Outcome Measures in the Hearing Aid Fitting/Selection Process

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INTRODUCTION

The World Health Organization (1980) defines health as both the absence of disease and infirmity and the presence of physical, mental, and social well-being. The latter are considered quality of life domains relevant to health care practice and research. A key issue in this era of changing health care priorities is whether a patient's health improves as a result of a given treatment with the net benefit measured using health-related quality of life assessment measures. That is, change in physical, social, mental, and functional health, is used to evaluate the human benefits and financial value of selected programs and interventions (Testa and Simonson, 1996). Corporations and consumer organizations are pressing health plans to provide them with quality of life indicators of how well patients are faring in the hands of a particular health professional, and/or health care organization. In addition to outside agencies, patients themselves are seeking assurance that the rehabilitative services they seek are both beneficial and cost-effective (Gagne et al, 1995). Interestingly, Wall Street investors as well are monitoring the quality issue and in their view "the challenge for health plans is to re-engineer the business so the product they are selling can be evaluated on a quality as opposed to a price basis," (Freudenheim, 1996). In turn, health professionals in general and audiologists in particular, are faced with unprecedented pressures to demonstrate the efficacy of the services they are providing.

A number of reliable and valid measures of health related quality of life are available to the clinician and researcher. Some of the measures are disease-specific while others are more generic. Increasingly audiologists are considering the im-

pact of a patient's hearing impairment in a more global/generic manner with reference to its impact on the physical, psychological and social domains or dimensions of health status. This change in philosophy is manifested in the observation that more and more audiologists are beginning to assess the effectiveness of a given intervention namely hearing aids, in terms of the functional impact or more globally the impact on quality of life. In this context, the functional impact of hearing aids implies how well is this type of intervention helping a patient achieve maximum quality of life including independence in important activities of daily living (Granger, 1984). Two domains or dimensions of auditory function tend to be measured including objective health status, such as "impairment" and subjective health status such as self-perceived "disability or handicap" (Testa and Simonson, 1996). Disability/handicap measures translate the impairment dimension into an estimate of the actual impact on quality of life impact (Testa and Simonson, 1996). It is well-known that the latter perceptions of health status are affected by the level of impairment, as well as expectations regarding health, and the ability to cope with a given set of limitations. However defined, two persons with the same objective health status (e.g. impairment) may have very different perceptions of their health related quality of life (Testa and Simonson, 1996).

According to the speculative model of temporally-evolving impairment, disability and handicap, individuals choose to pursue amplification because the hearing impairment has begun to interfere with quality of life (Hyde and Riko, 1994). Specifically, the impairment domain of auditory function/dysfunction appears to increase slowly over time, sometime later disability accrues relat-

ing nonlinearly to the impairment. At some unknown point in time, the individual perceives a handicap and a decision to pursue amplification ensues with differential response to intervention (Hyde and Riko, 1994). It has been suggested that in light of the above model, each of these dimensions of health status should be measured objectively and subjectively prior to and at selected intervals following the hearing aid fitting. The measurement of outcomes over time allows for the process of acclimatization to take place. Acclimatization implies an improvement in objective or subjective performance with hearing aids that cannot be attributed to the task, any procedures or training effects (Gatehouse, 1991).

GOAL OF HEARING AID FITTING

According to the above model, the goal of the fitting process is to select hearing aid circuitry, which will achieve some or all of the ends listed in Table 1. It is typically presumed that once the impairment oriented goals are achieved, hearing aid benefit and satisfaction will ensue. This is not necessarily the case. Whether audiologic intervention in the form of a hearing aid fitting is beneficial is intertwined with the concept of efficacy. Efficacy refers to the probability that individuals in a defined population will benefit from a well defined treatment applied for a given problem or predicament (Gagne et al, 1995). According to Gagne et al (1995) the patient's predicament is the sum of all pertinent aspects of their state and situation including disorders, impairment disabilities, and handicapping situations. The treatment, namely the hearing aid, is seen as complementary to the audiologic rehabilitation process such that the hearing aid is the nucleus of the rehabilitation and the rehabilitation reinforces the success of the hearing aid fitting (McCarthy, 1996). The efficacy of a given treatment is defined in terms of the extent to which it reduces, or eliminates the patient's problems in one or more areas of function. Typically, the amount of change in predicament the individual undergoes following the treatment, defines the benefit or advantage conferred by the treatment (Gagne et al, 1995).

The Measurement of Hearing Aid Benefit

Hearing aid benefit refers to the difference between a patient's status with and without a hearing aid. The challenge for the audiologist who fits hearing aids is to demonstrate that observed

Table 1. Goals of the hearing aid fitting.

IMPAIRMENT ORIENTED
Enable reasonably good aided audibility across a broad frequency region without simultaneously making average and loud speech too loud
Place amplified speech should be above threshold and below discomfort level
Restore normal loudness growth (Ricketts and Van Vliet, 1996).
DISABILITY/HANDICAP ORIENTED
Minimize the communicative disability
Reduce the psychosocial handicap
Improve functional status

changes in the patient's status, however defined, are due to hearing aid treatment effects. It is up to the patient to decide whether in fact the benefit is significant enough to warrant the substantial financial outlay currently associated with available technology. These include completely-in-the-canal units, digitally controlled analog devices or digital signal processing hearing aids which may cost more than \$4000 for a binaural fitting. In short, professionals have the responsibility to demonstrate that the improved audibility and restoration of normal loudness growth associated with hearing aids is considered to be both beneficial and satisfactory from a communicative and quality of life perspective. From the perspective of the consumer, perceptions of disability/handicap reduction will be the most tangible and meaningful way to make a decision as to whether or not amplification has proven to be successful.

Hearing aid benefit has traditionally been measured using objective data. That is, the nature and severity of the impairment is defined objectively using threshold or suprathreshold-based measures. These data serve as a baseline against which the adequacy of the electroacoustics, the signal processing, and ultimately the hearing aid fitting are judged. Thus, improvement in performance on such clinical measures as real ear gain, functional gain, speech intelligibility, and restoration of normal loudness growth, is seen as synonymous with benefit. Recently, it has become apparent that while these measures are integral to the fitting process, in that they serve to verify the adequacy of the signal processing, their face validity may be questionable. For example, a hearing aid can provide reasonably good aided audibility across a

broad frequency region as evidenced by the aided audibility or articulation index (AI), but the residual auditory disability or psychosocial handicap may remain considerable. Conversely, a hearing aid may make only a small percentage of speech audible yet the extent of perceived disability or handicap may be dramatically reduced. In light of the imperfect relation between “objectively measured outcomes and those based on patient perceptions,” subjective measurement of the adequacy of a hearing aid fitting is gaining acceptance as a critical component of the hearing aid fitting (McCarthy, 1996; Mueller, 1996; Weinstein, 1996).

Consistent with a problem-solving approach to rehabilitation, the patient’s perception of the overall advantage conferred by a hearing aid (e.g. the extent to which a hearing aid is perceived to facilitate communication and reduce the psychosocial handicap) is increasingly used by audiologists to prove the value of the hearing aid fitting. That is the centrality of the consumer’s perspective as the ultimate arbiter of efficacy is gaining acceptance as research continues to demonstrate a link between therapeutic intervention with hearing aids, and meaningful short, medium and long term quality of life changes (Gatehouse, 1994; Cox et al, 1991). In turn, health care policy planners can use these quality of life treatment effects to justify the inclusion of audiologic rehabilitation with hearing aids as a benefit for the increasing number of adults and older adults with handicapping hearing impairments.

Available disability and handicap questionnaires are of the self-report variety, focusing attention on what the patient is telling the audiologist rather than on what audiometric test results suggest. More and more dispensing audiologists find themselves asking the hearing impaired consumer to judge how he or she feels about a given hearing impairment and their function in the presence of the condition. Thus, the impact of a particular device on audibility of pure-tone and speech signals (impairment), communication in selected situations (disability) and corresponding well-being and psychosocial function (handicap) is seen as being of utmost importance to both the consumer and the hearing health care provider. In fact, The 1990 Consensus Statement for “Recommended Components of a Hearing Aid Selection Procedure for Adults,” suggested that verification strategies also incorporate the individual’s perception of benefit obtained from amplification (Vanderbilt/VA Hearing Aid Conference, 1990). Similarly, the Abbreviated Profile of Hearing Aid

Benefit (APHAB), a measure of self-reported auditory disability, has recently been incorporated into the Independent Hearing Aid Fitting Forum (IHAF) protocol (Mueller, 1994).

