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By

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(ABSTRACT)

The aim of this study was to measure the effects of audiologic intervention on self-perceived quality of life in the elderly hearing-impaired population. The tested hypothesis was that hearing aid use would result in improved quality of life as measured by utilities. In this study, utilities were obtained using the U-Titer II, an interactive software program designed to measure an individual's health state preference or *utility*. This study also examined the issue of *numeracy*, which is described as an understanding of basic probability, and its effect with an individual's ability to accurately complete utilities.

Data from 54 individuals fit with hearing aids in this randomized, controlled, pre-test/post-test experimental design study were analyzed. The participants completed the U-Titer II, a test of numeracy and the International Outcome Inventory for hearing Aids (IOI-HA). Three utility approaches were used in this study: Time Trade-Off (TTO), Standard Gamble (SG) and Rating Scale (RS). With each of the utility approaches, disease-specific (e.g., deafness vs. perfect hearing) and generic (death vs. perfect health) anchors were incorporated. Several research questions were posed to examine the sensitivity of utilities to hearing aid intervention.

Question 1: Can the effects of hearing aid intervention be determined with a utility approach? Statistically significant differences between pre- and post-intervention utility scores were measured with disease-specific and generic anchors for only the TTO and RS approaches. These findings suggest that hearing aid intervention outcomes can be measured using either the TTO or RS utility approaches.

Question 2: Is numeracy ability a factor in the usefulness of a utility approach for assessing the effects of hearing aid intervention? Statistical analysis showed that mean utility scores changed very little as a function of numeracy ability. These findings suggest that numeracy ability does not appear to affect utility scores.

Question 3: What, if any, are the relationships between hearing aid benefit as measured by a utility approach and hearing aid benefit as measured by the IOI-HA? Spearman Rho correlations were conducted on the benefit data obtained from the two self-report measures (IOI-HA and utilities). The major findings from these analyses determined that the IOI-HA total scores were significantly correlated with utility outcomes as measured by TTO generic, TTO disease-specific, and RS disease-specific anchors. In general, correlations between the measures were higher with the disease-specific anchors than the generic anchors. Also, none of the correlations between any IOI-HA outcome domains and utility change scores with generic anchors obtained with the RS scale were significant. For utilities measured with disease-specific anchors, significant correlations were found with two IOI-HA outcome domains (*benefit* and *satisfaction*) and utility change scores as measured by the TTO technique. When the RS technique was utilized, significant correlations were found for four of the seven outcome domains (*benefit, satisfaction, participation* and *impact of others*). Thus, if the IOI-HA is used as a measure against which to validate the utility approach as a measure of hearing aid outcomes, the measure with the most face validity is a RS method with disease-specific anchors. However, if one wished to compare hearing aid intervention to intervention in other areas of health care, these data support the use of a TTO approach.

Introduction

The use of hearing aids is the primary means of intervention for individuals with sensorineural hearing loss. Measuring the outcomes of hearing aid intervention has received increasing attention in recent years. This is primarily due to an increased emphasis on accountability for health care interventions (Abrams & Hnath Chisolm, 2000; Weinstein, 1997).

Traditionally, hearing aid outcomes are measured by using behavioral objective data, such as changes in functional gain and speech recognition performance. Functional gain is described as the difference between unaided and aided soundfield thresholds. Functional gain thresholds can be obtained for frequency specific stimuli or speech. Speech recognition performance is typically reported as a percentage that represents the number of words correctly perceived by an individual. When the use of hearing aids results in an improvement in these measures, benefit is said to have occurred.

Real-ear gain can also be used to verify hearing aid outcomes. Real-ear gain is described as the increase in the sound pressure level at the tympanic membrane provided by the hearing aid. This measure is calculated by placing a small probe microphone into the ear canal and measuring the sound pressure level with and without the hearing aid in place. Real-ear gain is used to show whether a particular hearing instrument is meeting the necessary prescribed amount of amplification for a given hearing loss and ear canal dynamics (Valente, 1996).

There are both advantages and disadvantages associated with the use of objective hearing aid outcome measures. For example, an advantage of objective measures is that they are not influenced by individual biases such as differences in life experiences. On the other hand, objective measures do not take into account the perspective of the individual with hearing loss. For example, pure tone thresholds displayed on an audiogram do not describe degree of handicap. For individuals with essentially identical audiograms, there is likely to be a difference in the amount and type of impact the hearing loss has on the individual’s quality of life. This correlation is supported by the results of several studies which clearly demonstrate a lack of a strong relationship between objective measures of hearing aid benefit and self-report, subjective measures (e.g., Bryne, 1992; Cox, Alexander & Gilmore, 1991; Dillon, James, & Ginis, 1997; Humes, Halling & Coughlin, 1996).

A variety of subjective hearing aid outcome measures have been developed, with perhaps the two most commonly used being the <u>Abbreviated Profile of Hearing Aid Benefit</u> (APHAB) (Cox, 1997) and the <u>Hearing Handicap Inventory for the Elderly</u> (HHIE) (Ventry & Weinstein, 1982). The APHAB is a hearing aid outcome measure that reflects the impact of hearing loss and subsequent hearing aid fitting on daily communication function. The HHIE, on the other hand is a measure of both the communication and psychosocial impact, created by hearing loss on the elderly population. Thus, the HHIE can be reconsidered as addressing restrictions in participation as well as activity limitations. Other subjective outcome measures which examine hearing aid use in the satisfaction domain include the <u>Satisfaction with Amplification in Daily Life</u> (SADL) (Cox & Alexander, 1997), the <u>ASHA Consumer Satisfaction Measure</u>, and the <u>Hearing Aid Users Questionnaire</u> (HAUQ) (Dillon, Birtles & Lovegrove, 1999). Although these measurements are an easy way to examine an individual's satisfaction with hearing aids, other factors may also influence satisfaction. These include issues such as cosmetic appeal, cost, clinician competency and the patient's expectations of the hearing aids (Abrams & Hnath Chisolm, 2000). Therefore, these extraneous factors may make satisfaction measures non-specific to the treatment employed.

As there are both advantages and disadvantages associated with objective hearing aid outcome measures, there are also advantages and disadvantages related to the subjective measure of hearing aid outcome. For example, since the APHAB, HHIE, SADL and other questionnaires measure hearing aid benefit in different domains, it would seem beneficial to complete several measures for each individual patient before and after treatment. This would be a lengthy process on the part of the patient and personnel needed to score the measures. However, there is no current evidence that supports the benefit of completing multiple outcome measures as opposed to a single measure (Dillon et al., 1997).

In addition to the time factor involved with completing subjective measures, those currently used often include questions that may not be relevant to individual's listening needs. For example, one item on the HHIE asks about hearing difficulty at religious services. This item may not be relevant to an individual who has no interest in attending such services. However, the individual must answer each question in order for the outcome measure to be scored correctly and for the results to be considered valid and reliable. This approach may lead to a score that does not accurately represent the individual's self-perceived benefit. Furthermore, many self-reported outcome measures utilize indistinct terms such as "benefit," which may be interpreted differently from person to person (Dillon et al., 1999).

To address the issue of time and relevancy of items, Dillon et al. (1997) and his colleagues at National Acoustic Laboratories (NAL) – Australia, developed the Client Oriented Scale of Improvement (COSI). The COSI is a measure of hearing aid benefit that utilizes patient participation to determine the particular listening situations where improved hearing ability is needed. Prior to treatment, the patient chooses up to five situations in which improved hearing would most improve their quality of life. Following treatment, the patient is asked to estimate how much the hearing aid has impacted the identified situations. One advantage of the COSI is that all items are relevant to the individual's hearing loss because the individual actually chooses the listening situations creating the greatest difficulty. Although the COSI may be useful in detecting individual hearing aid benefit, it may be a difficult to use as a measure of programmatic evaluation (Abrams & Hnath Chisolm, 2000). An evaluation of the services provided by an established health department, such as an audiology clinic, is important in the development of appropriate health care planning and policy making. It also provides information regarding the efficacy of treatment procedures used which is particularly important for third party payers and administrators.

