While we were not able to demonstrate a statistically significant difference in MCS improvement as a function of type of treatment, the mean HA + AR change score was more than twice that of the mean HA change score. One possible reason for not finding a statistically significant differential treatment effect may be related to the issue of power. Typically, main effects are stronger and thus easier to detect than complex interaction effects [29]. Although the results of the current study were consistent with change scores reported for the treatment for several other chronic conditions [31], the range of mean change scores observed for the component scale scores as a function of type of treatment was relatively small in magnitude (0.3 to 3.0 points). In the present study, the sample size (n = 105) provided sufficient power for detecting the main effect of test time but may have been too small to detect a three-way interaction between test time, type of treatment, and component scale score. Indeed, Crandall's lack of finding any improvement in the SF-36 among hearing aid users was likely to the small number of subjects (n = 30) in his study [4]. Because the primary problem of hearing loss, audibility, is usually satisfactorily resolved with hearing aids, the other quality-of-life consequences of the impairment are minimally impacted, by comparison, with hearing instruments.

Why might we expect the addition of AR to yield a better outcome on the MCS scale than the provision of hearing aids alone? It could be argued that the socialization among the participants over four sessions may make them more accepting of their impairment and the content of the sessions may make them more accepting of their limitations. In addition, the opportunity for research staff to attend to hearing aid-related problems among the participants in the HA + AR group more frequently than those in the HA group might influence outcomes. A conclusion that group AR positively impacts on the emotional consequences of hearing impairment is consistent with previous research that demonstrated significantly greater improvements in HHIE scores following HA + AR as compared with HA, but only on the "emotional" subscale [14]. The emotional subscale of the HHIE addresses issues such as anger and frustration. No difference was found between the two groups on the "social" subscale of the HHIE, which focuses on communication performance in specific situations (e.g., television, church). It should be recalled that the four-session AR program focused on counseling and adjusting to hearing

instruments and their limitations as opposed to formal communication training (i.e., speech reading and auditory training).

Given the apparent relative equivalence of HA and HA + AR on a generic quality-of-life measure, a comparison of the cost-effectiveness of each treatment option assumed particular importance. Differences in the mental health domain as a function of treatment were used to determine if the additional costs associated with providing a postfitting AR program were justified in terms of outcomes. The model chosen to determine if the outcome justified the costs was a CUA. The results of the CUA suggested that providing hearing aids alone yielded a cost per QALY gained of $60.00. Adding the AR component improved the outcome and reduced the cost per QALY gained to only $31.91. This difference of $28.09 in cost per QALY gained between the two treatment groups seems quite substantial when considering the potential cumulative impact across the VA system. In fiscal year (FY) 2001, almost 155,000 hearing aid orders costing nearly $81,000,000 were placed.

The method of economic analysis used here, cost utility, is often preferable when conducting health-related quality-of-life research, because it allows economic comparisons of various health interventions (e.g., hip prosthesis, cardiac pacemaker, hearing aid) against each other. CUAs require the use of a generic health-related quality-of-life measure, such as the MOS SF-36, because its questions are purposely general, without targeting any specific health condition. While the audiologic literature has repeatedly demonstrated the positive impact of hearing aids and AR, the outcome measures used for these studies have been disease-specific (e.g., HHIE, Abbreviated Profile of Hearing Aid Benefit (APHAB), Communication Profile of Hearing Impairment (CPHI)) [6,34,35]. Even studies that purport to examine the impact of hearing aids on quality of life use questionnaires that are clearly targeted to hearing loss [36]. As such, it is difficult to compare how audiologic intervention compares with other healthcare intervention in impacting quality of life. The data obtained in the present study are shown in **Table 2**, along with the costs per QALY gained for several common medical procedures [37–40]. While we did not adjust the data obtained in previous studies for inflation, a comparison of the present results to those obtained in earlier studies clearly demonstrates that audiological intervention is extremely cost-effective.

Table 2.
Cost per QALY gained for different healthcare interventions.

Technology	Cost/QALY
Coronary angioplasty	$11,485 [37]
Implantable defibrillator	$29,200 [38]
Knee replacement	$49,700 [39]
Cochlear implant	$15,928 [40]
HA alone	$60
HA + AR	$32

HA = hearing aid alone
HA + AR = hearing aid use with short-term group postfitting audiologic rehabilitation
QALY = quality-adjusted life year

Before conclusions are drawn from this study, one should note that several potential direct and indirect benefits of a postfitting AR program were not examined as part of this investigation and should be considered for future study. These included reduced visits to the clinic for hearing aid modifications and for reduced returns and reorders because of patient dissatisfaction. In addition, it is not clear at this time whether changes in the AR model incorporated in this study would yield differences in the results; that is, could we have achieved the same outcome at even a lower cost by reducing the number of sessions, or might a change in content with more formal communication training over the same number of sessions have yielded better MCS scores?

A possible limitation of this study's findings is its generalization to the nonveteran population. The retail value of hearing aids is considerably higher than the VA expenses used to calculate cost utility. While this cost difference will naturally increase the cost of services for nonveterans, it will do so equally for those receiving hearing aids alone and for those receiving hearing aids and undergoing a postfitting AR program. As the costs associated with providing AR are primarily labor- and transportation-related, the difference in the AR-related costs to veterans as compared to nonveterans should be minimal. Recall that one of the largest for-profit audiology networks doubles the hearing aid trial period at no additional cost if the patient completes a postfitting AR program, suggesting that the for-profit sector recognizes the value of postfitting AR for their paying patients [13].

Perhaps a more important limitation is the lack of patient-specific cost data. Such information would allow the CEA and CUA findings to be expressed as point estimates with confidence intervals. Future research that will

examine the cost of audiologic services should incorporate both group and patient-specific analyses.

Although not finding a statistically significant differential treatment effect for the HA + AR participants was somewhat disappointing, we are encouraged that both treatment options improved our patients' overall perception of their quality of life on a widely used generic quality-of-life instrument and did so quite cost-effectively. Future research that will examine generic outcome measures that include questions specific to hearing and communication and/or include larger groups of participants may help to clarify whether or not the addition of AR can result in statistically significant treatment differences.

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