

## Outcomes Measurement in the Audiologic Rehabilitation of the Elderly

*Harvey B. Abrams*

### Introduction

The measurement of treatment outcomes is a recommended clinical practice guideline (American Academy of Audiology 2006) and has become an expected component of audiologic intervention. Given the large number of available outcome measures, however, there is little agreement as to which are the most appropriate for a given patient. This may be a particular problem when assessing treatment effectiveness in the older patient. Limitations imposed by age-related physical, cognitive, emotional, memory, higher order auditory processing, and visual conditions may dictate an approach that differs from that more routinely employed in a younger population. This paper will present a suggested approach to selecting the most appropriate outcome measures for elderly patients that take into account the challenges imposed by aging.

### A Case Study

B.B. is an 88 year old female who resides in an Assisted Living Facility (ALF). Her health is generally good and she is reasonably independent within the ALF setting. She admits to failing eyesight and she reports that she remembers events that occurred many years ago with great clarity but has trouble remembering what she ate for lunch an hour ago. She is particularly frustrated that her hearing is failing and she reports trouble carrying on a conversation with her table mates at meal-

time. In addition, the resident who lives next door to her has been complaining about the volume of B.B.'s television. If she turns the television down, however, she has trouble following the programs and TV is a primary source of entertainment for her.

B.B.'s communication challenges involve not only overcoming the audibility issues associated with her peripheral impairment but also overcoming issues associated with aging sensory and motor systems. As a minimum, these include:

- Peripheral hearing impairment
- Higher level auditory processing
- Working memory
- Cognitive resource allocation
- Visual impairment
- Cognitive decline
- Motor decline
- Divided attention
- Speech understanding in multiple talker environments

The clinician's challenge is to develop a treatment plan for B.B. that considers these limitations and to select appropriate tools to measure the effectiveness of that treatment—the outcome measures. How should a clinician determine the appropriate outcome measures for B.B.?

### A Suggested Approach

An effective approach to the selection of an appropriate outcome measure(s) involves three steps:

- Determine specific treatment goal(s)
- Determine which outcome domain(s) are most appropriately matched to the goal(s)
- Determine which specific measure(s) are most appropriate for addressing the domains of interest

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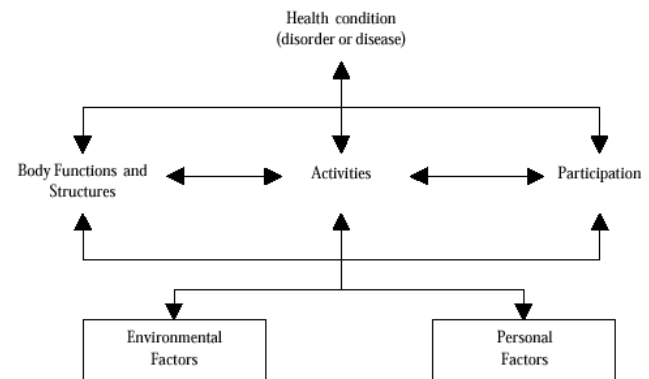
**Address correspondence to:** Harvey B. Abrams, Ph.D., Research & Development Service, Bay Pines VA Healthcare System, 10,000 Bay Pines Blvd, Bay Pines, FL 33744, harvey.abrams@va.gov, 727-398-9368

## Determine the Specific Treatment Goal(s)

The identification of treatment goals is the most critical part of the treatment planning process. The goals drive all aspects of the plan including amplification technology, post-fitting care, and the assessment of outcome. Determining specific treatment goals involve the use of “income measures”, i.e. the careful and specific assessment of patient needs. Several such measures are available including the Hearing Aid Selection Profile (HASP; Jacobson, Newman, Fabry & Sandridge 2001). The HASP is a 40-item questionnaire that measures the extent to which individuals agree (from strongly agree to strongly disagree) with statements regarding their motivation, expectation, cost concerns, appearance, communication importance, and comfort with technology. Another standardized measure that assesses patient expectation is the Expected Consequence of Hearing Aid Ownership (ECHO; Cox and Alexander 2000). The 15-item ECHO assesses expectations across 5 domains (Positive Effect, Service and Cost, Negative Features, and Personal Image) providing scores in each of these domains as well as a global expectation score. Normative data for the ECHO can be found at: [http://www.memphis.edu/ausp/harl/downloads/EC\\_HOplot.pdf](http://www.memphis.edu/ausp/harl/downloads/EC_HOplot.pdf).