Another client-centered outcome measure that addresses the concerns of individual relevancy is the Glasgow Hearing Aid Benefit Profile (GHABP) (Gatehouse, 1999). In addition to allowing the patient to identify specific situations, similar to the COSI, the GHABP contains 25 preset items that can be easily utilized in programmatic evaluation. Thus, one advantage of the GHABP is that it addresses a combination of pre-specified listening situations, as well as individual listening difficulties determined by the hearing impaired individual.

It is important to note that while the APHAB, HHIE, COSI and Glasgow measures are useful in determining the amount and type of hearing aid benefit they do not allow for the comparison of hearing aid intervention outcomes against other health conditions and their interventions. These comparisons are important for health care planning, accountability of treatment procedures and policy making (Abrams, 2000). To perform such comparisons, generic measures, as opposed to disease-specific measures, must be used (Crandall, 1998). Comparison studies involving hearing aid outcome measures and outcome measures of other diseases can be useful in demonstrating the need for further research funding and insurance coverage for hearing related disorders. Such funding will likely be more available if a high correlation is found between quality of life improvement and hearing aid intervention (Abrams & Hnath Chisolm, 2000).

One generic health-related outcome measure that has been used in audiologic research, is the Sickness Impact Profile (SIP) (Bergner, Bobbit, Cater & Gilson, 1981). The SIP is a behaviorally based measure of health status. It consists of 136 items concentrating on twelve areas of dysfunction. The SIP was developed to detect individual limitations due to illness, focusing on the detection of minimal changes in health status over time. This scale has been previously used in a study by Crandall (1998) to examine hearing aid benefit.

Another generic health-related outcome measure is the Short-Form Health Survey 36-Item (SF-36) (Ware & Sherbourne, 1992). The SF-36 is described as a 36-item scale which focuses on eight subscales. The subscales include: (a) physical functioning, (b) role limitations due to physical health problems, (c) bodily pain, (d) general health perceptions, (e) vitality, (f) social functioning, (g) role limitations due to emotional problems, and (h) mental health. This measure was developed to focus on general health, as opposed to specific age, disease, or treatment options.

The SIP and SF-36 examine general quality of life; however, the SF-36 may not be sensitive to hearing aid benefit. For example, Crandall (1998) found significant changes in the SIP measure and not in the SF-36 as a function of hearing aid use. Unfortunately, given its length, the SIP is a time consuming measure to administer. Another approach that allows for examining both disease-specific and generic quality of life and which may be useful in examining hearing aid outcomes is utility measurements (Feeney, Torrance, & Furlong, 1996).

A utility is a number ranging from 0-1 which provides a quantification of an individual's preference for particular health states or conditions, with 0 typically indicating the least favorable condition (e.g., death or total deafness) and 1 typically indicating the most favorable condition (e.g., perfect health or perfect hearing) (Nease, Kneelang, O'Connor, Sumner, Lumpkins, Shaw, Pryor, & Sox, 1995). A utility measure is also described as a preference based measure which displays the effects of an intervention or treatment protocol using interval-scale properties (Feeney et al., 1996; Feeney, Labelle & Torrance, 1990). There are several methods used in utility measurement, which include Standard Gamble (SG), Time Trade-Off (TTO), and Rating Scale (RS).

In the SG approach, the individual must decide between two given choices. An example of treatment effects may present the following choices: the person can choose to live, with certainty, in the health state of choice B, or they may choose a treatment with an uncertain outcome in choice A (Feeney, Labelle & Torrance, 1990). For example, this approach examines what chance of death, if any, the patient is willing to take in order to have perfect health or to live without a specific disease (e.g., hearing loss, heart disease, cancer, etc.). The SG technique prompts the patient to decide between living in their current state of health (including any related symptoms) or to continue living a life after receiving an imaginary treatment that will completely cure the symptoms, but carries a varying risk of death.

The TTO method of utility measurement also offers the individual two choices. One choice gives the subject x number of years to live in perfect health. The other choice offers $x + y$ number of years in a less desirable health state. The number of "perfect health" years is then decreased until the subject cannot choose between the shorter duration in perfect health and the longer duration in the less desirable health state (Feeney, Labelle & Torrance, 1990).

In the RS approach to measuring utility, a visual analog scale is incorporated to subjectively examine an individual's current health state. This approach uses a scale from 0 to 100 called a "feeling thermometer." In this method, the individual is asked to rank their health status on several dimensions, such as physical function, sensory function or special features of a disease or its treatment. The scores for each of these dimensions imply the ordinal position of each health state indicated (Feeney, Labelle & Torrance, 1990).

One reason the use of a utility measure may be beneficial is that it allows for the comparison among different health-related conditions and treatment effects within a single scoring method. This score can also individualized because situational items are not used. Therefore, a utility measure can be utilized to estimate changes in overall quality of life as the result of a treatment including, for example, audiologic intervention (Feeney, Labelle, & Torrance, 1990).

Recently, investigators examined utility measures to assess hearing aid benefit. For example, Piccirillo, Merritt, Valente, Littenberg, and Nease (1997) used a computer-based utility assessment tool, the U-Titer (Sumner, Nease & Littenberg, 1991) to measure preferences for hearing with and without amplification using the TTO approach. In this study, participants included 33 adult subjects receiving hearing aids for the first time. In this case the time trade-off measure was used to determine how much time a patient was willing to trade for perfect hearing over current hearing before and after amplification. That is, the TTO approach was used to determine if the difference between the utility scores before and after amplification represented the benefit of amplification. Results indicated that 84% of the subjects showed improvement and the difference (mean change = 0.13, SD = 0.22) in utility between pre- and post-issuance of amplification was statistically significant. Overall there was a greater than 10% change in utility measures which the investigators interpreted as “clinically significant.” These results suggested that utilities, as measured via a TTO approach, might be a valid way to measure hearing aid benefit and patient preferences for hearing.

In a more recent study, however, Yueh, Souza, McDowell, Deyo, Sarubbi, Loovis, Hendrik and Ramsey (1999) utilized the U-Titer II which incorporates the TTO, SG and RS approaches with disease-specific (deafness vs. perfect hearing) and generic (death vs. perfect health) anchors. This automated computer program was utilized to examine differential treatment effects for the use of (1) an assistive listening device (ALD); (2) standard hearing aids; (3) programmable hearing aids with directional microphone technology and, (4) no amplification which served as the control group. Outcomes were also measured through questionnaires (e.g., HHIE, APHAB, MOS-SF-36), patient diaries, and willingness of patients to pay for their devices if they were lost. The traditional disease-specific questionnaires (HHIE and APHAB), patient diaries and willingness-to-pay measures differentiated each treatment approach from the no treatment condition. However, no differential treatment effects were found with the use of generic measures (SF-36) or utilities with generic anchors. Furthermore, the TTO and SG approaches appeared to be insensitive to hearing intervention when both generic and disease-specific anchors were used. Only the RS approach utilizing disease-specific anchors showed significant change from pre- to post-intervention for the two hearing aid groups. This finding demonstrated a change in utility for the standard hearing aids (mean change = 0.24) and programmable hearing aids with directional microphone technology (mean change = 0.22) as compared to the control (mean change = 0.01) and ALD (mean change = -0.01) groups. The apparent lack of sensitivity of utility methods to hearing aid intervention led the authors to examine the content and knowledge needed to complete a utility measure. The authors believed that one possible explanation for the lack of consistency between the questionnaires and the TTO and RS utility approaches might be related to a lack of “numeracy”. Numeracy is the understanding of basic probability and numerical concepts, which is crucial for the understanding of risks and benefits (Schwartz, Woloshin, Black, & Welch, 1997).