OUTCOME MEASURES IN THE DISABILITY AND HANDICAP DOMAINS

Hearing Handicap Inventory for the Elderly (HHIE)

The most widely used tools available for measuring outcomes in the disability and handicap domains of functions are listed in Table 2. As will be discussed in a later section, responses to each of the scales can be used to provide the documentation demanded by health care providers and third-party payers. For each of the scales, a benefit metric can be generated which will help the clinician determine whether the patient’s performance with the hearing aids is truly improved over unaided performance. This information will be of considerable interest to patients, hopefully confirming their subjective impressions (Cox, 1997). When available, the guidelines for determining significant benefit are provided in the sections below.

According to a recent survey of audiologists about audiologic rehabilitation services, the HHIE is the most widely used clinical tool for measuring self-reported handicap, albeit most audiologists continue to resist use of self-assessment inventories (Mueller, 1997; Schow et al, 1993). The simplicity, reliability and validity of the HHIE may account in part for its acceptance as a self-assessment questionnaire. According to Etienne (1996), the HHIE provides the clinician with insights into the relationship between hearing loss and psychological/emotional and social/communication variables and is thus a nice complement to impairment data.

The twenty-five item Hearing Handicap Inventory for the Elderly (HHIE) is a self-administered questionnaire which quantifies the emotional (thirteen items) and social/situational (twelve items) problems associated with hearing loss in older adults. A “no” response to an item is awarded 0, a “sometimes” response is awarded two points, and a “yes” response is awarded 4 points. Scores for the HHIE range from 0 to 100 %, with higher values representing greater perceived handicap. The HHIE was shortened from the full version (twenty-five-items) to a ten-item screening tool (ie, HHIE-S) for which sensitivity- specificity values have been determined to be adequate (Newman et al. 1993;

Table 2. Self-Assessment Tools for Measuring Domains of Auditory Dysfunction: Disability and Handicap.

<i>Disability Domain of Auditory Dysfunction</i>
Measure disadvantage with the auditory activities of daily living. Areas assessed include speech perception, environmental awareness and orientation (Mueller, 1997).
Abbreviated Profile for Measuring Hearing Aid Benefit (APHAB)
Hearing Performance Inventory (HPI)
Hearing Aid Performance Inventory (HAPI)
Shortened Hearing Aid Performance Inventory (SHAPI)
Client Oriented Scale of Improvement (COSI)
<i>Handicap Domain</i>
Measure the non-auditory problems resulting from diminished auditory capacity and the auditory demands of real life situations (Gagne et al, 1995). The areas assessed may include independence, personal relations, social integration (Mueller, 1997).
Hearing Handiap Inventory for the Elderly (HHIE)
Hearing Handicap Inventory for Adults (HHIA)
Screening Version Hearing Handicap Inventory for the Elderly (HHIE-S)
Screening Version Hearing Handicap Inventory for Adults (HHIA-S)
Communication Profile for the Hearing Impaired (CPHI)

Ventry and Weinstein, 1982). The 95% confidence interval (or critical difference values) associated with the HHIE is 18.7% using a face to face administration, while the 95% confidence interval for the HHIE-S is 10%. Test-retest reliability diminishes, and the 95% confidence interval increases slightly, as one moves to a face-face/paper-pencil administration (95% confidence interval = 19.2%) or paper-and-pencil format on each occasion (95% confidence interval = 36.0%). The face-face/paper/pencil mode of administration, wherein the client responds to questions read is preferable clinically as responses are more reliable than those obtained when the patient completes the scale independently without the clinician on each occasion. For the Hearing Handicap Inventory for Adults (HHIA), the 95% confidence interval using a face-to-face administration is 11.9 %. For example, if an individual obtains a score 64% on the HHIE using a face to face administration prior to the hearing aid fitting and following a three week interval of hearing aid use obtains a score of 34%, this translates into a difference score of 30%. This value is greater than the 95% confidence interval, thus the patient experiences clinically significant benefit in the psychosocial domain of function. However if the scales were administered using a paper-and-pencil format on each occasion, a dif-

ference score of 30% would not translate into a clinically significant change in perception of hearing handicap, as the 95% confidence interval of the HHIE (p-pmode) is 36.0%.

Abbreviated Profile of Hearing Aid Benefit (APHAB)

The Profile of Hearing Aid Benefit (PHAB) is the precursor to APHAB consisting of 66 items comprising seven subscales (Cox and Rivera, 1992). The subscales include: (a) familiar talkers, (b) ease of communication, (c) reverberation, (d) reduced cues, (d) background noise, (e) aversiveness of sounds, and (f) distortion of sounds. Using a seven point scale, the respondent merely indicates the proportion of time the statement about a given situation is true ranging from always to never. Each of the 66 items is answered twice, once without the hearing aid and again with the hearing aid. By comparing responses to items with and without a hearing aid, a measure of the respondent's opinion about some of the benefits associated with hearing aid use emerges.

For a variety of reasons, the PHAB was modified and shortened and is now known as the Abbreviated Profile of Hearing Aid Benefit (APHAB). The APHAB consists of 24 items scored on four

6-item subscales (Cox, 1997). The subscales include:

- Ease of communication (EC): The strain of communicating under favorable conditions.
- Background noise (BN): Communication in settings with high background noise levels.
- Reverberation (RV): Communication in reverberant rooms such as classrooms.
- Aversiveness of sound (AV): The unpleasantness of environmental sounds.

The APHAB is considered a measure of disability with respondents indicating the percentage of time they experience problems hearing under the situations described by each of the items in the subscales. (Mueller, 1996). Specifically, each item of the APHAB is a statement, such as "When I am in a small office, interviewing or answering questions, I have difficulty following the conversation." The patient must decide how often each statement is true out of seven possible alternatives. The APHAB seven response alternatives range from always to half of the time to never (Cox, 1997). Using these response alternatives, each of the 24 items is answered "without my hearing aid" and "with my hearing aid," and each subscale produces a score for unaided and aided listening (Cox, 1997). Responses from the patient can be obtained using a paper-and-pencil format or with the patient responding directly on the computer keyboard. A software program, available from the author is used in scoring the APHAB with scores generated for each subscale accompanied by a graphic display. Cox (1997) suggested that to maximize the reliability and validity of responses, during the post-fitting evaluation, patients should be given the opportunity to see their responses to the "without hearing aid" portion while they are completing the "with hearing aid" part. She also suggested that patients should be instructed that they can change their responses on the "without hearing aid" part retrospectively if they no longer agree with the original responses. As normative data on the APHAB were gathered with the patient completing both portions of the inventory in the same sitting, this is an acceptable, albeit less valid, administration format.

For each of the subscales, benefit in the disability domain obtained from a particular fitting is the difference between the unaided and aided scores. Using equal-percentile profiles generated for three normative groups, the merit of a particular hearing aid fitting can be judged (Cox, 1997). The norm groups are established wearers of linear hearing

aids, elderly persons with few or no self-assessed hearing problems, and young normal hearing listeners (Cox, 1997). Norm Group 1 consists of a sample of established users of linear hearing aids (Cox and Alexander, 1995). Norm Group II are responses obtained from older adults who have few self-assessed hearing problems and do not use hearing aids. Norm Group III consists of young normal-hearing listeners who sometimes experience hearing difficulty in daily life.

Using statistical concepts and data from the normative groups, the clinician can place the patient's fitting outcome in perspective (Cox, 1997). In addition, and perhaps most relevant in this era of managed care, the clinician can determine if observed differences between aided and unaided responses depict real benefit. When considering individual subscales, a difference of about 22% between unaided and aided scores for "EC" or "RV" or "BN" is necessary to be reasonably certain that the change in scores represents a real difference between conditions (Cox, 1997). According to Cox (1997) the clinician can be more confident that real benefit is obtained when there is a pattern in which aided performance with linear hearing aids is better than unaided performance by at least ten points on all three subscales. It is important to emphasize that these guidelines for evaluating differences were established on experienced users of linear hearing aids and thus their applicability to new hearing aid users and experienced users of DCA and DCP hearing aids, as of this writing, remains unknown.

Client Oriented Scale of Improvement (COSI)

The COSI, a new measure of self-reported benefit and satisfaction, was developed as an alternative to already existing scales. According to Dillon et al (1997) the COSI differs from other measures in that the client decides on the listening situations in which help with hearing is required. At the start of the intervention, the patient nominates up to five situations in which he/she would like to cope better. The patient is asked to rank each situation in order of importance. At the follow-up appointment (presumably during the trial period), the patient is asked to judge the degree of change attributable to the intervention. For each situation, the client is asked how much better he/she can now hear relative to before rehabilitation (question a) and how ably he/she can hear after rehabilitation (question b). Degree of change is ranked on a five point scale from worse to slightly better to much better or from hardly ever

to occasionally to almost always. A “5” corresponds to much better/almost always whereas a “1” corresponds to worse/hardly ever. Test-retest reliability data have been reported however it appears that the data are confounded by the effects of intervention thereby minimizing the conclusions to be drawn regarding test stability. The COSI is in its infancy stage and thus data are unavailable as to its clinical utility as a measure of benefit. However Dillon et al (1997) did report that clinicians with experience using the COSI method consider it useful and convenient to use.