While standardized income measures of patient expectations such as the HASP and ECHO may be effective in a younger population, these questionnaires may present challenges for B.B. due to its structure (e.g. format, length, response choices). An alternative to standardized questionnaires is the Client Oriented Scale of Improvement (COSI; Dillon, James and Ginis 1997). Rather than consisting of pre-set questions, the COSI is an open-ended instrument on which the patient’s goals, listed in priority order, are listed. In order for the COSI to be an effective income (and subsequently, outcome) measure the patient must articulate, very specifically, what their communication needs are and in what order of priority. It is not enough for the patient to want to “hear better in noise” but should preferably identify the type of noise (e.g. multiple talkers), the situation (e.g. dining room), and the speaker (e.g. table mates). An example of a COSI goal for B.B. might be, “I want to be able to follow the conversation of my table mates at meal time.” The patient’s needs can almost always be categorized into one of the 16 COSI categories such as (using the above table mate example) “Conversations with 1 or 2 in noise”.

## Determine Which Outcome Domain(s) Are Most Appropriately Matched to the Goal(s)



**Figure 1.** Schematic representation of the interactions among the components of the World Health Organization’s International Classification of Functioning, Disability, and Health.

As illustrated in Figure 1, the World Health Organization’s (WHO) International Classification of Functioning, Disability, and Health (ICF) (World Health Organization, 2001) provides a useful model by which to identify the outcome domains that may be best suited to the goals identified by our patient. For example, B.B.’s hearing loss is a consequence of an impaired “body function or structure”. Her impairment negatively impacts on the “activity” of understanding speech which restricts her ability to “participate” in mealtime conversation. The extent to which B.B.’s impairment impacts limits her activities and restricts her participation is heavily influenced by environmental (e.g. availability of assistive technology, support personnel, and acoustic properties of the dining room) and personal (e.g. age, motivation, general health, and income). Given B.B.’s complaints and goals, it would appear that assessing treatment outcomes in each of these domains (body function, activity, and participation) will be necessary.

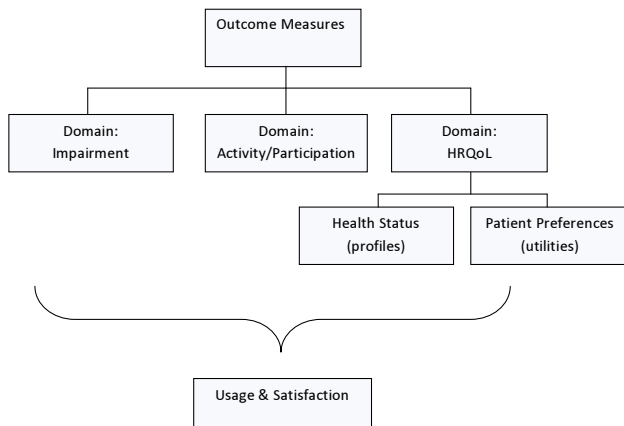
## Determine Which Specific Measure(s) Are Most Appropriate for Addressing the Domains of Interest.

The selection of an appropriate measure is, in large part, determined by the domain of interest. Figure 2 illustrates a suggested taxonomy for classifying the many outcome measures available as a function of the ICF domains. In addition to the impairment, activities, and participation domains, we’ve added a health-related quality of life (HRQoL) domain which is becoming increasingly

prevalent in the health care literature as an important measure of treatment outcome.

### Impairment domain

The primary consequence of damage to the sensory structures of the hearing system is diminished audibility. The goal of audiologic intervention in the impairment domain is to improve audibility of speech; therefore the preferred outcome measures will successfully assess the degree to which the intervention has improved audibility. The current standard of practice is to use probe microphone measures to ensure that the performance of the hearing aid (or other device) meets



**Figure 2.** A simplified schematic representation of an outcome measurement taxonomy

some set of characteristics prescribed for the patient (American Academy of Audiology 2006). That prescribed response is often based on the Speech Intelligibility Index (SII; ANSI, 1997) which is a measure of the amount of speech information available to the listener. Probe microphone measures are relatively quick, require little cooperation from an adult, and are easily tolerated which make them appropriate for an elderly patient. While improved audibility does not necessarily guarantee improved communication performance (particularly in the elderly) there is evidence that improved audibility is associated with improved self-perceived benefit (Gatehouse, 2000).