Based on the conflicting results, between the Piccirillo et al. (1997) and Yueh et al. (1999) studies and given the importance of utilities in the health care arena, it appears that further research into the sensitivity of utility measures to hearing aid benefit is needed. Thus the present study was designed to address the following quesitons:

1. Can the effects of hearing aid intervention be determined with a utility approach

    a. regardless of health state anchors (e.g. generic vs. disease-specific)?
    b. regardless of utility measurement technique (e.g. TTO, SG, RS)?
    c. as a function of the interaction between health state and utility measurement technique utilized?

2. Is numeracy ability a factor in the usefulness of a utility approach for assessing the effects of hearing aid intervention?

3. What, if any, are the relationships between hearing aid benefit as measured by utility approach with generic and disease-specific anchors and hearing aid benefit as measured using a self report approach?

Methods

Participants

Data were collected and analyzed from 54 participants, 53 males and 1 female. The participants ranged in age from 40 to 86 years old, with a mean age of 72 years old. Individuals were selected from the Audiology Clinic at the VA Medical Center, Bay Pines, Florida. Random selection was accomplished by inviting any individual who met the selection criteria to be a part of the study until the appropriate number of participants was obtained. There was no exclusion based on gender or age.

Inclusion/exclusion criteria. The participants had general good mental and physical health as determined by the Mini-Mental State Exam (MMSE) (Appendix A) and case history, respectively. The MMSE was performed as a measure of cognitive impairment during the initial appointment. The MMSE is often used as a screening tool and consists of 30 questions or tasks of everyday knowledge. This test was administered to the subject by the researcher. A score of less than 24 on the MMSE indicates the presence of cognitive impairment. One potential subject obtained a score of less than 24 on the MMSE, and was therefore was excluded from the study.

All participants were eligible to receive hearing aids through the VA and were new hearing aid users. The selection criteria specified the range of acceptable hearing loss for inclusion as a bilateral, sloping, sensorineural hearing loss shown in Table 1.

Table 1

Range of Acceptable Hearing Loss Used for Inclusion

	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	6000 Hz	8000 Hz
Minimum value	10 dB	15 dB	20 dB	25 dB	40 dB	45 dB	45 dB
Maximum value	65 dB	65 dB	65 dB	75 dB	90 dB	100 dB	105 dB

Selection criteria did not discriminate further for hearing loss unless medical intervention was indicated based on the audiologic diagnosis. For example, an individual was not selected to participate in the study if retrocochlear, fluctuating hearing loss or middle ear disease was found to be present. Participants also had to be willing to participate in the study, sign an informed consent, and be able to read and comprehend the tasks of interest for the required questionnaires (IOI-HA, U-Titer II, and test of numeracy).

Subjective Measures

International Outcome Inventory for Hearing Aids (IOI-HA) (Appendix B). The IOI-HA (Cox & Alexander, 2001) is a seven-item questionnaire, which measures hearing aid benefit in seven unidirectional outcome domains. The seven outcome domains include: (a) use, (b) benefit, (c) residual limitations, (d) satisfaction, (e) participation, (f) impact of others, and (g) quality of life. In completing the IOI-HA, the participant is given five choices for each of the seven items. These choices are coded 1-5, where higher scores represent better outcomes. Each item is considered a single content domain; however, responses to the items can be added together to obtain an overall score. The IOI-HA was designed to measure aided performance only.

U-Titer II (Example in Appendix C). The U-Titer II (Sumner et al., 1991, as adapted by Yueh, 1999) is a Macintosh computer based program which is used to determine individual preference for a given intervention using any of three techniques; TTO, SG, and RS. Other versions of this program exist for use with other computer platforms, such as U-Titer/Java and U-Titer/internet. The U-Titer II program specifically examines overall quality of life and its relationship to more specific health related problems and interventions. Therefore, the U-Titer II utilizes patient preference to estimate changes in overall quality of life, as well as in a specific area of treatment. To assess treatment effects in the present study, the U-Titer II program was utilized to measure pre- and post-amplification utility scores. Utilities were completed with the subject and researcher sitting together during the instructional portion of the measure. The subject was also encouraged to ask questions regarding the measure at any time.

Test of Numeracy (Appendix D). Numeracy is a concept referring to a person's ability to understand fundamental ideas of probability and numerical theory (Schwartz et al., 1997). In a questionnaire designed by Schwartz et al. (1997) the subject is asked to answer three questions which in turn, reflect their knowledge of risks and benefits. The test is scored as the total number of correct answers to the three questions, with 0 being the lowest score and 3 being the highest score. The lower the score the less knowledge the person has on topics related to risks and benefits. Therefore, in theoretical terms, probability and numerical theory have less meaning for a subject scoring at the low end of the scale and more meaning for a subject scoring at the high end of the scale.

Procedures

Initial appointment. During the initial appointment, pure-tone audiometry, immittance testing, the Dichotic Digits (Broadbent, 1956) and the Quick SIN (Etymotic Research, 2001) tests via CD administration were performed and a case history was taken according to the standard evaluation approach utilized at the Bay Pines VA Audiology clinic. Audiometric and immittance testing was performed using Grason-Stadler, GSI-10 audiometers and GSI-33 middle ear analyzer systems respectively. The standard audiometric evaluation was performed in a sound treated booth (Tracoustics RS-255 double-walled acoustic enclosure) in accordance with applicable American National Standards Institute (ANSI) standards and clinical practice procedures. At the initial appointment, the hearing aids were selected and ordered on the basis of the audiologic evaluation, specific patient needs, and the predicted 2 cc full-on coupler gain responses. Each participants was fit binaurally with amplification. Clinicians were instructed to use their discretion in selecting any programmable hearing aid according to the patient's audiometric results and specific individual needs. Also, during this appointment, the U-Titer II, MMSE and test of numeracy (Appendix D) were completed and represented data for the unaided condition.

Second (fitting) appointment. The fitting appointment was scheduled approximately 3-6 weeks following the initial audiologic appointment. During the fitting appointment, verification of hearing aid performance was conducted using one of two real ear instrumentation devices, the Frye Electronics Fonix 6400 or 6500-CX systems. Real ear instruments calculate probe-microphone measurements, in sound pressure level, as a function of frequency. These measurements were used to verify that an individual was receiving the appropriate amount of gain from the hearing aid as reflected by a given target. This verification procedure was used throughout the experimental protocol. Initially, insertion gain was determined by matching a target, to achieve a "best-fit" response in accordance with the NAL-R (Bryne & Dillon, 1986) formula using a 65 dBSPL output from the sound source. Insertion gain was then adjusted to maximize self-perceived speech quality and/or speech intelligibility as articulated by the patient. The hearing aid(s) were programmed using the appropriate NOAH fitting software for programmable instruments via the Hi-Pro interface. The participants also received a comprehensive hearing aid orientation that covered care, hygiene, and operation of the hearing instrument(s).

Third appointment (hearing aid follow-up). This appointment was scheduled approximately eight weeks following the fitting appointment to allow for adjustment to amplification and acclimatization (Arlinger, Gatehouse, Bentler, Bryne, Cox, Dirks, Humes, Neuman, Ponton, Robinson, Silman, Summerfield, Turner, Tyler & Willott, 1996). Auditory acclimatization is a systematic change in auditory performance that occurs over time due to a change in the acoustic information available to the listener as a result of neural plasticity. During this appointment any hearing aid related problems were addressed. The IOI-HA and U-Titer II measures were also be administered at this appointment, and served as the data for the aided condition.

Results and Preliminary Discussion

The primary purpose of this study was to examine the sensitivity of three utility measurement approaches (TTO, SG, and RS) to hearing aid intervention using both generic and disease-specific anchors. In addition, the effect of numeracy on utility was examined. Finally, the relationship between hearing aid benefit as measured by utility approaches using generic and disease-specific anchors, and a disease-specific self report measure was examined.