Hearing Aid Performance Inventory (HAPI)

The Hearing Aid Performance Inventory developed by Walden et al (1984) is one of few available tools specifically designed for use in the hearing instrument verification process. It consists of 64 items designed to assess hearing aid benefit in a variety of listening situations across a wide range of ages. The four types of listening situations surveyed include noisy listening situations, quiet situations with speaker in close proximity, situations with reduced signal information and situations with non-speech stimuli. The HAPI is somewhat different from the above measures in that it provides a post-fit assessment of subjective hearing aid benefit. The patient is presented with a particular communication situation and/or environment and is asked to rate the amount of help afforded by the hearing aid ranging from very helpful to hinders performance. The patient directly assesses the benefit of the hearing aid in each of the listening situations comprising the inventory. The lower the patient's score, the better the hearing aid performance. The HAPI was recently shortened to include 38 items consisting of three factors: speech understanding in quiet listening environments, listening in noisy environments, and listening in situations that are low in redundancy with reduced visual cues (Schum, 1992). As with the 64 item version of the HAPI, on the Shortened Hearing Aid Performance Inventory (SHAPI) the respondent rates the benefit of the hearing aid in each of the 38 situations sampled. Overall, higher SHAPI ratings indicate lower benefit. According to Jerram and Purdy (1997) and Schum (1992) the internal consistency of the overall questionnaire and of the three factors is high, ranging from .85-.95. It provides a profile of hearing aid benefit in three different listening situations with group data available against which to compare a patient's score. Percentiles for SHAPI

ratings overall and for each factor are available for older adults. The percentiles generated by Schum (1992) are appropriate for new users whereas the percentiles generated by Jerram and Purdy (1997) are appropriate for experienced users. In light of its psychometrics, the SHAPI appears to be a robust measure of hearing aid benefit.

The Communication Profile For Hearing Impaired Individuals (CPHI)

The CPHI developed by Demorest and Erdman (1986) quantifies the behavioral and psychosocial adjustment to hearing impairment. It consists of 25 scales which assess: (1) aspects of communication effectiveness in a variety of settings (2) communication importance in social, work and home settings (3) the communication environment (4) communication strategies and (5) personal adjustment to hearing impairment. Normative data on the CPHI were originally gathered at Walter Reed Army Medical Center and as of this writing normative data are being gathered at five clinical centers across the country. The sample of subjects on which data are currently being gathered is more heterogeneous than the original with regard to demographic variables and audiometric data. The internal consistency reliability of the CPHI and its subscales is currently being studied on this more representative sample and will most likely be available soon. Data on military personnel suggest that the CPHI is high in reliability and validity.

The Hearing Performance Inventory (HPI)

The Hearing Performance Inventory (HPI) was originally developed by Giolas et al (1979) as a self-report inventory of daily listening problems. It consists of 158 items divided into six subsections. The six subscales include: (a) understanding speech, (b) intensity, (c) response to auditory failure, (d) social, (e) personal, and (f) occupational. The original HPI was shortened to 90 items with similar categorizations (Lamb et al, 1983). Bentler et al (1993) described an even more abbreviated version (HPI-38) which consists of only items which tap speech understanding in fairly quiet backgrounds, in a noisy background, and with speakers at a small distance away. For each of the versions of the HPI the respondent is presented with everyday listening situations and is asked to evaluate the frequency with which he/she experiences the difficulty ranging from practically always (1) to almost never (5). The higher the mean score on the HPI, the more disabled the individual.

Hearing Aid Outcomes Using Disorder Specific Quality of Life Measures

A number of studies to date have demonstrated both the immediate and longer term consequences of treatment with hearing aids in a number of areas of patient function. Most studies have used disease specific instruments which focus on the dimensions of function closely linked to persons with hearing impairments. However, some have used generic instruments which assess a wide range of domains of function applicable to a variety of disease states (Testa and Simonson, 1996). The report card on outcomes with hearing aids using generic and disease-specific quality of life measures administered over the short (three weeks), medium (two to three months) and long term (more than three months) is encouraging. For the purposes of the review, I have chosen to incorporate an overview of benefit in various domains as it occurs over time, as the apparent psychosocial acclimatization which appears to take place in the adjustment to hearing aids has implications for follow-up throughout the hearing aid fitting process. In this context, acclimatization refers to a systematic change in auditory performance with time, not linked to a change in the acoustic information available to the listener. It involves an improvement in performance that cannot be attributed to the task, any procedures or training effects yet may grow out of exposure to auditory events. If in fact acclimatization takes place, evaluations performed only immediately after the hearing aid fitting may underestimate benefit potential (Turner and Humes, 1996).

The majority of studies on the efficacy of audiologic rehabilitation with hearing aids have documented that hearing aids are beneficial in reducing the perceived auditory disabilities and psychosocial handicap associated with a given hearing impairment and that these beneficial effects are sustainable as much as one year after the hearing aids have been purchased. Evidence of the short term benefits of hearing aids has been most pronounced in the handicap domain/dimension yet increasing attention is being drawn to their value in the disability domain/dimension, as well.

Benefit in the Disability Domain

Recently a number of investigators have utilized a variety of disability measures to assess the functional benefits of hearing aids. Bentler et al (1993b), evaluated the efficacy of hearing aids on

a sample of 65 adults with mild to moderate sensorineural hearing loss. The majority of subjects were new hearing aid users. All subjects completed the 38 item HPI at baseline, six months and twelve months after the initial fitting. The most notable finding was a substantial improvement in scores on the scales which measure speech understanding in a fairly quiet background. Improvements were notable after six months and one year of hearing aid use. It was noteworthy that Bentler and her colleagues reported that beneficial treatment effects were not apparent on the subsections which assessed speech understanding in the presence of background noise, nor in performance on the Nonsense Syllable Test (NST) and the Speech in Noise Test (SPIN), irrespective of the type of noise reduction circuitry (e.g. adaptive filter, adaptive compression, frequency dependent input compression and the Zeta™). Utilizing the HPI, Dempsey (1986) noted a significant decrease in hearing handicap on each of the the subsections of the HPI, excluding the emotional subscale. These studies confirm patient reports that hearing aids improve speech understanding in optimal listening situations.

Cox et al (1991) demonstrated benefit in the disability domain utilizing the Profile of Hearing Aid Benefit (PHAB). The data which emerged from their study revealed that short term hearing aid benefit is demonstrable in easy listening situations yet the magnitude of benefit in the disability domain decreases as the listening situation becomes more difficult. Similarly, Cox (1997) described benefit and satisfaction outcomes for twenty-two older adults fitted with their first hearing aids. All subjects were fit with linear processors. Subjects wore their hearing aids for three months and completed the Abbreviated Profile of Hearing Aid Benefit (APHAB). With one exception, all subjects (N=22) demonstrated significant overall benefit from amplification. It was notable that despite significant improvement in communication ability in various daily life situations, a number of subjects still chose to return their hearing aids. Subjects choosing to keep their hearing aids showed significant benefit according to difference scores on the APHAB. Most of the individuals who chose to return their hearing aids showed significant benefit in the disability domain of function according to benefit scores on the APHAB, as well. It was noteworthy that speech communication scores of those choosing to keep the hearing aids were on the order of 15% higher than those not choosing the aids. In light of their findings, the authors tentatively con-

cluded that the amount of reported benefit in the disability domain (i.e. difference scores on the APHAB) is not always enough to make the hearing aid purchase worthwhile for the hearing impaired individual. In a sense, this conclusion and their preliminary findings, tend to suggest that hearing aid satisfaction does not necessarily correlate with hearing aid benefit in the disability domain. Stated differently, benefit is an important aspect of satisfaction, but other variables, not necessarily audiologic, have a substantial impact on the decision concerning hearing aid uptake (Cox, 1997).

Ebinger et al (1995) recently reported on the benefit experienced by ninety adults with varying degrees of sensorineural hearing loss who obtained completely-in-the-canal (CIC) hearing aids. Subjects completed the APHAB two to ten months following the initial hearing aid fitting. Approximately half of the subjects were new users and half previous hearing aid users. They reported that the CIC fitting reduced the percent of aided problems to below the 50th percentile of the Cox and Alexander (1995) norms. The authors concluded that the benefits of CIC hearing aids are not age dependent with beneficial treatment effects emerging in the variety of situations assessed by the APHAB.

