An Evaluation of the HHIE-S as a Screening Tool for the Elderly Homebound Population

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The homebound elderly individual often does not receive audiological services even though many are hearing impaired. The feasibility of using the screening version of the Hearing Handicap Inventory for the Elderly (HHIE-S) as a substitute for pure-tone screening in initiating hearing health care with this population was evaluated. The relation between the HHIE-S and the 3-frequency, pure-tone average (PTA) in the better ear was investigated in 50 elderly homebound subjects. The PTA was used as the criterion measure. The results indicated that pure-tone sensitivity was most highly correlated with the situational subscale of the HHIE-S ($r = .67$) followed by HHIE-S total score ($r = .63$) and HHIE-S emotional subscale score ($r = .52$). Sensitivity/specificity rates and predictive value positive and predictive value negative further indicated that using the HHIE-S is a reasonable approach in identifying those individuals in need of further audiological services.

Faced with limited mobility and often overwhelming medical and physical problems, homebound elderly often receive little attention to their communication needs. Providing an audiometric evaluation may not be possible because of financial as well as physical limitations. However, it is important for health care workers to identify accurately an individual who has a hearing impairment so that intervention can be initiated. Although the medical signs of pathology can be detected with visual inspection of the ear and case history information, identifying hearing impairment (degree of hearing loss) and hearing handicap (its functional impact) are more problematic. Many different protocols have been proposed to identify elderly individuals who are potential candidates for further assessment

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(ASHA, 1989; Lichenstein, Bess, & Logan, 1988a; Schow, 1991; Schow & Gatehouse, 1990; Schow, Smedley, & Longhurst, 1990; Weinstein, 1986). One way of initiating hearing-health care for elderly homebound individuals is with a self-assessment scale of hearing handicap. Using a self-assessment questionnaire when a pure-tone screen is not available would provide a tool for assessing communication functioning and assist in identifying those individuals who should obtain further services.

The HHIE was developed by Ventry and Weinstein (1982) to use specifically with the elderly population. Since that time other studies have shown the significant audiometric correlates and test-retest reliability of the HHIE (Jupiter, 1982; Lichenstein, Bess, & Logan, 1988b; Newman & Weinstein, 1989; Weinstein, Spitzer, & Ventry, 1986; Weinstein & Ventry, 1983). Investigators have advocated using a pure-tone screening and a hearing-handicap assessment to identify hearing impairment when screening elderly individuals (Fino, Bess, & Lichenstein, 1989; Lichenstein et al., 1988b; Ventry & Weinstein, 1983). Weinstein (1986) reported using the HHIE-S and 40 dB HL pure-tone fence in a study that used the audiologist's recommendation for medical or audiologic intervention as the gold standard. The HHIE-S, a 10-item screening test, was derived from the 25-item version of the HHIE. This shortened version has comparable reliability and validity to the long form with an adequate internal consistency and high test-retest reliability (Ventry & Weinstein, 1983). They recommended using a 40 dB HL pure-tone screen and/or a handicap screen as the screening protocol. In an examination of many screening issues, Schow et al. (1990) concurred with this finding and concluded that the HHIE-S can reasonably be used as a substitute for pure-tone screenings in certain locations.

The HHIE-S is a valuable tool for a screening program. It is easily scored and does not need to be administered by an audiologist. The contribution of using a hearing-handicap scale as well as pure-tone screen in identifying hearing handicap and hearing impairment in elderly persons has been established; however, pure-tone testing with the homebound is not always possible. Furthermore, although using a questionnaire as a substitute for pure-tone testing has been investigated in other populations, the efficacy of this procedure has not been explored with homebound elderly persons (Lichenstein et al., 1988a; Schow et al., 1990; Weinstein, 1986). It is possible that the administration of a handicap scale in the home would identify those individuals who need further assessment. The results obtained on the HHIE-S administered by a nurse in the home could, thus, be used as the appropriate criterion measure for referral. The homebound elderly could then obtain needed rehabilitative services and improve their quality of life.