To address the research questions, the pre- and post-intervention utility scores for each method (TTO, SG, and RS) and each health state (generic and specific) were subjected to a mixed model analysis of variance (ANOVA), with one between factor (numeracy) and three within-group factors: test time, measurement method, and health state. The results are shown in Table 2 and discussed in relation to the research questions posed.

Question 1: Can the effects of hearing aid intervention be determined with a utility approach?

The significant main effect of time is addressed in this question. The mean utility score, collapsed across methods and health states, pre- and post-hearing aid use was calculated and it was determined that the utility score improved from a mean of 0.8378 to a mean of 0.9211. This suggests that hearing aid intervention outcomes can be measured using a utility approach.

Question 1 summary: Statistically significant differences in mean utility score were found from pre- to post-intervention suggesting that the effects of hearing aid intervention can be determined with a utility approach.

Question 1a: Can the effects of hearing aid intervention be determined with a utility approach regardless of health state anchors?

The time and health states (T x S) interaction addressed the question of whether utility changes over time for generic health state and hearing health state as a function of hearing aid use. This interaction was found to be significant. Figure 1 shows the time and health state interaction for Time 1 (pre-intervention) and Time 2 (post-intervention).

Table 2

Analysis of Variance Summary Table for Examining Utility Scores as a Function of Numeracy (N), Time (T), Measure (M) and Health State (S)

Source	df	MS	F	P
Numeracy (N)	3	0.12	1.48	0.23
Error	50	0.08		
Time (T)	1	0.88	21.33	0.00
Error	50	0.04		
Measure (M)	2	0.94	24.64	0.00
Error	100	0.04		
State (S)	1	0.01	0.28	0.6
Error	50	0.02		
N x T	3	0.13	3.11	0.03
Error	50	0.04		
N x M	6	0.06	1.53	0.18
Error	100	0.04		
T x M	2	0.15	7.42	0.00
Error	100	0.02		
N x S	3	0.01	0.3	0.83
Error	50	0.02		
T x S	1	0.05	5.23	0.03
Error	50	0.01		
M x S	2	0.08	8.22	0.00
Error	100	0.01		
N x T x M	6	0.02	1.05	0.4
Error	100	0.02		
N x T x S	3	0.00	0.24	0.87
Error	50	0.01		
N x M x S	6	0.01	0.97	0.45
Error	100	0.01		
T x M x S	2	0.11	19.44	0.00
Error	100	0.01		
N x T x M x S	6	0.01	1.87	0.09
Error	100	0.01		

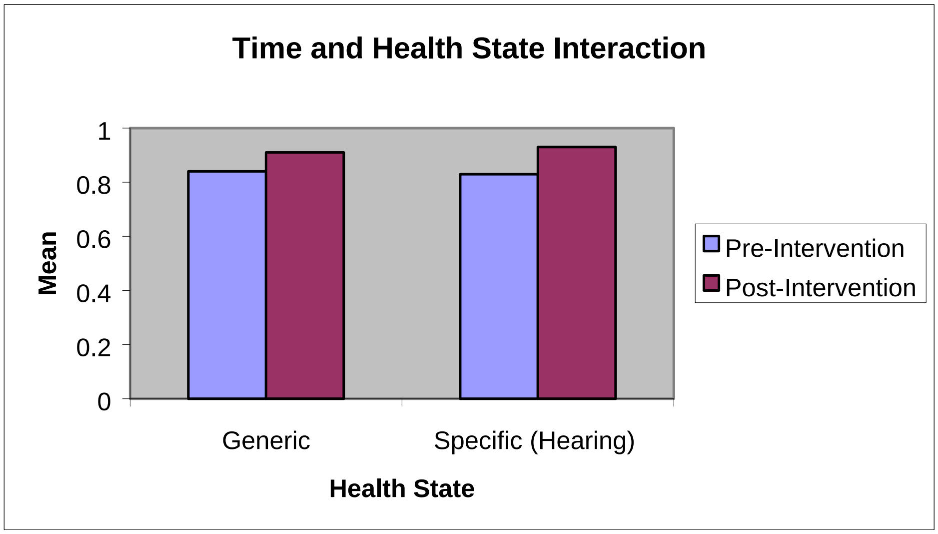

Figure 1. Mean utility changes over time for generic and hearing health states

Although the mean generic scores were higher than the mean disease-specific scores at both pre- and post-intervention, results of the Tukey post-hoc test indicated that neither differences between generic and specific scores at pre-intervention nor post-intervention testing were statistically significant. More important was the post-hoc finding that the increase in mean utility score from pre- to post-intervention was significant for both generic and hearing health states. Perhaps not surprising, the hearing health state score improvement was greater (approximately 10 points) than that of the generic health state score (approximately 6 points). Thus these results indicate that a utility approach can be used to assess the effects of hearing aid intervention with disease-specific or generic health anchors. This result is very encouraging as the improvement seen in generic utility measurement approaches confirms what many clinicians believe about the pervasive effects of hearing loss and the benefits of hearing aids for not only hearing ability but also for overall quality of life.

Question 1a summary: Statistically significant differences in mean utility score were found from pre- to post-intervention for both generic and disease-specific anchors suggesting that the effects of hearing aid intervention can be determined with a utility approach regardless of health state anchors.

Question 1b: Can the effects of hearing aid intervention be determined with a utility approach regardless of utility measurement technique?

The time and measurement method (T x M) interaction addresses the question of whether utility changes over time for each of the three methods of measuring utility (TTO, SG, and RS). Figure 2 shows the mean pre- and post-intervention scores for each of the three approaches. For the pre-intervention condition it can be seen that mean utilities were highest in measures using the SG approach, followed by the TTO and RS approaches. Indeed, post-hoc testing using the Tukey test revealed that the mean RS utility, pre-intervention, was significantly lower than the SG and TTO scores. The difference between SG and TTO, however, was not statistically significant. It is apparent that in the post-intervention condition the mean utilities were highest for the SG and TTO approaches followed by the RS approach. Again, post-hoc testing using the Tukey test showed the mean RS utility, post-intervention, was significantly lower than the SG and TTO scores. The difference between SG and TTO was also not statistically significant. The most important result of the post-hoc testing was that significant increases in utility were only found for two methods (RS and TTO). That is, the increase in utility from 0.92 to 0.95 as measured by the SG was not statistically significant. This finding is most likely due to the high scores obtained at pre-intervention. Essentially there was little room for increasing utility when using the SG measurement method.

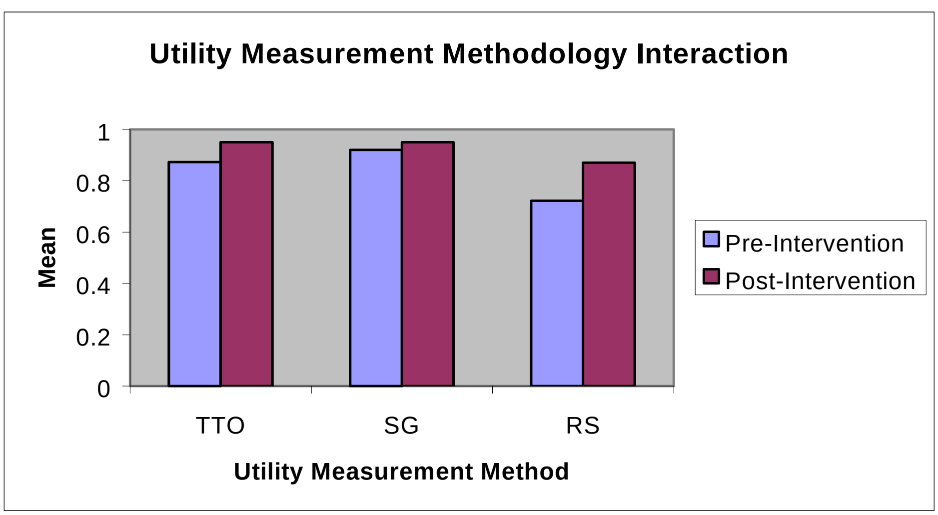

Figure 2. Mean utility changes over time for the three measurement methodologies

It is important to remember that these results were obtained from the data collapsed across health state. The issue of “ceiling effect” may be important to consider in the analysis of this question. Ceiling effects may influence the results when analyzing the utility measures in that scores cannot be higher than 1. For example, in the analysis of utility, the SG approach yielded high overall scores at the pre-intervention administration, leaving little room for improvement in benefit score at the post-intervention administration. Therefore, the results of the present study suggest that if utility is going to be used to examine hearing aid intervention, the best method may be the RS or TTO approaches but not the SG approach.