Humes et al (1996) followed a sample of twenty older adults fit with binaural multiple memory in-the-ear hearing aids. A close match to NAL-R target was achieved for the majority of subjects. Subjects underwent speech understanding testing using the Hearing in Noise Test (HINT) and the CUNY Nonsense Syllable Test (NST). The HINT is a sentence test designed to closely represent real-world communication abilities. In addition, subjects completed two subjective measures of benefit, one which assessed the extent of disability (i.e. the HAPI) at several intervals including 20, 40, 60, 80 and 180 days post-fitting and HHIE which assesses extent of psychosocial handicap. Depending on the subscale of the HAPI subjects experienced significant amounts of benefit in the disability domain from hearing aids after a brief interval of use. Between 45% to 65% of subjects demonstrated significant benefit according to absolute scores on the HAPI subscales. It was of interest that scores on the subjective measures were correlated with each other, and scores on the speech understanding measures were correlated with each other. However, scores on the objective speech measures did not correlate with either of the more subjective measures. It is noteworthy that performance of their subjects on the above outcome

measures was tracked over time with no significant improvement over time noted on any of the measures or groups in the study.

Finally, a recent study, conducted by Kricos and Holmes (1996) demonstrated that four weeks of active listening training (i.e. training in the recognition of message meaning), coupled with hearing aid use, can reduce the extent of self-perceived communication disability in adverse listening conditions, as demonstrated by change in scores on the Communication Profile for the Hearing Impaired (CPHI). Their finding was noteworthy underlining the importance of some form of listening training when self-perceived speech understanding in adverse situations fails to improve with hearing aid use.

The above studies clearly demonstrate that using disease-specific measures of auditory disability, hearing aids have proven an effective means of reducing the extent of self-perceived speech understanding difficulties in quiet. The study by Kricos and Holmes (1996) was noteworthy in that it is among the first using a disability measure, to show the value of listening training for enhancing benefit of hearing aids in adverse listening situations. It was of interest that listening training had little effect on psychosocial handicap according to difference scores on the HHIE. Their finding makes a case for measuring benefit in a variety of domains of auditory dysfunction, as benefit in the disability domain of auditory dysfunction is not necessarily related to benefit in the handicap domain. Further, the form of intervention namely listening training may not impact on psychosocial adjustment to communicative disability.

Benefit in the Handicap Domain of Auditory Dysfunction

A number of investigators have demonstrated that using the HHIE as a gold standard the following conclusions can be drawn: (1) beneficial treatment effects from hearing aids emerge as early as three weeks after the initiation of treatment; (2) the benefit of hearing aids is demonstrable and sustainable in the handicap domain throughout a one year period; (3) the overwhelming majority (70% to 80%) of experienced or new hearing aid users experience dramatic reductions in the extent of psychosocial handicap after only three weeks of hearing aid use; (4) audiometric data bear little relationship to benefit; (5) presence of central auditory processing disorder (CAPD) reduces the effectiveness of hearing aids; (6) age,

financial status and neuropsychologic status bear little relation to benefit in the handicap domain; (7) counseling oriented rehabilitation can improve benefit among those not experiencing significant reduction in hearing handicap, and (8) hearing aid benefit is more pronounced using disorder-specific quality of life measures than generic quality of life measures (Primeau, 1997; Taylor, 1993; Newman et al, 1993; Newman et al, 1991; Mulrow et al, 1990; Malinoff and Weinstein, 1989).

Short Term Benefit

A number of investigators have recently explored the short term benefit of hearing aids when dispensed to new users. The studies have been conducted in a variety of settings with older adults who recently obtained hearing aids for the first time. Malinoff and Weinstein (1989) conducted a study of benefit in the psychosocial domain as perceived by a sample of older adults three weeks after first receiving their hearing aids. Subjects were recruited from the hearing aid dispensary at an eye, ear and throat hospital. The majority had mild to moderate bilateral sensorineural hearing loss and were fit with in-the ear hearing aids. The majority of the fittings were monaural. Subjects completed the HHIE prior to the hearing aid fitting and again at three to four weeks following the fitting. At the time subjects received their hearing aids they received routine instruction on use, operation and maintenance of their hearing aids. Following a rather brief period of hearing aid use, there was a statistically and clinically significant reduction in self-perceived hearing handicap in the emotional and social domains of auditory function. It was of interest that nearly 80% of the subjects had mean scores which differed by more than 18%; the value which reflects the 95% confidence interval for a true change attributed to intervention. The audiologists who initially were reluctant to gather outcome data were ultimately quite enthusiastic about their findings and the potential of the information to be used as a form of quality assurance at their facility.

Newman et al (1991) explored the short term benefits of hearing aids using the screening version of the Hearing Handicap Inventory for the Elderly (HHIE-S). Ninety-one new hearing aid users, ranging in age from 65 to 90 years completed the HHIE-S prior to receiving and three weeks after using the recommended hearing instrument. The majority of subjects (ie., 58%) had mild hearing loss, while 36% had moderate hear-

ing loss, and 6% presented with moderately-severe to profound hearing loss. Mean total, emotional and social HHIE-S scale scores improved significantly after short term hearing aid use. Using 10 points as the 95% confidence interval for computing a true change in HHIE-S scores, 78% of subjects demonstrated a true change/reduction in perceived hearing handicap, whereas 7% of subjects did not reach the criterion for a significant change in handicap (Newman et al, 1991). The remaining proportion of subjects (ie., 15%) had total handicap scores which were less than the confidence interval of 10 points, and thus were not eligible for this computation. Once again these data speak to the beneficial effects of hearing aid use among older adults.

Primeau (1997) recently reported on the efficacy of hearing aids worn by a population of two hundred thirty-three veterans ranging in age from 27 to 97 years, with a mean age of 65.5 years. The majority of subjects had mild-to-moderately-severe, bilateral symmetric sensorineural hearing losses. The average of thresholds across the octave frequencies tested was 44 dB HL for the adults and 54 dB HL for the older adults. The mean age of the former group was 54 years and of the latter group 74 years. Most subjects were fit binaurally with in-the-ear hearing aids. Prior to obtaining the hearing aid(s) each young adult completed the screening version of the Hearing Handicap Inventory for Adults (HHIA-S) or the screening version of the Hearing Handicap Inventory for the Elderly (HHIE-S). After six weeks of hearing aid use, each of the 233 patients completed the handicap inventory to determine the short-term efficacy of hearing aid treatment. Overall, the mean change in HHIA-S and HHIE-S scores following hearing aid use was between 14 and 15 points (depending on the group), a change which is considered statistically and clinically significant. Interestingly, the mean baseline score on the HHIE-S and on the HHIA-S was comparable for the young and older adults (30) as was the mean score postfitting. The majority of individuals with hearing impairment in his clinic experienced significant reductions in communicative and psychosocial handicap with hearing aid use. Specifically, of the 233 individuals obtaining hearing aids, 181 (77.7%) experienced a significant reduction in self-perceived handicap following a short interval of hearing aid use. Interestingly, 81% of the older adults and 73% of the younger adults experienced a significant reduction in hearing handicap. Thus, older and younger adults derived dramatic bene-

fits from hearing aids contradicting a widely held stereotype that older adults do not derive as much benefit as young adults from hearing aids.

In sum, the studies described above clearly demonstrate that the majority of first time users of hearing aids derive significant psychosocial benefit from their hearing aids even after only three weeks of hearing aid use. It is noteworthy that in each of the above studies the hearing aid fitting was only accompanied by 45 to 60 minutes of orientation and counseling. The important question however remains to what extent can the benefit which may reflect initial relief at finally being able to communicate, be sustained as listening experiences become more varied and challenging. To answer the latter question, a number of investigators have followed subjects longitudinally, beyond the three week period, to see if in fact the new hearing aid remains beneficial.

Medium Term Benefit in the Psychosocial Domain of Function

The most comprehensive randomized controlled clinical trial of the short and medium term benefits of hearing aids was conducted on a sample of male veterans (Mulrow et al, 1990). One hundred and ninety four older adults with mild to moderately-severe sensorineural hearing loss participated. Half of the subjects were assigned to a hearing aid group and the other half to a waiting list group. Each group was matched on important demographic and clinical characteristics including socioeconomic status, educational level, medical status, etc.. Ninety-eight percent of individuals in the hearing aid group received monaural in-the-ear hearing aids.