### Activity/Participation Domain

It might be useful to think of outcome measures in the activity domain as measuring what our patient *can* do,

and in the participation domain as measuring what our patient *does* do. In B.B.'s case, her hearing impairment is affecting her ability to understand speech in noisy environments (activity limitation or what she can do) which further impacts on her ability to engage in conversation during meal time (participation restrictions or what she does do). There are many available measures of speech understanding ranging from phoneme level identification to sentence level intelligibility tests but the degree to which speech intelligibility improves as measured in the clinic does not often correlate to the degree of benefit as perceived by the patient. On the other hand, subjective or "patient-centered" measures can assess the degree to which the patient perceives that benefit has been achieved across multiple environments and situations. Following are a few examples of the more commonly used patient-centered outcome measures.

### The Abbreviated Profile of Hearing Aid Benefit

(APHAB; Cox & Alexander, 1995) is a 24-item questionnaire with each situational-specific item categorized into one of 4 subscales: Ease of Communication (e.g. "When I am in a small office interview or answering questions, I have difficulty following the conversation"); Reverberation (e.g. "When I am talking with someone across a large empty room I understand the words"); Background Noise (e.g. "When I am in a crowded grocery store talking with the cashier I can follow the conversation"); and Aversiveness ("Traffic noises are too loud"). The APHAB has published norms for elderly users of linear hearing aids (1995 norms) and more recently published norms for users of wide dynamic range compression instruments (2005 norms). Both sets of norms can be found on the Hearing Aid Research Laboratory website (<http://www.memphis.edu/ausp/harl>). In terms of its applicability for elderly patients, the APHAB may present problems. Each of the 24 questions requires a response along a 7-point scale from "never" to "always" and is administered twice – as a baseline measure and at some interval following the hearing aid fitting. Some of the described situations may not be applicable for an elderly patient which can result in an incomplete questionnaire. The reading level exceeds what would be expected of a high school graduate.

### The Hearing Handicap Inventory for the Elderly

(HHIE; Ventry & Weinstein, 1982) is a 25-item questionnaire subdivided into 13 "emotional" domain ques-

tions (e.g. “Does a hearing problem cause you to feel embarrassed.”) and 12 “social” domain questions (e.g. “Does a hearing problem cause you difficulty when listening to radio or TV?”). As the name of the questionnaire indicates, the scale is specifically designed for the elderly patient. The response task is relatively easy to complete. The patient answers “yes” (4 points), “sometimes” (2 points) and “no” (0 points) to the 25 questions. As with the APHAB, the questionnaire is administered twice and reduction in the scores represent benefit as perceived by the patient.

### *The Speech, Spatial and Qualities of Hearing Scale*

(SSQ; Gatehouse & Noble, 2004) is a relatively recent questionnaire and was designed to evaluate the consequences of hearing impairment across three hearing domains: Speech (e.g. “You are in a group of about 5 people in a busy restaurant. You can see everyone in the group. Can you follow the conversation?”); Spatial (e.g. “Do you have the impression of sounds being exactly where you expect them to be?”); and Qualities (e.g. “Do other people’s voices sound clear and natural?”). There are a total of 43 questions each requiring a response along a 10-point Likert scale. The anchors differ depending upon the specific question. While the SSQ evaluates activity limitation and participation restrictions in domains not addressed by other hearing-specific questionnaires (i.e., spatial and quality attributes) the length of the questionnaire and the response task may present significant challenges to our elderly patients.

As noted earlier, *the COSI* is an effective “income measure” for establishing treatment goals. It is an equally effective patient-constructed outcome measure. Unlike the questionnaires described above, the Client Oriented Scale of Improvement does not consist of any particular questions or described situations; rather the patient, with the clinician acting as facilitator, identifies up to 5 situations that is perceived to be most impacted by the hearing impairment (the patient can also identify emotional consequences such as frustration and embarrassment). Upon completion of treatment, the patient reports the degree to which the problems are resolved (the change score) on a 5-point scale from “worse” to “much better”. In addition, the patient reports the extent to which the problem still occurs (final ability) on another 5-point scale from “hardly ever” to “almost always”. Depending upon the identified situation, the COSI items can relate directly to the ICF domains of activity and/or participation. In terms of its applicability

and ease of use among the elderly, the COSI is ecologically valid as the hearing-related problems to be assessed are self-identified and the response task for the patient involves simply verbalizing the extent to which those problems have been resolved.