To validate the use of the HHIE-S alone to screen the elderly homebound, pure-tone sensitivity, specifically the PTA, was used as the criterion standard. Information on follow-up compliance from those individuals who had been referred was also used to evaluate the effectiveness of the HHIE-S. The PTA was chosen

as the criterion standard because using the three-frequency PTA is consistent with the way audiologists typically predict the threshold for speech as well as establish degree of disability and handicap imposed by a hearing impairment. Although it is accepted that two persons with the same degree of hearing loss may report different degrees of hearing handicap, both handicap measures and pure-tone findings are most often used when referring for follow-up evaluations. Therefore, in order to determine whether or not the use of a handicap scale would provide a means of identifying those individuals in need of follow-up, the PTA was chosen as the criterion measure. Compliance with follow-up would indicate that persons who had received the HHIE-S agreed with the findings, therefore validating the measure. The purpose of this study was to evaluate the relation between the HHIE-S and the PTA in the homebound elderly in order to determine the feasibility of using a handicap scale as a means of identifying those individuals who are in need of audiological services.

METHOD

Subjects

The subjects were 50 elderly individuals ranging in age from 65 to 85 years, selected from the homebound patients on the caseload of two nurse managers of the Visiting Nurse Service of New York City. All subjects were part of the Long Term Care Lombardi Program. Subjects who met the following criteria were randomly chosen to participate in the study:

1. No history of otologic disease, exposure to high-intensity occupational noise or ototoxicity. None of the subjects were hearing aid users.
2. Intact cognitive and linguistic abilities as reported in their medical charts and as evidenced on the Mental Status Questionnaire (Kahn, Goldfarb, Pollack, & Peck, 1960). This is a test consisting of 10 questions of orientation to place, time, recent memory, and calculation questions, such as date, what year it is, age, where is this place, and name of the president.
3. All subjects had received the HHIE-S administered by their nurse in a face-to-face interview format within the past year. The HHIE-S is a 10-item screening test, which includes five emotional items and five social-situational items. Scores on the HHIE-S range from 0-40; a "Yes" is given 4 points, a "No" is given 0 points, and a "Sometimes" response is 2 points (Ventry & Weinstein, 1983).

Procedure

Audiometric testing was completed using a Beltone portable audiometer 12D with TDH-49 earphones. Testing was conducted in the patients' homes. The au-

diometer was calibrated prior to the investigation and checked periodically over the 2-month period of the study. The audiological evaluation consisted of obtaining pure-tone thresholds using the Carhart-Jerger procedure (Carhart & Jerger, 1959). The PTA was based on thresholds obtained at 500, 1000, and 2000 Hz. All testing was conducted by a second-year graduate student in audiology who had completed all the required ASHA practicum hours and academic coursework for completion of the Master's Degree in Audiology. The student was supervised for the initial testing session. Audiometric testing conducted in the patient's home was done in the quietest room available. In most cases, this room was a carpeted bedroom. In order to insure test reliability, the threshold obtained at 1000 Hz was always obtained twice. The ear tested first was the better ear if there was one or the right ear. A repeat audiogram was performed if there was a high percentage of false positive/false negative responses. This was necessary for one-third of the subjects at the same session.

RESULTS

The distribution of subjects by hearing-loss category in this study is similar to the distribution of hearing loss found in the general geriatric population (Gates, Cooper, Kannel, & Miller, 1990). The majority of subjects had mild-to-moderate losses. The distribution of the subjects by hearing-loss category was as follows: 30% of the subjects (n = 15) had normal hearing, 30% (n = 15) had a mild hearing-loss, 24% (n = 12) had a moderate hearing-loss, 14% (n = 7) had a moderate-to-severe hearing-loss, and 2% (n = 1) had a severe hearing-loss. Data for moderate-to-severe and severe hearing-loss categories were collapsed to form one moderate-to-severe hearing-loss category. The mean three-frequency PTA for the better ear for all subjects was 36.8 dB HL.