Hearing aid benefit was considered a multi-dimensional phenomena, defined according the amount of improvement in scores on a variety of quality of life measures. The domains of function which were tapped included the social, emotional, cognitive, physical and psychological. Responses to items on the Hearing Handicap Inventory for the Elderly (HHIE) provided data on the perceived emotional and social effects of hearing loss. The other disorder specific outcome measure was the Denver Scale of Communication Function (DSCF) which provided an estimate of perceived communication function. Subjects completed each of these disorder-specific quality of life measures at baseline and at the six week and four-month follow-up visit. Mean scores on each of these measures were comparable between the

control (waiting list) and experimental (hearing aid recipients) groups at baseline.

According to scores on the HHIE, 63% of the subjects perceived their hearing handicap in the psychosocial domain to be severe and 20% perceived it to be mild to moderate. Moderate communication difficulties were reported by 85% of the subjects on the Quantified Denver Scale (QDS) (Mulrow et al, 1990). The QDS is a 25-item questionnaire that assessed perceived communication difficulties due to hearing loss (Mulrow et al, 1990). Dramatic hearing aid treatment effects were noted on each of the disorder specific quality of life outcome measures for the experimental group at both the six week and four month follow-up. While statistically and clinically significant improvements in social and emotional function as assessed by the HHIE emerged in the hearing aid group, mean scores for the control group remained the same. Similarly, the hearing aid group demonstrated significant improvement in communication function as measured on the QDS, whereas no change in communication function was noted for the waiting list group. Change score improvements in social and emotional function as assessed by the HHIE was 34, and for communication function as assessed by the Quantified Denver Scale was 24. Of interest was the finding that benefit, according to the difference between unaided and aided responses to items on the HHIE and the DSCF, emerged six weeks after receipt of the hearing aid and was sustained at the four-month follow-up (Mulrow et al, 1990). That is, hearing aid benefit at four months following hearing aid use was comparable to that obtained as early as six weeks following the initial fitting. The authors concluded that their study established that hearing aids do in fact improve the quality of life of persons with hearing loss and that their short and medium term effects are most pronounced when using disorder specific quality of life instruments.

Newman et al (1993) evaluated the short (three-week) and medium-term (six-month) benefit of hearing aids as measured by the HHIE. Subjects ranged in age from 65 to 85 years, were new hearing aid users with essentially mild to moderate sensorineural hearing loss. After three weeks of hearing aid use subjects experienced a dramatic reduction in self perceived hearing handicap. Subjects continued to experience benefit after 6 months of hearing aid use. The mean HHIE score at six months post fit was slightly higher than that obtained at three weeks albeit still significantly better than the mean baseline HHIE score. This

trend suggests that a type of psychosocial acclimatization may take place wherein following exposure to varied listening experiences, the patient experiences some of the limitations inherent in hearing aid technology, but continues to feel the advantage in the psychosocial domain of auditory dysfunction over their unaided hearing.

Clemens Tesch-Romer (1996) recently completed a quasi-experimental study of the effects of hearing aid use on five dimensions of psychological functioning including: communication problems, social activities, satisfaction with social relationships, psychosomatic well-being and cognitive functioning. Sixty-two individuals were assigned to the "aural rehabilitation group," forty one individuals to the hearing impaired control group, and twenty seven to the normal hearing control group. The average age of participants was 71.2 years. All hearing impaired subjects were considered eligible for a hearing aid using the criterion of the German public health insurance for hearing aid prescription by virtue of their hearing loss. The two hearing impaired groups were similar with regard to sociodemographic and health characteristics. The mean pure-tone average of the experimental group was 36 dB HL versus 26 dB HL for the hearing impaired control group and 12 dB for the normal hearing control group. The mean score for the experimental group on the HHIE at baseline was 26% versus 11% for the hearing impaired control group and 4% for the normal hearing control group. The majority of subjects in the experimental group purchased a monaural in-the-ear hearing aid. All subjects completed the following prior to and six months following the hearing aid fitting: (1) a hearing diary, (2) the HHIE, (3) two measurement instruments which assessed the involvement in and enjoyment of leisure activities, (4) a scale assessing satisfaction with social relations, (5) a scale assessing psychosomatic well-being, and (6) five tests of cognitive function. The majority of respondents judged themselves to be satisfied with their hearing aids using them on average 7 hours per day at baseline and at follow-up. Hours of hearing aid use was correlated with hearing aid satisfaction ($r = 0.46$ at baseline and 0.32 at follow-up). Statistical analysis revealed an intervention effect of hearing aids in the domain of self-perceived hearing handicap for the experimental group whereas for the control groups mean HHIE scores remained stable over time. To compensate for the differences between the experimental and control group in baseline pure-tone average and HHIE scores, a matched subsam-

ple was created such that the hearing impaired control group was comparable to the hearing impaired experimental group. In the subsample as well an intervention effect of hearing aids was noted. Mean HHIE scores for the experimental group improved by approximately 16 points following hearing aid use in the original sample whereas scores remained stable for the two control groups. The authors concluded that high hearing aid use at baseline reliably led to lowered self-perceived hearing handicap at follow-up.

The above studies clearly demonstrate that benefit from hearing aids is sustainable up to six months following the initial fitting and as will be evident from the discussion below can be sustained for as long as one year after first receiving the unit(s).

Long-Term Benefit in the Psychosocial Domain of Auditory Function

Newman and Weinstein (1988) were among the first investigators to assess the efficacy of the HHIE as an index of long-term hearing aid benefit in the area of psychosocial function. Eighteen male veterans with ages ranging from 66 to 84 years and a mean pure-tone average of 43 dB HL in the better ear and 56.6 dB HL in the poorer ear were fit with hearing aids. Subjects responded to the HHIE at baseline and one year following the fitting. Differences between scores on the initial and readministration of the HHIE were statistically significant on the total, emotional and social/situational subscales. The mean difference score was rather large (27.7 points) exceeding the 95% confidence interval which defines a clinically significant change due to the intervention.

Using a randomized controlled clinical trial, Mulrow et al, (1992a) conducted a longitudinal study of hearing aid benefit, with the goal being to determine whether it can be sustained as long as one year following the initial fitting. Subjects were new hearing aid users with mild to moderate sensorineural hearing loss. 192 older adults with a mean age of seventy-two years participated in the study. The majority of subjects were fit with monaural in-the-ear hearing aids which the majority wore for more than four hours daily at the four, eight and twelve month follow-ups. It was noteworthy that over time, mean hours of daily use declined. At the four month follow-up 90% of subjects wore their hearing aids more than four hours daily, at the eight month follow-up 83% wore their units more than four hours daily whereas at the twelve month follow-up 76% wore

their aids four hours daily. In general, 70 to 80% of the 162 subjects reported being quite satisfied with their hearing aids over the one year period during which they were followed. Mean scores on the HHIE improved after 6 weeks of hearing aid use. Benefit in the handicap domain as measured by the HHIE was sustained at four, eight and twelve months. Similarly, mean scores on the Quantified Denver Scale also improved over time suggesting sustained benefit in the area of communication function over time. The authors concluded that the benefits of hearing aids in the psychosocial and communicative domains of auditory function are sustainable over a period of one year. In their study, absolute and relative benefit in the psychosocial domain at six weeks was comparable to that at four months, eight months and one year. The authors concluded that benefits which were sustained over the one year follow-up period were likely true improvements not potentiated by placebo or Hawthorne effects because of the large magnitude of the change scores on the measures of self-perceived communication, social and emotional function.

The data of Taylor (1993) corroborate the findings of Mulrow and her colleagues. Taylor (1993) also conducted a longitudinal study of change in self-perceived hearing handicap following three weeks, three months, six months and one year of hearing aid use. The majority of the 58 subjects were older, first time hearing aid users, with mild to moderate sensorineural hearing loss. Subjects were fit monaurally with in-the-ear hearing aids. In general, the majority of subjects (78%) demonstrated statistically and clinically significant reductions in HHIE scores after three weeks of hearing aid use. Taylor (1993) found significant differences in HHIE scores at baseline, three weeks, three months, six months and one year after the hearing aid fitting. The most dramatic reduction in social and emotional function emerged just three weeks after hearing aid use. Interestingly, the mean score on the HHIE rose significantly after three months of hearing aid use, but stabilized after six months and one year, suggesting some form of acclimatization in the psychosocial domain. These data once again demonstrate the medium and long-term benefit of hearing aids on the emotional and social domains of function. It was noteworthy that while subjects scores on the HHIE changed somewhat overtime, functional gain estimates and aided word recognition scores remained stable over time failing to reflect acclimatization effects noted on responses to the HHIE.