### *Health-Related Quality of Life (HRQoL) Domain:*

While HRQoL is not identified as a specific domain within the ICF construct, it is nonetheless an important consideration when evaluating the effects of hearing impairment and the outcome of intervention. Measures of HRQoL are increasingly being utilized in medical outcomes research and as part of health care policy decision-making. HRQoL is a multi-factorial concept that represents the sum of the impact of a disease, injury, treatment or policy on an individual’s functional states (physical, social role and psychological), self perception (related to an individual’s values and preferences), and societal and familial opportunities (National Institutes of Health 1993). A significant hearing impairment results in activity and participation consequences which in turn can result in isolation, withdrawal, depression, and a marked reduction in HRQoL. The effects of hearing loss on HRQoL may even more pronounced in the elderly who are struggling with other health problems, displacement from home and family, loss of employment, and death of friends and life partners. There is a considerable literature devoted to the assessment of HRQoL and the classification of HRQoL measuring instruments which is beyond the scope of this paper. The interested reader is referred to Abrams, Chisolm, and McArdle (2005) and Abrams and Chisolm (2008) for a more thorough review of HRQoL as it relates to audiologic intervention.

HRQoL measures can be categorized into patient preference or health status measures. Patient preference measures (also known as utilities) are derived from economic theory and are more commonly used for research purposes than to assess individual treatment outcomes. Health status measures are sub-classified into disease-specific or generic measures. Disease-specific HRQoL measures (e.g. the HHIE) tend to be sensitive to the effects of audiologic intervention but their results cannot be compared across other diseases or interventions. Generic HRQoL measures such as the Medical Outcome Survey Short Form-36 (MOS SF-36; Ware & Sherbourne, 1996) has been used to compare across diseases and interventions, but is relatively insensitive to audiologic intervention as none of its questions specifically pertain to hearing



impairment. One generic HRQoL measure, the World Health Organization's Disability Assessment Schedule II (WHO-DAS II; World Health Organization, 1999) has been shown to be sensitive to audiologic intervention and it is briefly described here.

### *The WHO-DAS II*

Is a 36-item instrument (with shorter versions available) that assesses an individual's self perception of their functional status in six domains. The first three domains (understanding and communication, getting around, and self care) map on the ICF activity domain and the remaining three (getting along with others, household and work activities, and participation in society) map on the ICF participation domain. The WHO-DAS II provides a total score as well as individual profile scores across the six domains. In a large multisite study (McArdle, Chisolm, Abrams, Wilson & Doyle, 2005) the WHO-DAS II was found to be sensitive to the effects of hearing aid intervention (i.e., improved HRQoL). The total WHO-DAS II score indicated sustained improvement over a 6-month period but returned to baseline values by 1 year. The understanding and communicating subscale score, however, revealed sustained improvement over the entire 1-year period. In terms of HRQoL measures for an elderly population, generic profiles are useful research tools for this group but they have limited application for assessing outcomes on an individual basis. The length and structure of most HRQoL instruments will likely present challenges for elderly patients.

### *Device Usage*

While not a specific outcome "domain", device usage can be considered an indirect measure of benefit. Unlike the patient-centered benefit measures discussed above, there are no specific scales or questionnaires developed for device usage or hearing aid wear time (other than a simple question regarding hours of hearing aid use). Instead of (or in addition to) questioning a patient concerning hours of use, the clinician might want to determine the proportion of time the hearing aids are worn in those situations where they are felt to be needed. In some cases, wearing hearing aids for only a few hours a day (e.g. at mealtime) may be perceived as very beneficial if the problems associated with that situation are resolved. While we may not know how much benefit an individual experiences based simply on number of hours of use, there is little doubt that if hearing

aids are not worn there cannot be any benefit. Clinicians will often comment that patients are not necessarily good recorders of hearing aid wear time often overestimating the amount of time the instruments are worn. This problem has been largely resolved through the use of a data logging feature found on most current hearing instrument software programs (assuming, of course, the hearing instruments are not left in the "on" position but "off" the ear). Data logging provides information on average daily use as well as the number of hours the hearing aids are used in each program.

### *Satisfaction*

Unlike the outcome domains described above, the concept of satisfaction involves several factors that may be peripheral to the treatment itself to include expectations, cosmetics, comfort, ease of use, perceived competence of staff, and perceived value (Chisolm & Abrams, 2008) and may serve to be a valuable addition to other measures of outcome discussed earlier in this paper.