The mean HHIE-S total scale score was 9.8; the mean HHIE-S emotional scale score was 3.9, and the mean HHIE-S situational scale score was 5.8. Therefore, according to the revised pass/fail criteria on the HHIE-S (Weinstein, 1986), 66% of the subjects (n = 33) passed the handicap screen (0-10 on the HHIE-S), 20% of the subjects (n = 10) reported a mild-to-moderate handicap (12-24 on the HHIE-S), and 14% of the subjects (n = 7) demonstrated significant handicap (26-40 on the HHIE-S).

Table 1 depicts the distribution of total HHIE-S scores for each hearing level category. For those individuals with a mild hearing loss, the distribution of hearing-handicap scores was similar to those for individuals with normal hearing. As hearing loss increases to the moderate category, a greater number of subjects reported some degree of hearing handicap. For those subjects with hearing losses greater than 55 dB HL PTA, the hearing handicap scores were more evenly distributed across handicap levels. The positive relation between the HHIE-S total score and PTA can be seen in Figure 1. To summarize, individuals with normal hearing or mild hearing loss reported little or no handicap and individuals with a

Table 1

Distribution of Subjects by HHIE-S (Total Score) and Hearing-Level Category (Based on the Three-Frequency PTA in the Better Ear)

Hearing-level category	*N*	HHIE-S 0-10	HHIE-S 12-24	HHIE-S 26-40
Normal (0-25 dB HL)	15	13	2	0
Mild (26-40 dB HL)	15	12	2	1
Moderate (41-55 dB HL)	12	6	3	3
Moderate-to-Severe (>55 dB HL)	8	2	3	3

moderate-to-severe hearing loss reported more significant handicap.

The mean total and subscale HHIE-S scores and mean PTAs as a function of hearing-level category are shown in Table 2. The mean total scale and mean emotional and situational subscale scores increase with increasing hearing impairment. The emotional subscale score was consistently lower than the situational subscale score for all hearing-impairment categories.

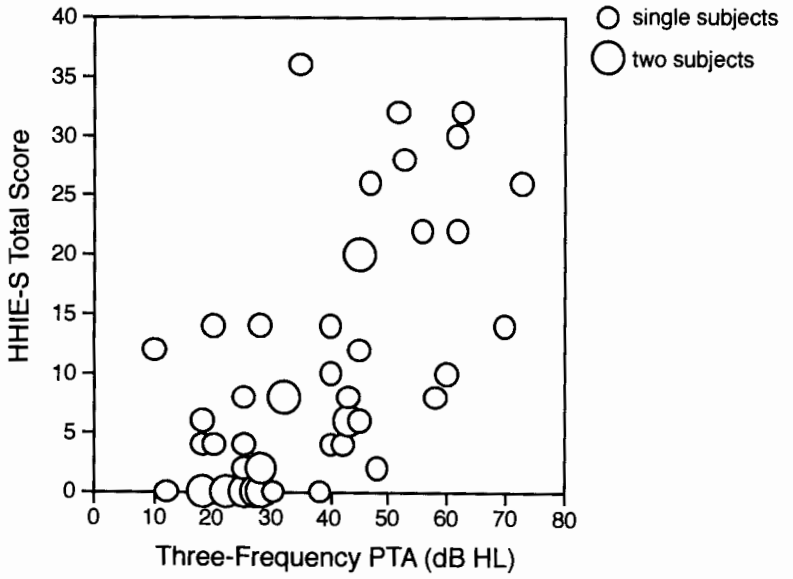

Figure 1. Scattergram of three-frequency PTA in the better ear by HHIE-S Total Score; small circles represent one-subject data points; large circles represent two-subject data points.