It is of interest that the findings of Malinoff and Weinstein (1989) confirmed the potential for some form of psychosocial acclimatization over the first three months of first time hearing aid use. As noted above, subjects in their study were older adults with mild to moderate sensorineural hearing loss. They reported that the initial benefit from hearing aids, which emerged at three weeks (mean difference score of 29.6%) was more dramatic than that which emerged at three months and one year (difference score of ~15 points). It appears that in their sample, as in that of Taylor (1993), benefit may stabilize at three months such that it is comparable and sustainable after one year of use. The longitudinal study of Malinoff and Weinstein (1989) corroborated the data of Taylor (1993) as well as the findings of Newman et al. (1993). Based on the pattern of findings described above, it appears that a period of accommodation, adaptation or acclimatization may occur within the first several months of hearing aid use such that the magnitude of benefit in the psychosocial dimension may change somewhat over time, with reality and exposure to a variety of listening situations, moderating the initial euphoria some people feel after the initial hearing aid fitting. The findings from the longitudinal studies on benefit in the psychosocial domain concur with the data of Gatehouse in that stabilization appears to take place about three months after the initial fitting. This trend underlines the importance of following patients over time at least for three months as problems seem to arise which can probably be remedied through counseling and/or hearing aid modification. Interestingly, the psychological literature is replete with studies demonstrating that three months is a key time frame for adaptation or "acclimatization" in a variety of domains of function.

Audiologic Correlates

Figure 1 summarizes the potential audiometric correlates of hearing aid benefit. With regard to pure-tone data investigators have considered the relation between aided functional gain and hearing aid benefit in the handicap domain of auditory function, the relation between hearing loss severity and hearing aid benefit in the handicap domain of function, and the extent to which real ear insertion gain measures correlate with self-perceived benefit derived from hearing aids.

As noted above, Newman et al (1991) reported on the beneficial effects of short term hearing aid

Figure 1. Potential correlates of benefit in the impairment domain of auditory function.

use in their large sample of new hearing aid users. As an adjunct to their study they explored the relation between hearing loss severity, word recognition ability and benefit in the handicap domain. They found that severity of hearing loss, and word recognition ability, did not influence the absolute handicap perceived by the respondents. Similarly, the amount of improvement in the psychosocial domain, associated with hearing aid use was not influenced by the latter audiometric variables. Subjects with mild and those with moderate to severe sensorineural hearing loss presented with comparable mean pre-fitting HHIE-S scores (16-18 points) and post-fitting HHIE scores (e.g. mean score = 3 points). Similarly, subjects with excellent word recognition ability perceived their handicap to be comparable to those with fair to poor performance on the monosyllabic word recognition task (Newman et al, 1991). As irrespective of hearing loss severity and word recognition ability, the mean HHIE-S score of subjects in the sample was approximately 18 points, this score may in fact be indicative of need for a hearing aid.

Mulrow et al (1992b) examined the audiological and non-audiological correlates of hearing aid use and benefit in a large sample of older subjects. The majority of subjects were fit monaurally with in-the-ear hearing aids. They reported on hearing aid benefit in a sample of older adults having moderate sensorineural hearing loss based on the mean HFPTA (1000, 2000 and 4000 Hz). The average functional gain in the high frequencies was reportedly 26 to 30 dBHL. The majority of subjects experienced over a 50 percent improvement in social and emotional function as assessed by the HHIE. As would be expected, the satisfaction rate was quite high, with nearly 70 to 80 percent reporting satisfaction with their units. Amount of functional gain in the high frequencies and gain in the speech recognition thresholds (SRT) following hearing aid use accounted for less than 11 % of the variance in hearing aid success as defined by improvements in HHIE scores. The HHIE

score measured at baseline was predictive of subsequent improvement in HHIE score as well as hearing aid satisfaction. The authors concluded that baseline handicap, in combination with age, education and number of medications is more predictive of individual success with or benefit from hearing aids than routine audiometric data. The data of Taylor (1993) corroborated their findings in that functional gain was minimally correlated with the magnitude of benefit in the psychosocial domain according to difference scores on the HHIE.

With regard to word recognition ability investigators have considered the relation between performance on a variety of speech recognition tests and hearing aid benefit in the handicap domain of auditory function. Overall, it seems that the beneficial treatment effects of hearing aids is differentially apparent depending on speech material used and whether in fact individuals present with peripheral or central auditory processing disorders.

Chmiel and Jerger (1996) evaluated the impact of hearing aids on the quality of life of older adults with primarily high frequency sensorineural hearing loss. Subjects were classified into two groups according to scores on the dichotic sentence identification (DSI) test (Fifer et al, 1983). In the latter test two different synthetic sentences, selected from a closed set of ten possible target sentences (SSI test materials), are presented to each ear simultaneously. The test is presented under two conditions, free report (FR) and directed report (DR). In the FR condition the patient reports the number corresponding to the two sentences heard. In the DR task, the patient hears both sentences once again, but is cued to report the sentence heard in a particular ear. The DSI sentences are presented at 20 dB SL re the pure-tone average of the poorer ear. On the basis of their performance on the dual mode DSI test, subjects are classified as "DSI normal" or "DSI abnormal." If the DSI results are abnormal on both FR and DR modes, the subject is classified as abnormal and it is assumed that the subject has

a peripheral auditory deficits accompanied by a central auditory processing disorder (CAPD). If there are no DSI abnormalities, the auditory deficit is attributed to a peripheral deficit with no central auditory processing deficit.

Subjects were fit monaurally with either a Siemens Triton 3000 or a 3M Memory Mate digital/analog hybrid instrument. The desired frequency response of the hearing aid was determined using the NAL-R procedure and all hearing aids were adjusted until the frequency response matched as closely as possible to the NAL-R target. The DSI-normal group ($n=42$) had comparable audiograms to those in the DSI-abnormal group ($n=21$). Similarly, the groups were closely matched for age with a mean age of 72 years for the former group and 70 years for the latter group. Their data suggested that treatment effect varied as a function of group membership. Persons in the DSI-normal group derived significant benefit from their hearing aids as evidenced by the reduction in HHIE scores following six weeks of hearing aid use. Subjects in the DSI-abnormal group, namely those considered to have CAPD, did not derive clinically significant benefits from hearing aids in the psychosocial domain of auditory function, as evidenced by the comparability of scores on the HHIE at baseline and following six weeks of hearing aid use. In short, the apparent central auditory deficit appeared to attenuate the self-perceived improvement in quality of life afforded by amplification in the latter group. It was of interest that informal caregivers however, perceived benefits in the psychosocial domain attributable to hearing aid use in older adults with CAPD. Caregiver ratings of psychosocial handicap experienced by subjects with CAPD revealed statistically significant reductions in scores on the Hearing Handicap Inventory For the Elderly for Significant Others (HHIE-SO). That is, even when the patient with CAPD did not report a reduction in hearing handicap with hearing aid use, the significant other often reported a reduction in handicap as a result of hearing aid use. The latter finding suggests that hearing aids may reduce the stress on communication partners despite the fact that the respondent with CAPD does not necessarily judge hearing aids to be effective in reducing their psychosocial handicap.

Hnath-Chisolm and Abrams (1993) investigated the relation between improvement in speech recognition performance and improvement in self-perceived handicap among new hearing aid users. Speech recognition performance was assessed at

baseline and at two-week intervals over a period of four sessions. The City University of New York (CUNY) Topic Related Sentence Test in the presence of multiple talker babble was used for the speech recognition tasks. Changes in auditory and auditory-visual word recognition ability were assessed over time. The HHIE was completed at baseline and at the final test session approximately six to eight weeks following the initial hearing aid fitting. While large individual differences in performance on the word recognition tasks emerged, significant differences between unaided and aided performance did not emerge on any of the word recognition tasks. Significant changes did however emerge in the perception of handicap such that the mean HHIE score at approximately two months after the fitting revealed a clinically and statistically significant reduction in self-perceived emotional/social handicap associated with the hearing impairment. As would be expected, only a minimal correlation emerged between subjective (HHIE) and objective (speech) measures. According to the authors, their findings are consistent with the data of Cox and Alexander (1992) who also found that significant changes in speech recognition performance in the presence of a background of noise did not emerge following hearing aid use in their sample of older adults. They did however note a relation between objective benefit using speech measures and more subjective benefit in the disability domain according to scores on the Profile of Hearing Aid Benefit (PHAB). Hnath-Chisolm and Abrams (1993) concluded that perhaps other auditory abilities not tapped by the speech recognition materials employed in their study may account for the reductions in hearing handicap noted. It may also be surmised that performance on the speech recognition tasks with hearing aids may impact more on perceived function in the auditory/communicative domain than in terms of psychosocial handicap.