### *The Satisfaction of Amplification in Daily Life*

(SADL; Cox & Alexander, 1999) is a 15-item questionnaire with each question classified into one of 4 subscales – Positive Effect (e.g. "Do your hearing aid(s) reduce the number of times you have to ask people to repeat?"); Service and Cost (e.g. "How competent was the person who provided you with your hearing aid(s)?"); Negative Features (e.g. "Are you bothered by an inability to turn your hearing aid(s) up loud enough without getting feedback (whistling)?"); and Personal Image (e.g. "Do you think wearing your hearing aid(s) makes you seem less capable?"). Norms are available for each subscale as well as for a global score. At 15 questions, the SADL should be relatively easy for B.B. to complete and will provide the clinician with useful information concerning her perception of benefit and any remaining concerns.

### *Global Outcomes Measures*

There are several audiology outcome measures that assess outcomes across several different domains including activity, participation, use, HRQoL and satisfaction. The use of global measures may be a particularly attractive alternative when assessing benefit in an elderly patient as much information can be obtained with relatively few questions.

### *The Glasgow Hearing Aid Benefit Profile*

(GHABP; Gatehouse, 1999) combines the features of a standardized questionnaire containing established common situations (e.g. “TV at normal volume”) with those of an open-ended instrument (e.g. the COSI) where the patient can identify up to 4 situations not otherwise listed. For each situation, the patient is asked how worried, annoyed, or upset they are in this situation (HRQoL), the proportion of time the hearing aid is worn (usage), how much the hearing aid helps (perceived overall benefit), how much difficulty remains with the hearing aid (residual activity limitation/participation restriction), and how satisfied they are with the hearing aid (satisfaction).

### *The International Outcomes Inventory – Hearing Aids*

(IOI-HA; Cox & Alexander, 2002) is an 8-item, 5-response choice questionnaire targeting the domains of usage; benefit in terms of improvement in hearing related activities; residual activity limitations; satisfaction; residual participation restrictions; impact on others; and quality of life. While the IOI-HA was originally designed as a research tool, the instrument has become attractive to clinicians as well due to its ease of use and inclusiveness of several outcome domains (Cox, Alexander and

Beyer 2003). Cox and colleagues have developed normative data for the IOI-HA available at <http://www.ausp.memphis.edu/harl/oiha.html>.

### **Summary and Conclusions:**

The availability of a wide variety of outcome measures can present a challenge for practicing clinicians in terms of selecting the most appropriate tool for their patient. Table 1 provides a comparison of the measures reviewed in this article as a function of the of the various outcome domains that have been discussed, i.e., impairment, activity and participation, HRQoL, device usage, and satisfaction. A large “X” suggests that the outcome measure effectively targets the domain identified in the column; a small “x” indicates that the domain is only partially targeted. The last column, “Ease of Use”, attempts to illustrate how easy each questionnaire is to complete for a patient similar to one described in our case study.

From a practical perspective, the busy clinician may want to consider the following protocol for use with patients such as B.B.:

- Administer an “income” measure (e.g. COSI) to identify the patient’s most important needs from their own perspective
- Use the COSI to articulate specific and measurable treatment goals based on the income measures
- If fitting hearing aids as part of the treatment plan, verify audibility through probe microphone measures
- Measure 30-day post-treatment outcome using COSI
- Reassess outcomes in multiple domains in 6+ months using the IOI-HA

Given the unique challenges of managing the elderly patient, selecting the appropriate income and outcome measures are critical for identifying patient needs, measuring benefit and ultimately maximizing success. Looking to the future, research is beginning to emerge suggesting that certain hearing aid features may free up cognitive resources and improve non-auditory performance (Sarampalis, Kalluri, Edwards & Hafter, 2009). While clinicians already have a considerable array of outcome measures from which to choose, consideration may soon be given to assessing the benefits of hearing aids and post-fitting AR on such non-auditory behaviors as visual memory and reaction time in addition to improvements in communication performance.

	Impairment	Activity & Participation	HRQoL	Device Usage	Satisfaction	Ease of Use
Probe Tube	X					X
APHAB		X		x		
HHIE		X	X			x
SSQ		X				
COSI		X	x		x	X
WHO-DAS		X	X			
SADL		x			X	x
GHABP		X	X	X	X	x
IOI-HA		X	X	X	X	X

**Table 1.** A comparison of the outcome measures as a function of how well they address the outcome.

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