Question 1b summary: Statistically significant differences in mean utility score were found from pre- to post-intervention for the TTO and RS approaches but not for the SG approach suggesting that the effects of hearing aid intervention can be determined with a utility approach but only using the TTO and RS techniques.

Question 1c: Can the effects of hearing aid intervention be determined with a utility approach as a function of the interaction between health state and utility measurement technique utilized?

The 3-way interaction between time, measurement technique, and health state was statistically significant. To further examine this interaction, Figures 4-6 show the mean pre- and post-interaction scores for generic and disease-specific health states for the TTO, SG, and RS approaches, respectively.

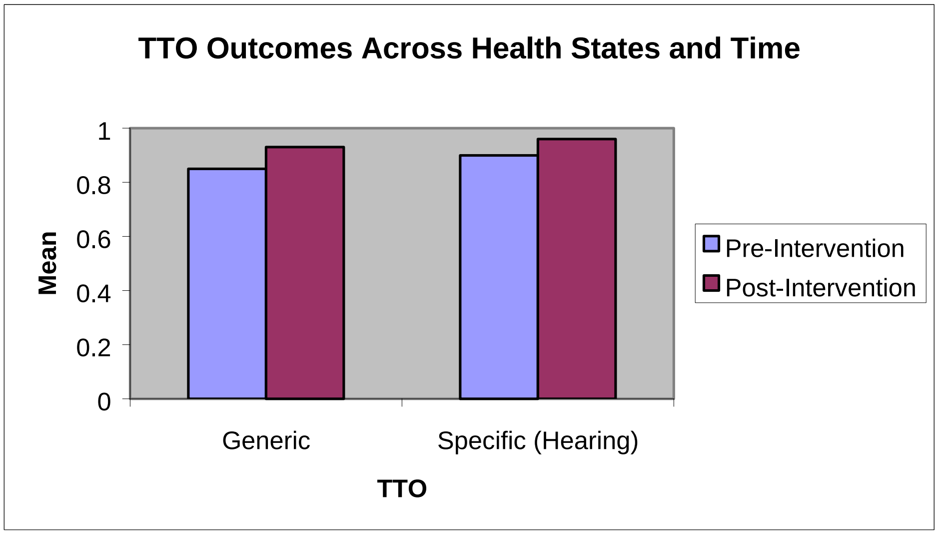

Figure 3. Mean TTO scores collapsed across health states and time

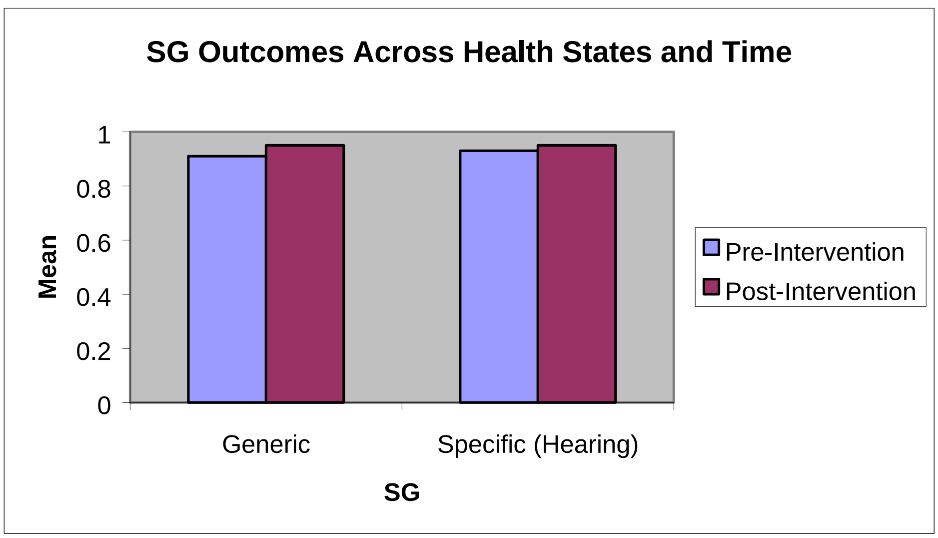

Figure 4. Mean SG scores collapsed across health states and time

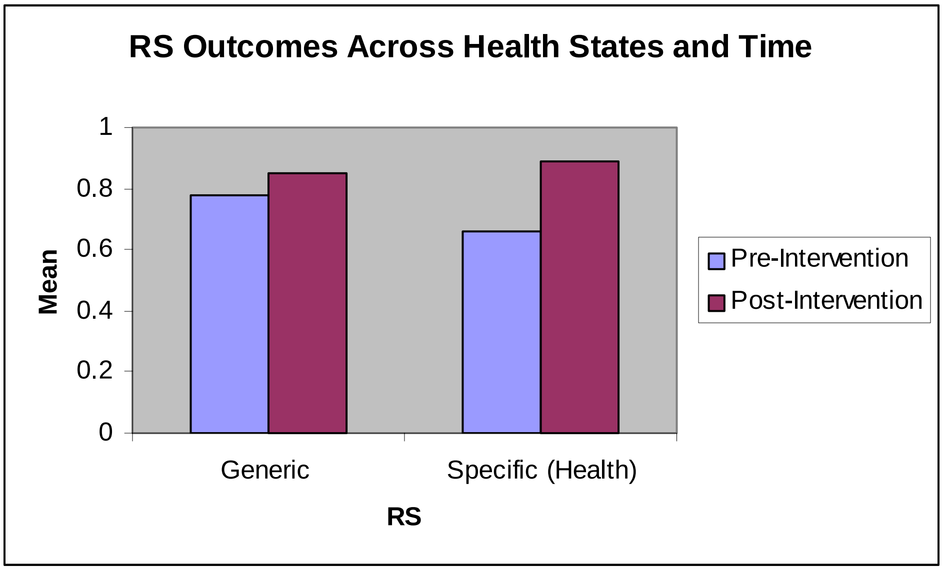

Figure 5. Mean RS scores collapsed across health states and time

Post hoc analysis utilizing the Tukey HSD revealed significant improvement in mean utility score from pre- to post-intervention for both the generic and disease-specific health states as measured using the TTO approach (Figure 4). When the SG method of utility was utilized, the change in mean scores pre- to post-intervention failed to reach significance for either health state (Figure 5). Significant improvements in generic and disease-specific utilities were also found when the RS technique was used, as illustrated in Figure 6. Thus these results also suggest that regardless of health state, or time of administration, the TTO and RS methods of utility measurement may more accurately measure improvement than the SG method of measurement.

Question 1c summary: Statistically significant differences in mean utility score were found from pre- to post-intervention for disease-specific and generic anchors when using the TTO and RS approaches but not for disease-specific or generic anchors when using the SG approach. These results suggest that the effects of hearing aid intervention can be determined as a function of the interaction between health states and utility measurement but only with the TTO and RS techniques.

Question 2: Is numeracy ability a factor in the usefulness of a utility approach for assessing the effects of hearing aid intervention?