The final audiologic variable to be studied in relation to hearing aid benefit in the handicap domain of auditory function is real ear data. As real ear measures are used by the majority of dispensing audiologists to select the electroacoustic characteristics of linear and nonlinear hearing aids and to verify their performance, it is important to know the extent to which these measures relate to perceived benefit in the handicap and/or disability domain. Nerbonne et al (1995) fit 51 adults and older adults with linear amplification using the NAL-R prescription formula. One to four months following the fitting, subjects completed the HHIE

or HHIA (depending on the subject's age) to determine their perception of aided performance with their newly acquired hearing aids. The authors computed the amount of "fitting error" or deviation from target found in real ear insertion gain (REIG) relative to NAL-R target values. They found that for the most part, fitting errors resulted in less gain than prescribed by the NAL-R formula. The correlation between REIG fitting error values and aided scores on the HHIE/HHIA were weak and for the most part, non-significant on the total scales and the emotional and social subscales of the HHIE/HHIA. The correlations are displayed in Table 3. Their conclusion that no obvious relationship appears to exist between degree of REIG fitting error and self-perceived benefit from amplification underlines the importance of verifying the fit of hearing aids using a variety of outcome measures. Real ear studies serve to verify the fit electroacoustically whereas measures of disability or handicap enable the patient to judge benefit according to their daily needs. In sum, real ear data may be viewed as evidence of improved audibility with amplification and as a way of verifying the desired electroacoustic response of the hearing aid. In contrast, change in HHIE/HHIA scores serve as an estimate of the amount of reduction in perceived handicap associated with hearing aid use. With the advent of non-linear hearing aids, the question becomes whether restoration of the loudness function implies benefit in the disability and handicap domains of auditory function. It is probable that the relation is imperfect and that the protocol for fitting nonlinear devices should incorporate a measure of benefit in the disability or handicap domain as in the IHAF protocol.

Hearing Aid Outcomes Using Generic Quality of Life Measures

As noted earlier, the effects of care on the health status of patients and populations is of utmost importance as agencies begin to consider the financial costs and benefits of various programs and interventions (Testa and Simonson, 1996). To this end, a number of recent studies have considered the impact of amplification on a variety of health related quality of life measures. The study conducted by Clemens Tesch-Romer (1996) was multidimensional in that subjects completed generic quality of life measures as well as the HHIE. The outcome domains assessed included: extent of involvement in leisure activities, satisfaction with social relations, psychosomatic well-being,

Table 3. Correlations between NAL/REIG and aided HHIE scores.

TOTAL and 500Hz:		-.41*
TOTAL and 1000 Hz:		-.22
TOTAL and 2000 Hz:		-.07
TOTAL and 4000 Hz:		-.09
TOTAL and HFA:		-.10
*Statistically significant		

and cognition. It was noteworthy that while hearing aid use dramatically reduced the self-perceived psychosocial and communication problems, intervention effects were negligible in the other functional and psychological domains of function studied. Tesch-Romer concluded that hearing aid use had no reliable effects on indicators of social activities, satisfaction with social relations, well-being or cognitive capacity.

Interestingly, the data of Mulrow et al (1990) and Mulrow et al (1992) were somewhat comparable to the above, in that intervention effects were more pronounced on disorder-specific than on generic quality of life measures. As noted above, approximately half of the subjects in their study obtained hearing aids and the other half were assigned to a waiting list group. Subjects in each group presented with a moderate sensorineural hearing loss with scores on the HHIE indicative of a moderate psychosocial handicap. Quality of life, measured at baseline, six weeks and four months following the hearing aid fitting, was defined as a multidimensional concept encompassing social, affective, cognitive and physical domains. Hearing aid treatment effects in the areas of cognition, affect, and global physical functional status were relatively small as compared to the effects detected on the disease specific instruments which assessed psychosocial handicap and communication function. Interestingly, at the twelve month follow-up while improvements in psychosocial function were sustained over a one-year period, the minimal changes in the area of cognition for example were not sustained after four months (Mulrow et al, 1992). The authors concluded that the differential effects and responsiveness of the quality of life measures may be due to the measures employed and to the fact that the effects of hearing impairment may be specific to certain domains of function.

Finally, Jerger et al (1996) recently reported on the impact of personal amplification systems (i.e. hearing aid Comtek personal FM system) on the quality of life of older persons. One hundred and eighty subjects with mild to moderate sensorineural hearing loss participated in their study. Subjects were fitted for six weeks with either the Siemens Triton 3000 or a 3M Memory mate digital/analog hearing instrument depending on the configuration of hearing loss. At baseline and six weeks following the experimental condition, namely the hearing aid fitting (HA), the FM system, or the combined HA/FM, all subjects completed a measure of speech understanding (i.e. the Speech Perception in Noise test-SPIN), and the HHIE. The generic quality of life measures completed at baseline and following each of the experimental conditions included: a measure of emotional status, a measure of participation in various activities, an index of life satisfaction, and a measure of affect. Amplification significantly improved speech recognition scores and reduced the self-assessed handicap according to improved scores on the HHIE. In contrast, treatment effects did not emerge on the generic quality of life measures. Jerger et al (1996) suggested that the high level education, adequacy of financial resources, and overall familial support which characterized participants in this study may have served as a "buffer" against the hearing loss impacting on scores on the more global quality of life measures.

In sum, while it appears that the benefits of hearing aids are best detected using disorder-specific questionnaires, clinicians must continue to examine how outcomes with hearing aids can be felt in the physical, cognitive and affective domains of function. It may well be that instruments with different specificity and responsiveness characteristics must be selected, or that counseling must extend into domains outside of communication. It is evident from the discussion below that counseling-oriented rehabilitation does in fact increase the proportion of people benefiting from hearing aids at least in the psychosocial domain.

Counseling-Based Audiologic Rehabilitation as Part of the Hearing Aid Fitting

In the aforementioned studies the hearing aid fitting was accompanied by a thirty minute to one hour counseling session that outlined the use, operation, and maintenance of the hearing aid. For the most part, the majority of subjects experienced significant benefit from hearing aids on se-

lected measures of communicative disability and psychosocial handicap. The data of Abrams et al (1992) demonstrate that benefit from hearing aids, namely improvements in emotional and social function, can be enhanced when a hearing aid is dispensed in the context of a counseling-based audiologic rehabilitation program. Abrams and his colleagues (1992) divided their sample of older adults with mild to moderate sensorineural hearing loss into three treatment groups. Treatment group I received a hearing aid and participated in three weeks of counseling-based audiologic rehabilitation. The rehabilitation consisted of an overview of hearing aids, their use, operation and maintenance; discussions about assistive listening devices, and an overview of speechreading strategies. Treatment group II received the hearing aid accompanied by a brief counseling session, typical of the aforementioned studies. Treatment group III served as the control group, merely completing the HHIE at baseline and at the two month follow-up.

Mean HHIE scores for each group were comparable at baseline. Two months after the hearing aid fitting, there was a clinically and statistically significant reduction in HHIE scores for treatment groups I and II. Interestingly, subjects obtaining the hearing aid and counseling-based audiologic rehabilitation experienced more significant reductions in psychosocial handicap than those who obtained the hearing aid without rehabilitation. This study confirmed the short-term benefit of hearing aids in the psychosocial domains of function lending support to the value of counseling-based audiologic rehabilitation. While counseling-based audiologic rehabilitation is not a standard part of the hearing aid delivery system, these data suggest that when a hearing aid is not effective in reducing the psychosocial or communicative handicap (e.g. noted at the three week follow-up), a brief interval of counseling should be instituted as it has the potential to promote hearing aid benefit. Primeau (1997) also found that a hearing aid fitting accompanied by more extensive counseling about hearing aids, and communication strategies, and/or hearing aid modifications, can promote hearing aid benefit among older adults who initially do not realize benefit from their hearing aids. He reported that 73% of subjects in the hearing aid only group showed a significant reduction in hearing handicap on the HHIE using the 95% confidence interval criteria. When the hearing aid only group was combined with the hearing aid plus rehabilitation group, 89% of his

subjects demonstrated a significant reduction in hearing handicap. His data confirm the conclusions of Abrams and his colleagues (1992) regarding the contribution of rehabilitation to the success of a hearing aid fitting. In short, hearing aid adjustments coupled with a brief period of audiologic rehabilitation which includes informational and personal adjustment counseling, discussions of assistive listening devices and environmental manipulation training, assertiveness training, and referral to consumer organizations such as a local Self Help for the Hard of Hearing (SHHH) group serve to promote end-user satisfaction and benefit.