Table 2

Means, Standard Deviations, and Range for the HHIE-S by Hearing-Level Category Based on Three-Frequency PTA in the Better Ear

Hearing-level category	*N*	PTA (dB HL)	Total	Emotional	Situational
Normal (0-25 dB HL)					
M	15	20.2	3.7	1.5	2.3
S.D.		(4.7)	(4.9)	(2.9)	(2.4)
Range		10-25	0-16	0-10	0-6
Mild (26-40 dB HL)					
M	15	32.1	6.7	2.4	4.3
S.D.		(5.1)	(9.7)	(4.5)	(5.5)
Range		27-40	0-36	0-16	0-20
Moderate (41-55 dB HL)					
M	12	45.9	14.0	5.7	8.3
S.D.		(3.5)	(10.5)	(5.5)	(5.7)
Range		42-53	2-32	0-14	2-20
Moderate-to-Severe (>55 dB HL)					
M	8	63.0	20.5	8.8	11.6
S.D.		(5.8)	(8.8)	(6.1)	(4.2)
Range		56-73	8-32	0-16	6-16
TOTAL					
M	50	36.8	9.8	3.9	5.8
S.D.		(15.7)	(10.4)	(5.3)	(5.7)
Range		10-73	0-36	0-16	0-20

In order to determine the relation between PTA and self-assessed hearing handicap, Pearson product moment correlations were computed. Each of the correlations between the PTA and self-assessed hearing handicap as measured by the HHIE-S was significantly different from zero at the .05 level of confidence. The highest correlation was found between PTA and the situational subscale of the HHIE-S (r = .67), followed by the total scale score (r = .63), and the emotional subscale score and PTA (r = .52).

When screening the elderly in the community, Weinstein and Ventry (1983) advocated testing at 40 dB HL at 1000 and 2000 Hz as well as administration of the HHIE-S. If we use 40 dB HL PTA as our impairment fence and scores of >10 on the HHIE-S as indicating hearing handicap, the specificity rate is 83%, indicating that 83% of the people without hearing loss will be correctly identified and the sensitivity of the screen is 60%. These results are nearly the same as results by Weinstein (1986) who reported specificity of 83% and sensitivity of 65% when evaluating the revised HHIE-S.

The main objective of a screening test is to identify those individuals who have a disorder and to rule out or pass those individuals who do not have a disorder.

Table 3

Sensitivity/Specificity, False Negative/False Positive Rates of Screening Protocol for Elderly Homebound Individuals

	Failing scores on the HHIE-S scores for handicap					
	>10	>12	>14	>16	>18	>20
	40 dB HL PTA					
Sensitivity	60%	55%	50%	50%	50%	40%
Specificity	83%	87%	97%	97%	97%	97%
False negative	40%	45%	50%	50%	50%	60%
False positive	17%	13%	3%	3%	3%	3%

To determine the best cut-off score to use when administering the HHIE-S to the homebound, an investigation manipulating both HHIE-S cut-off scores and PTA of 40 dB HL was conducted (see Table 3). When using 40 dB HL as the PTA cut-off score and modifying the pass/fail criteria on the HHIE-S from 10 to 20, the sensitivity decreased from 60% to 40% and the specificity improved from 83% to 97%.

When evaluating a screening test, the predictive value positive and predictive value negative need to be calculated. The predictive values are related to disease prevalence and evaluate the percent of the patients correctly identified in the population. The predictive value of a positive (PVP) test is the expectation that an individual with a positive test has the disease and the predictive value of a negative (PVN) test is the expectation that a person with a negative test does not have the disease (Mausner & Kramer, 1985). The predictive value of using HHIE-S was computed using a 50% prevalence of hearing problems in the non-institutionalized elderly (Weinstein, 1986). Table 4 presents the predictive values associated with the HHIE-S screen using different cut-off scores on the HHIE-S and 40 dB HL as the PTA cut-off. As is evident from Table 4, the highest PVP (82.4%) and PVN (98.5%) is obtained when 14 is used as the cut-off score on the HHIE-S and 40 dB HL is used as the criterion measure.