To examine the effects of numeracy on utility several results of the ANOVA should be considered. First, the main effect of numeracy as shown in Figure 7 was not found to be statistically significant. The number of participants receiving each of the four numeracy scores is shown inside each bar. The bars show mean numeracy values. It can be seen that mean utility scores collapsed across time and measurement technique changed very little as a function of numeracy and that there was not a consistent pattern of either an increase or a decrease in utility scores as a function of numeracy. In fact, the main effect of numeracy was not statistically significant. Further, none of the interactions with numeracy reached statistical significance. This suggest that contrary to the hypothesis presented by Yueh et al. (1999) numeracy ability does not affect utility scores.

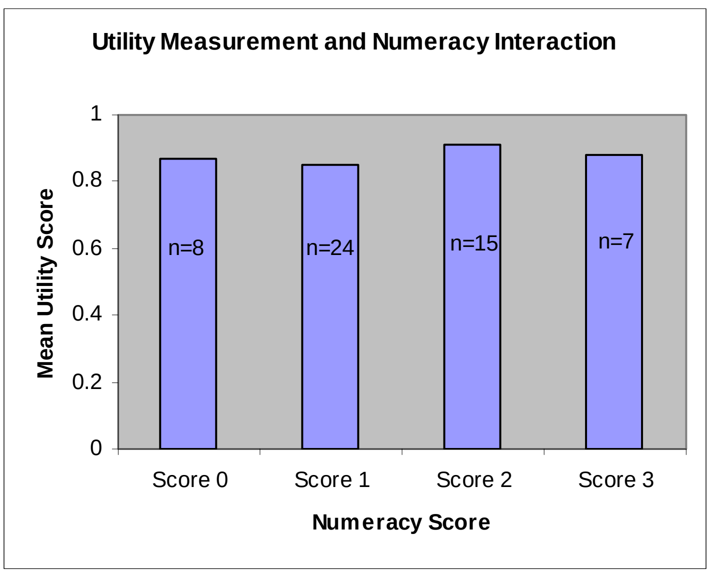

Figure 6. Relationship between participants' numeracy scores and the mean utility scores collapsed across measurement methods.

Question 2 summary: Difference in mean utility score from pre- to post-intervention did not demonstrate statistical significance as a function of numeracy ability suggesting numeracy ability does not appear to affect utility score.

Question 3: What, if any, are the relationships between hearing aid benefit as measured by utility approach with generic and disease-specific anchors and hearing aid benefit as measured using a self report approach?

In this question, hearing aid benefit was compared using results from utility measurement methods for generic and disease-specific health states and a self report approach. The self report measure used in this study was the International Outcome Inventory for Hearing Aids (IOI-HA). The mean total IOI-HA score was 30.17 (SD = 0.46). The mean scores for each of the outcome domains (± 1 SE) are shown in Figure 8. In a recent study by Cox and Alexander (2001), 172 subjects completed the IOI-HA. Most of the subjects in this study were older men and women who had received hearing aids no more than 2 years prior to the study. Cox and Alexander (2001) found that the *use* outcome domain reflected the highest mean score for the IOI-HA, and the *activity limitation* outcome domain demonstrated the lowest mean score. Although conflicting results were obtained between the Cox and Alexander study and the present study, overall mean scores for each of the outcome domains were not drastically different between the studies.

Finally the correlations between utility change scores obtained through TTO and RS methods with disease-specific and generic anchors and the IOI-HA outcome domains were examined. Figure 8 shows the mean (± 1 SE) for each of these domains. It can be seen that the *satisfaction* outcome domain demonstrates the highest mean score in this analysis and *participation* revealed the lowest mean score.

To examine the relationships between the total IOI-HA scores and utility improvements measured from the TTO and RS elicitation techniques, Spearman rho correlations were conducted due to the ordinal nature and skewed distribution of the IOI-HA scores. The results from these correlational analyses are displayed in Table 3. Significant correlations are indicated by asterisks (*). It can be seen that the IOI-HA total scores were significantly correlated with utility outcomes as measured by TTO generic, TTO specific and RS specific methods. The highest correlation was with RS disease-specific method of measurement, with IOI-HA total scores accounting for 16% of the variance in utility change scores.

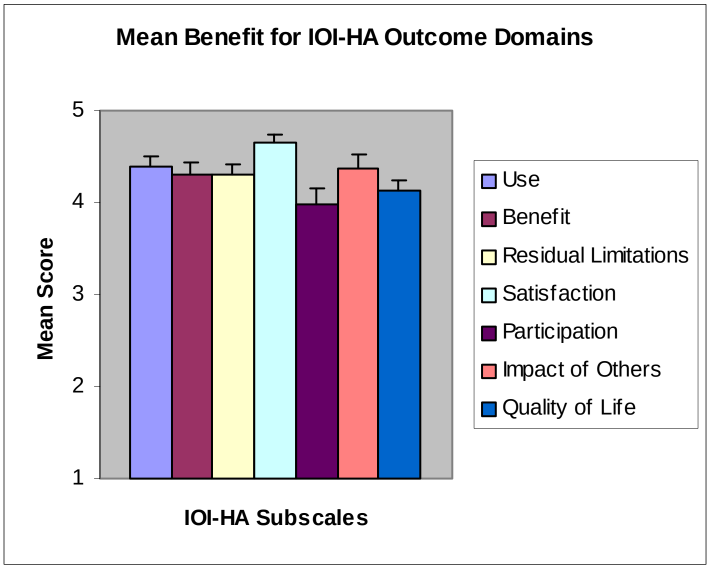

Figure 7. Relationship between IOI-HA outcome domains as shown in mean scores

It can also be seen that correlations between the measures were higher with the disease-specific anchors than the generic utility anchors. That is, the utility change scores obtained using the TTO technique and generic anchors were only significant for the correlation with IOI-HA outcome domain for *benefit* (0.34). Also, none of the correlations between any IOI-HA outcome domains and utility change scores with generic anchors obtained with the RS scale were significant. For utilities measured with disease-specific anchors, significant correlations were found with two IOI-HA outcome domains (*benefit* and *satisfaction*) and utility change scores as measured by the TTO technique. When the RS technique was utilized, significant correlations were found for four of the seven outcome domains (*benefit, satisfaction, participation* and *impact of others*).

In further examining the relationships between the IOI-HA domains, it is apparent that the *benefit* domain demonstrates the largest number of significantly correlated events when collapsed across measurement methods and health states. The *participation* domain is considered to be the second most highly correlated domain with utility measures. The *quality of life* and *satisfaction* domains appear to be equally correlated, closely followed by the *residual limitations* domain. The *use* and *impact of others* domains have the least amount of correlation when collapsed across utility and health state. Finally, the IOI-HA total score was significantly correlated with five of the six domains, showing a strong relationship between the IOI-HA total score and each of the utility measurement methods and health states, except for the RS generic measure.

Question 3 summary: When the IOI-HA is used as a measure against which to validate the utility approach to hearing aid outcomes, the measure with the most face validity is a RS method with disease-specific anchors. However, if one wished to compare hearing aid intervention to intervention in other areas of health care, these data support the use of a TTO approach.

Table 3

Correlations Between IOI-HA Outcome Domains and Total Score as Measured Against Utility Measurement Methods

	Hearing Aid Benefit					
	TTO		SG		RS	
	Generic	Specific	Generic	Specific	Generic	Specific
Use	0.18	0.18	0.32*	0.18	0.06	0.03
Benefit	0.34**	0.26*	0.20	0.37**	0.08	0.47**
Residual Limitations	0.19	0.15	0.30*	0.30*	0.05	0.24
Satisfaction	0.19	0.32**	0.18	0.22	-0.15	0.32**
Participation	0.13	0.16	0.30*	0.29*	0.18	0.29*
Impact of Others	0.10	0.07	0.03	0.22	0.37**	0.08
Quality of Life	0.21	0.20	0.17	0.32**	-0.04	0.52**
Total Score	0.32**	0.38**	0.30*	0.47**	0.20	0.43**

Note. *p<.05; **p<.01.