While not all professionals provide orientation programs, the consumer organization Self Help For Hard of Hearing People, Inc. (SHHH), recently recommended that all hearing aid dispensers make available and encourage participation in group programs. Group orientation programs should be short term, three to six weeks, and provide sufficient time for an instructional component and for the emergence of group exchanges. The instructional component should include: (1) discussions about hearing loss and the audiogram; (2) instructions in troubleshooting hearing aids; (3) discussions about the availability of assistive listening devices to supplement hearing aids; (4) an introduction to speechreading/auditory training; and (5) overview of coping and conversational repair strategies to facilitate communication. It is helpful if the audiologist obtains objective feedback from patients regarding the value of the group orientation program to help justify it.

Benefit in the Disability Domain Equals Benefit in the Handicap Domain?

The typical protocol for fitting hearing aids incorporates the pre-selection, the hearing aid selection and the verification phase. The latter phase should be tied to the pre-selection and selection process. The measures administered during the pre-selection should serve as both the basis for making decisions regarding the technology recommended as well as the baseline against which to judge outcomes (Mueller, 1996). Mueller (1996) suggested that pre-selection measures should include the following: measures of audibility, supra-threshold measurements and responses to one-or more self-assessment inventories. With regard to the latter, he reasoned that self-assessment inventories are the best way to measure the outcome of the hearing aid fitting and thus should be incorporated from the beginning during the pre-selection phase.

Information garnered from responses to the initial self-assessment can assist in identifying candidates and can also be used as a benchmark against which to judge the benefit associated with a particular fitting. As we are trying to achieve a variety of outcomes with hearing aids, self-assessment inventories which measure different domains can assist in objectifying that which we are trying to assess. Mueller (1997) commented that audiologists need to conduct some measure of the patient's self-assessment of the benefit achieved with hearing aids and that this should be part of every hearing aid fitting. Mueller (1996) concurs with Weinstein (1996) in that he recommends that the HHIE/HHIA and the APHAB should be completed on all patients as they measure different domains of auditory function namely disability in the latter case and handicap in the former. The data of Weinstein et al, (1995) demonstrate the importance of measuring outcomes in a variety of areas as audibility does not insure disability reduction and disability reduction may not insure handicap reduction.

Weinstein et al (1995) recently completed a pilot study on seven subjects fit with linear hearing aids. The goal was to assess outcome in a multi-dimensional manner, namely in terms of impairment, disability and handicap and to determine the extent of relation between benefit which emerges in each of the domain. In all cases, REIG values met the NAL-R prescribed target with slight deviations at 4000 Hz. Seventy-one percent of their subjects were reportedly satisfied with their hearing aids according to responses to the Knowles Satisfaction Survey and 71% experienced statistically and clinically significant reductions in perceived handicap on the HHIE/HHIA. The remaining 29% of subjects met the NAL-R target, but were not satisfied and felt that the hearing aid did not alleviate their handicap. Benefit in the disability domain, as evidenced by change in APHAB scores unaided and aided, was more difficult to achieve because of the large critical differences necessary to conclude that the hearing aid is in fact beneficial (Cox and Alexander, 1995). Most notable was the imperfect relation between benefit in the handicap and disability domains. In their view the latter finding underlines the importance of combining measures of outcome as even when target values are met, benefit in one domain of auditory function (e.g. disability) does not necessarily signify benefit in another domain (e.g. handicap). If a patient experiences a dramatic reduction in the extent of disability yet continues to

perceive a handicap than counseling oriented rehabilitation should be considered as advocated by Abrams et al (1992). Similarly, if the patient experiences a reduction in handicap yet continues to be disabled in a number of situations than active listening training as described by Kricos and Holmes (1996) can be instituted. Kricos and Holmes (1996) demonstrated that active listening training can help older adults cope with communication breakdowns, can improve speech recognition ability and can reduce the extent of self-perceived disability. The goal of the listening training was to develop good listening habits in order to increase confidence and to help patients concentrate on the message being delivered. Strategies for recognizing nonverbal and situational cues were offered and the importance of environmental manipulation to facilitate listening was discussed. The training emphasized coping strategies to enable the person with hearing loss to comprehend the meaning of what has been said even when only a portion of the message has been heard. In short, the active listening training is similar to synthetic auditory training.

The case study presented below underlines the importance of obtaining impairment, disability, and handicap data to assist in judging the value of a given hearing aid. A 64-year old woman was fit with binaural completely-in-the canal hearing aids. The high frequency pure-tone average (1000, 2000, 4000 Hz) was 38 dB HL in the right ear and 40 dB HL in the left ear. Monosyllabic word recognition ability using the NU-6 lists was 88% and 86% in the right and left ears, respectively. At the time of the fitting she completed the HHIE-S to determine the extent of self-perceived handicap and the APHAB to determine the extent of her auditory disabilities prior to the hearing aid fitting. At the post-fitting stage, real ear measures were completed to verify that the frequency gain characteristics met the target. REIG values met

the NAL-R target (± 5 dB) at all frequencies except 4000 Hz which was within 10dB of target for each ear. At the post-fitting, the patient reported wearing her hearing aids for five weeks, an average of 12 hours per day. At this time, handicap and disability measures were re-administered to determine if she perceived herself to be benefiting from the new hearing aids. In general, she reported being satisfied with her hearing aids, with the services rendered by the audiologist and indicated that in her view the hearing aids had improved the quality of her life. The difference between aided and unaided scores on the HHIE-S indicated that she was deriving clinically significant benefit from the hearing aids at least in the handicap domain of auditory function. In contrast, the benefit score on the EC, RV or BN subscales of the APHAB was rather small ($<22\%$), well below the cut off necessary for the clinician to be certain that the change in scores represents a real difference between conditions (Cox, 1997) to be indicative of benefit in the disability domain. She kept the hearing aids and some active listening training was introduced. The training emphasized assertiveness in the listening situation and strategies for deriving information from the environment and from non-verbal cues to alleviate some of the auditory disability she continued to experience. Informally, Mrs. X indicated that the hearing aids seem increasingly helpful in a variety of listening situations. This case points out the importance of a multi-dimensional assessment of hearing aid benefit and satisfaction as benefit in one domain (e.g. disability) does not guarantee benefit in another domain (handicap). As emphasized by Mueller (1997), some measure of the patient's self-assessed benefit and satisfaction that has been achieved with hearing aids should be part of every fitting protocol. The domains of benefit which could be quantified as part of the hearing aid fitting are displayed in Figure 2.

Figure 2. Domains of hearing aid benefit.

CONCLUDING REMARKS

Throughout this paper the terms “consumer,” “customer” and “patient” have been used. The choice of the term was based on my understanding of the definitions of each. A consumer is an individual who seeks information about available hearing technologies but may or may not have a hearing impairment (Bevan, 1997). The customer is the person who seeks assistance from the hearing health care professional. He or she is seeking information about products which may help to overcome communication problems which hinder their enjoyment of daily life. The patient is the individual who ultimately accepts and responds to the technological recommendations offered by the hearing health care professional which in the context of this manuscript is the dispensing audiologist (Bevan, 1997). The challenge for the audiologist is to convert as many customers as we can into real patients. This goal can best be achieved by matching advancing technology to the expressed communicative and psychosocial needs of the customer (Bevan, 1997). A satisfied patient is one whose expectations are realistic and are in synchrony with actual performance with hearing aids. Audiologic rehabilitation in conjunction with hearing aids can often insure that actual performance matches expectations.

Self-assessment inventories which quantify the patient's disability and/or handicap when employed during the pre-fitting and post-fitting phases of the hearing aid fitting are ideal tools for merging patient needs, goals and objectives as they relate to hearing with contemporary hearing instrument technology (Bevan, 1997). It is clear from the above review of nearly twenty studies using subjects drawn from a host of clinical settings, that the report card on some of the available hearing aid technologies is quite favorable. In short, when clinical researchers have attempted to measure outcomes, beneficial effects emerge in either the disability or handicap domain. The data presented above should be used by clinicians to demonstrate to patients what can be accomplished with hearing aid use. It is hoped that the information presented within the article will be used to demonstrate to customers that hearing aids are cost and treatment effective solutions to hearing impairments, disabilities and handicaps (Bevan, 1997). It is hoped from this review that it is clear that existing and emerging hearing aid technologies are efficacious in reducing, or eliminating the hearing impaired patient's difficulties in one or more do-

main of auditory function. Finally, my extensive review of the outcomes literature enables me to conclude, without qualification, that audiologists should feel comfortable in making claims to their customers that adults and older adults can and do benefit from hearing aids and that benefit achieved at about three to four months following the hearing aid fitting can be sustained up to one year of hearing aid use. At this point, it should be recommended that patients return to the dispenser for follow-up to insure continued benefit.

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