To further evaluate the effectiveness of using the HHIE-S as a screening tool,

Table 4

Predictive Values (PV) Associated With the HHIE-S for a 50% Prevalence (n = 50) and a PTA Cut-Off of 40 dB HL

	Cut-off scores on HHIE-S		
	10	12	14
Predictive value positive	68%	64%	82%
Predictive value negative	87%	91%	99%

information was obtained on compliance with follow-up for individuals who had been referred. Follow-up data were obtained in two ways, through review of medical charts as well as personal contact with the nurse. Fifteen of the individuals in the study were referred for follow-up (30%). The criteria used for recommending follow-up was a cut-off score of 14 on the HHIE-S. Six of those individuals subsequently received hearing aids, two patients have appointments for an audiological evaluation, and one patient received an audiological evaluation and currently attends a tinnitus clinic. Two of the patients died, two moved into Nursing Homes, and two patients refused follow-up services. In total, 60% of the persons who needed services received them and this percentage increases to 69% if the two patients who died are subtracted from the total. Other investigators have reported follow-up figures from a variety of settings ranging from 19% (Schwartz & Matsko, 1988) to a high of 59% (Lichenstein et al., 1988b).

DISCUSSION

This study was designed to evaluate the relation between hearing handicap and hearing impairment in the homebound elderly population. The object of the investigation was to explore the efficacy of substituting the HHIE-S for a pure-tone screen as the initial screening tool before recommending a referral for further assessment.

The audiometric characteristics of the sample of subjects in this study are strikingly similar to those reported by other studies evaluating self-perceived hearing handicap in the elderly using the HHIE. For example, the mean better-ear, three-frequency PTA for the subjects in this study was 36.8 dB HL, compared to other findings of 40.9 dB HL (Marcus-Bernstein, 1986), 39.6 dB HL (Weinstein et al., 1986), 37.6 dB HL (Weinstein & Ventry, 1983), and 37.5 dB HL (Jupiter, 1982). The range for the subjects in this study was quite wide (10-73 dB HL), indicating considerable variability in the degree of hearing loss. Most of the subjects fell into the normal, mild, or moderate hearing-level categories.

The mean total HHIE-S score obtained in this study can be characterized as falling into the *no handicap* range. The variability in the perception of hearing handicap is considerably less in this population than with other populations. The lower handicap scores and decreased variability obtained with the homebound elderly compared to other populations may result from the fact that individuals who are homebound socialize less than the non-homebound, share a particular characteristic (being homebound), and may feel a decreased need for communication in a limited environment. There may be less variability in the handicap scores obtained on the HHIE-S with this population because there are fewer individual differences in personality, health, and lifestyle. In addition, individuals are often homebound because they have a number of medical problems, and, therefore, other physical and medical needs take precedence over the ability to communicate effectively.

Recall that a combination of the HHIE-S and 40 dB HL screening level was the screening protocol initially recommended by Ventry and Weinstein (1983). Homebound elderly individuals with greater than a 40 dB HL hearing-loss report greater self-perceived hearing handicap and are certainly candidates for further audiological care. Figure 1 demonstrates that of the 20 subjects with losses >40 dB HL, 10 had handicap scores of 18-40. A 40 dB HL PTA appears to be the level at which individuals begin to report handicap. It has been found that individuals who are not homebound begin to report some degree of hearing handicap when thresholds at 1000 Hz and 2000 Hz are greater than 25-30 dB HL and when thresholds are greater than 40 dB HL or 45 dB HL at 4000 Hz (Schow, 1991). The findings with the homebound population suggest that those persons who experience a moderate hearing loss report some degree of hearing handicap.