Discussion

Insensitivity of Standard Gamble Approach

The primary purpose of the present study was to examine the relative usefulness of standard utility measures (e.g., TTO, SG, and RS) with both generic and disease-specific anchors as a means of measuring the effects of hearing aid use. The results demonstrate that the utility approach can be used to measure hearing aid intervention, particularly when using the TTO and RS techniques. As previously mentioned the SG technique showed little change in utility score from pre- to post-amplification sessions. This finding can be partially attributed to a "ceiling effect".

Since a "ceiling effect" occurred only with the SG method, it is of interest to speculate about the possible causes for the finding. The SG approach requires subjects to decide whether they would rather take a "magic" pill with a certain chance of having perfect health or perfect hearing, and a certain chance of dying or becoming completely deaf or not take the pill, and live with their current health or hearing for the rest of their lives. The majority of the subjects were elderly individuals, many of whom were polymedicated. Several subjects indicated that they did not want to take more medication, even with a 100% chance of receiving perfect health or perfect hearing from taking this "magic" pill. Another possible reason for the "ceiling effect" among this population was the degree of hearing loss specified for inclusion in the study. It is possible that individuals with a greater degree of hearing loss may have demonstrated a greater change in SG utility from the pre- to post-amplification sessions as those with more severe impairments may have been willing to "gamble" more to achieve improved hearing. Gatehouse (2000) states that no outcome measure is universally valid, nor applicable to all individuals with a particular disorder. For example, hearing loss occurs in individuals of all ages, and affects them to different degrees, causing a wide variety of difficulties in their lives. For this reason, degree of impairment is an important construct to examine when incorporating utilities as outcome measures.

The fact that some techniques were shown to be better than others suggests that utility techniques lack consistency in quantifying the "same construct" of health preference. This lack of consistency should alert researchers to consider methodologic issues when using utilities as an outcome measure. For example, of the three utilities measured in this study (TTO, SG and RS) the SG technique may be the one most influenced by the subject's understanding of probability (numeracy). The nature of the questions require that subjects have an internal understanding and appreciation for stating preferences between a particular chance of living in one state versus a chance of living in another health state. There is reason to believe that many individuals do not possess this ability (Hanita, 2000). Indeed in this study, 32 of the 54 subjects (59%) scored a "0" or "1" on the numeracy test suggesting a low level of understanding basic probability. While the current study failed to yield a statistical effect of numeracy in relation to utility change scores, we do not know whether a better understanding of probability would have reduced the ceiling effect and yielded greater change scores for the SG approach.

Another limiting factor of the SG technique is that it does not consider time, i.e. how the gamble is influenced by the patient's age and their perceived life expectancy at the time of measurement administration. That is to say that the patient's perceived life expectancy incorporates both time and overall health. It is unreasonable to measure preference as related to health states without considering the time consumed in that particular health state (Gafni, 1994). The TTO technique overcomes this limitation by addressing remaining life years directly and in fact TTO, unlike SG, was shown to be sensitive to hearing aid intervention.

Utilities as a Means of Comparing Different Health Conditions

While this investigation focused on the use of utilities as a measure of audiologic outcomes, the techniques used here may serve as a model to compare the impact of hearing impairment (and audiologic intervention) against those of other disorders. For example, how many years would an individual be willing to trade for perfect hearing vs. perfect vision? How would an individual with a severe hearing loss rate the quality of their life on a rating scale vs. an individual with insulin dependent diabetes? The answers to these questions are critical as our society struggles with a national health care policy particularly in an era of rising health care costs. Utilities offer a way of comparing the costs of improving health related quality of life across disorders and interventions. Cost utility analysis may provide the profession of audiology the data required to compete for third party reimbursement and Medicare coverage for hearing aids and associated audiologic services.

Yueh et al. Versus Current Study

Whereas Yueh, et al failed to find a significant difference in hearing aid outcomes as measured by the RS method using generic anchors and SG and TTO methods using either generic or disease specific anchors, the current study yielded significant differences in hearing aid outcomes with some of these same utility measures. One possible reason for the difference between our results and those of Yueh et al. (1999) may be related to power issues. In the present study, pre- and post-intervention utility data were collected from 54 subjects with amplification. Although Yueh et al. (1999) included 60 subjects, the purpose of his study was to compare four different intervention strategies resulting in a small number of subjects in each intervention group. Furthermore, only two of the groups used hearing aids as the treatment method. This resulted in only 30 subjects receiving amplification possibly causing Yueh et al. (1999) to be under-powered to detect differential treatment effects. Further studies with large subject populations may support the sensitivity of utility measures to differentiate among various amplification strategies.

Another possible explanation for the different results found in these two studies was the method of administration of the U-Titer II utility assessment. Yueh reported (personal communication, March 6, 2001) that the researcher reviewed the U-Titer II instructions with the patient prior to administration after which the patient was left alone to complete the measure. In the present study, instructions were reviewed with the patient and the researcher stayed with the patient as they completed the measure. The patients were able to ask for clarification at any point during the administration of the U-Titer II.

Limitations of Utility Measures

Hanita (2000) discussed several issues regarding utility measures and possible problems related to their use. One concern is that cognitive function may dictate a person's ability to successfully complete a utility measure. Some researchers believe people do not possess the necessary cognitive skills required to complete utilities accurately (e.g., Kahneman & Tversky, 1982; Arkes & Hammond, 1986). Another concern posed is a potential bias created by the person's mood state. Hanita (2000) states that in order for utility measures to be reliable tools, the measure must not be influenced by a fluctuation in the person's mood from one test period to another, or within a single testing session. Research has shown that mood state may effect how a person views their life as portrayed by the tasks contained in the various utility measures (Isen, 1984). If significant, these findings would support low test-retest reliability for utility measures. Another potential problem related to the use of utility measures involves information accessibility. Utilities require the use of recalled information from memory to accurately complete these measures. If a person is unable to recall the appropriate personal values required to complete a utility measure, they are relying on a smaller set of values available at the time of testing (Salancik & Conway, 1975; Tourangeau, Rasinski, Bradburn & D'Andrade, 1989). Finally, Hanita (2000) states that the RS approach only correctly measures utility when data transformation (i.e., a power curve correction) is utilized. Data transformation is necessary because the RS approach was created only to measure value functions and not utility functions. Therefore, in order to obtain accurate utilities using the RS method, a data transformation technique must be used.

<u>Limitations of the Current Study</u>

Both the Yueh et al. (1999) study and the present study used subjects from the veteran population which raises a concern about generalizing the findings to the nonveteran population. Another limitation of the study was that the participants were primarily male. There is some reason to believe that women may respond differently than men on utility measures. In fact, several studies have shown gender to be a significant factor when examining outcome measures. While women are known live longer, they tend to live their lives in poorer health and elicit greater amounts of disability during their lives then men (Chatters, 1993). It has also been shown that women tend to report health related symptoms on a more regular basis, and in general rate their quality of life on a lower level than men (Wiklund, 1996). Gender differences have also been detected in other areas of health care such as renal disease. For example, women have been shown to report less benefit from renal replacement therapy (De-Nour & Brickman, 1996). These findings are significant in our examination of utility measures across diseases and interventions. Further research using utility measures to examine benefit from hearing aids in men and women may allow us to determine the most effective treatment options for men and women.

While this study has demonstrated the effectiveness of utilities as audiologic outcome measures, these findings do not tell us whether utility measures would be useful for measuring benefit from treatment in a clinical setting. Clinical practice, treatment and evaluation of that treatment depends greatly on the amount of time the clinician is able to spend with his or her patient. Since the amount of time spent with each patient affects the cost of care, it is important to utilize an outcome measure that will yield valid results relatively quickly. In the present study, it took approximately fifteen minutes to complete the TTO, SG and RS utility measures. It may not be feasible to invest this amount of time completing outcome measures in certain clinical settings. Therefore, one suggestion may be to utilize a single utility approach to effectively measure change in benefit. The results of the present study suggested that the RS technique with a disease-specific anchor resulted in the greatest amount of overall change in utility score, and therefore was the most sensitive to changes in benefit from hearing aids. Also, the RS was the least time consuming technique for measuring utility suggesting that if a single utility approach is going to be used to measure benefit the RS with a disease-specific anchor proves to be the most applicable for clinical practice.