The correlational analysis revealed that the association between hearing handicap measured with the HHIE-S situational subscale and the better-ear, three-frequency PTA was stronger than either the correlation obtained with the total HHIE-S score or the emotional subscale score. The moderate positive correlation of .63 between the PTA and the HHIE-S total score closely corresponds to the correlation of .56 between PTA and the total HHIE score reported by Jupiter (1982), and .61 reported by Marcus-Bernstein (1986) and Weinstein and Ventry (1983). The moderate correlation between self-assessed hearing handicap and PTA, and the higher correlation found with the situational subscale score demonstrate the importance of pure-tone hearing sensitivity to self-assessed hearing handicap.

In reviewing several different screening programs using several different questionnaires as a substitute for pure-tone screening, Schow et al. (1990) reported sensitivity and specificity rates from populations of 100 to 1,124 persons. Their results are quite similar to those found with this population when a cut-off score of 10 on the HHIE-S and 40 dB HL PTA are used as the criterion standard. Although the population used in this study was smaller, the results are equivalent, validating the use of the HHIE-S with this population, even though the false negative rate is 40-50%.

When the sensitivity and specificity rates in this population are examined, it is evident that, in general, as the HHIE-S cut-off point is adjusted toward greater handicap, specificity is increased and sensitivity is decreased. For example, by using 40 dB HL as the cut-off for hearing impairment and 14 as the cut-off for hearing handicap, the operating characteristics of the screen are substantially changed: that is, 97% of the time the elderly individuals who are unimpaired will pass the HHIE-S test.

However, in determining the best cut-off score to use, the PVP and PVN as well as sensitivity and specificity rates need to be considered. The PVP and PVN are slightly higher in this population, although not substantially different from those reported by Weinstein (1986). Using 50% prevalence for hearing impair-

ment, scores of 80% for the PVP and 71% for PVN were reported by Weinstein (1986) when 10 was used as the cut-off score on the HHIE-S. Using the same cut-off score of 10, scores of 68% for PVP and 87% for PVN were obtained in this study. To increase the likelihood that those individuals most in need of services are referred for further audiological testing and rehabilitation services, it is recommended that a cut-off score of 14 on the HHIE-S should be used with this population. This score offered the best PVP (82%) and PVN (99%), as well as acceptable sensitivity (50%) and specificity (97%) rates when 40 dB HL is used as the criterion measure.

How can using the HHIE-S alone as a screening tool be justified given the possibility of missing half of those individuals who need services? To begin, there is, at present, no quantifiable method being used to screen this population. Furthermore, providing services for those individuals who are in greatest need will decrease unwanted over-referrals. The elderly homebound individual often does not have access to audiological services. Transporting homebound elderly persons to and from home to a speech and hearing center is neither time nor cost efficient. Many audiologists are not available for home visits. There is definitely a need to establish a reliable and valid indicator of when an elderly person who is homebound should be referred for an audiological evaluation. A more quantifiable method of assessing the need for audiological services is necessary as visiting nurses do not have the appropriate equipment to assess hearing sensitivity. They can, however, accurately ask questions designed to assess hearing handicap in the elderly. Administration of the HHIE-S by a nurse appears to be a good first step in the identification of those elderly homebound who are in need of further services.

It is important to acknowledge that there is an imperfect relation between hearing handicap and hearing impairment and that by substituting a handicap measure to identify individuals with a hearing impairment we will miss some of the individuals who need service. However, the homebound elderly are in a well-monitored environment and the high percentage of compliance with follow-up substantiates the finding that most of those individuals who are referred for further testing will in fact receive the needed services.

Because of difficulty in reaching subjects at home, only 50 subjects were selected to participate in this study. However, these results are similar to those of other investigations using the HHIE and HHIE-S with larger samples. Further investigations with this population should explore the use of other scales to evaluate hearing handicap with this population. Finally, it is critical to mention one of the most important, yet unmeasureable aspects of this study: the cooperation of the visiting nurses. All of the nurses were cooperative, helpful, and very supportive. The direction that should be followed to assess the rehabilitation and audiological needs of this population is a short easy-to-administer questionnaire.

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