Conclusions

To date, many studies utilizing disease-specific measures have demonstrated improvements in quality of life resulting from amplification. As the field of audiology changes and matures we must demonstrate improvements in health-related quality of life through audiologic intervention. The results from this study have shown that generic outcome measures can be used to demonstrate the efficacy of audiologic treatment through hearing aids. More research, however, is needed to compare generic outcome measures across diseases and their interventions. With this in mind, the following conclusions can be drawn from the results of the present study.

1. Utility methods are sensitive to hearing aid intervention. The TTO and RS techniques were shown to be sensitive to hearing aid intervention, but the SG technique was not as sensitive, a finding that may be linked to a ceiling effect apparent for this technique.
2. The sensitivity of utilities is dependent on the interaction between measurement technique and anchors utilized.
3. The RS technique utilizing disease-specific anchors and the TTO technique utilizing either disease-specific or generic anchors are significantly correlated with an overall report of hearing aid benefit (IOI-HA Total score).
4. When correlations between IOI-HA outcome domains and utility outcomes are examined, the most valid utility approach (e.g. the utility most often correlated significantly with the IOI-HA outcome domains) is the RS technique utilizing a disease-specific anchor.
5. The data may support use of the TTO technique for comparison of hearing aid intervention to other disease treatments.

APPENDICES

APPENDIX A. MINI-MENTAL STATE EXAM (MMSE)

Take out the "CERAD Constructional Praxis" booklet. You will use only the first two cars for this test. Say:

Now I would like to ask you some questions to check your memory and concentration.

Some of them may be easy and some may be hard.

		Correct	Incorrect
1.	What is the year? ____________________	1	0
2.	. . . the season of the year? _____________	1	0
3.	. . . the date? ________________________	1	0
4.	. . . the day of the week? _______________	1	0
5.	. . . the month? ______________________	1	0
6.	Can you tell me where we are? (e.g., what state are we in?) ____________________________	1	0
7.	What country are we in? _______________	1	0
8.	What city are we in? __________________	1	0
9.	What floor of the building are we on? ____	1	0
10.	What is the name or address of this place? _____________________________________	1	0
11.	I am going to name 3 objects. After I have said them, I want you to repeat them. Remember what they are because I will ask you to name them again in a few minutes:		
	Apple	1	0
	Table	1	0
	Penny	1	0
	Please repeat the names for me. (Score the first try, repeat the list up to two additional times.)		
12.	Turn to the second page of the booklet and say: Here is a drawing. Please copy this drawing on the same paper.	1	0

APPENDIX A. (Continued)

		Correct	Incorrect
	Now, what were the three objects I asked you to remember?		
13.	(Apple) _______________	1	0
14.	(Table) ________________	1	0
15.	(Penny) _______________	1	0
16.	Now, I am going to give you a word and ask you to spell it forwards and backwards. The word is “WORLD” First, spell it forwards: ___ ___ ___ ___ ___ Now, spell it backwards: ___ ___ ___ ___ ___		
17.	Show the subject your wrist watch. Say: What is this called? _______________	1	0
18.	Show the subject a pencil. Say: What is this called? _______________	1	0
19.	I would like you to repeat a phrase after me. The phrase is “no ifs, ands or buts.” (Allow only one trial.) _________________	1	0
20.	Turn to the first page of the constructional praxis booklet. Say: Read the words on this page and then do what it says.	1	0
21.	I am going to give you a piece of paper. What I do, take the paper in your right (or left) hand, fold the paper in half with both hands, and put the paper down on your lap.	1	0
	Read the full statement, then hand over the paper. Do not repeat or coach.		
	Right hand	1	0
	Folded	1	0
	In lap	1	0
22.	Write any complete sentence on that piece of paper For me.		

Total for all 22 items; be sure to include item 16. Total: _______________
Range 0-30.

APPENDIX B. INTERNATIONAL OUTCOME INVENTORY FOR HEARING AIDS (IOI-HA)

1. Think about how much you used your present hearing aid(s) over the past two weeks. On an average day, how many hours did you use the hearing aid(s)?

none	less than 1 hour a day	1 to 4 hours a day	4 to 8 hours a day	more than 8 hours a day
☐	☐	☐	☐	☐

2. Think about the situation where you most wanted to hear better, before you got your present hearing aid(s). Over the past two weeks, how much has the hearing aid helped in that situation?

helped not at all	helped slightly	helped moderately	helped quite a lot	helped very much
☐	☐	☐	☐	☐

3. Think again about the situation where you most wanted to hear better. When you use your present hearing aid(s), how much difficulty do you STILL have in that situation?

Very much difficulty	quite a lot of difficulty	moderate difficulty	slight difficulty	no difficulty
☐	☐	☐	☐	☐

4. Considering everything, do you think your present hearing aid(s) is worth the trouble?

not at all worth it	slightly worth it	moderately worth it	quite a lot worth it	very much worth it
☐	☐	☐	☐	☐

5. Over the past two weeks, with your present hearing aid(s), how much have your hearing difficulties affected the things you can do?

affected very much	affected quite a lot	affected moderately	affected slightly	affected not at all
☐	☐	☐	☐	☐

6. Over the past two weeks, with your present hearing aid(s), how much do you think other people were bothered by your hearing difficulties?

bothered very much	bothered quite a lot	bothered moderately	bothered slightly	bothered not at all
☐	☐	☐	☐	☐

7. Considering everything, how much has your present hearing aid(s) changed your enjoyment of life?

worse	no change	slightly better	quite a lot better	very much better
☐	☐	☐	☐	☐

APPENDIX C. U-TITER II
TIME TRADE-OFF EXAMPLE (GENERIC ANCHOR)

Choose One:

Choice A	Choice B
Live to age 39 years with IDEAL health	Live to age 79 years in your CURRENT health (and with your current hearing)

Choice C
Choices A & B are about the same to me

APPENDIX C. (Continued)
TIME TRADE-OFF EXAMPLE (DISEASE-SPECIFIC ANCHOR)

Choose One:

Choice A	Choice B
Live to age 39 years with IDEAL hearing	Live to age 79 years with your CURRENT hearing

Choice C
Choices A & B are about the same to me

APPENDIX C. (Continued)
STANDARD GAMBLE EXAMPLE (GENERIC ANCHOR)

Choose One:

Choice A

Take the magic pill:
93% chance of having IDEAL health the rest of your life;
7% chance of dying today

Choice B

Don’t take the pill:
Have your CURRENT health (and current level of hearing) the rest of your life

Choice C

Choices A & B are about the same to me

APPENDIX C. (Continued)
STANDARD GAMBLE EXAMPLE (DISEASE-SPECIFIC ANCHOR)

Choose One:

Choice A	Choice B
Take the magic pill: 93% chance of having IDEAL hearing the rest of your life; 7% chance of becoming completely DEAF	Don't take the pill: Live with your CURRENT hearing the rest of your life

Choice C
Choices A & B are about the same to me

APPENDIX D. ASSESSMENT OF NUMERACY

1. Imagine that we flip a fair coin 1,000 times. What is your best guess about how many times the coin would come up heads in 1,000 flips?
   ________ times out of 1,000.

2. In the BIG BUCKS LOTTERY, the chance of winning a $10 prize is 1%. What is your best guess about how many people would win a $10 prize if 1000 people each buy a single ticket to BIG BUCKS?
   ________ person(s) out of 1,000.

3. In ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES win a car?
   ________ %.

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