Evaluation of the International Outcome Inventory for Hearing Aids in a Veteran Sample

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Abstract

Background: The International Outcome Inventory for Hearing Aids (IOI-HA) was developed as a global hearing aid outcome measure targeting seven outcome domains. The published norms were based on a private-pay sample who were fitted with analog hearing aids.

Purpose: The purpose of this study was to evaluate the psychometric properties of the IOI-HA and to establish normative data in a veteran sample.

Research Design: Survey.

Study Sample: The participants were 131 male veterans (mean age of 74.3 years, SD = 7.4) who were issued hearing aids with digital signal processing (DSP).

Intervention: Hearing aids with DSP that were fitted bilaterally between 2005 and 2007.

Data Collection and Analysis: Veterans were mailed two copies of the IOI-HA. The participants were instructed to complete the first copy of the questionnaire immediately and the second copy in two weeks. The completed questionnaires were mailed to the laboratory. The psychometric properties of the questionnaire were evaluated. As suggested by Cox and colleagues, the participants were divided into two categories based on their unaided subjective hearing difficulty. The two categories were (1) those with less hearing difficulty (none-to-moderate category) and (2) those who report more hearing difficulty (moderately severe+ category). The norms from the current veteran sample then were compared to the original, published sample. For each hearing difficulty category, the critical difference values were calculated for each item and for the total score.

Results: A factor analysis showed that the IOI-HA in the veteran sample had the identical subscale structure as reported in the original sample. For the total scale, the internal consistency was good (Chronbach’s $\alpha = 0.83$), and the test–retest reliability was high ($\lambda = 0.94$). Group and individual norms were developed for both hearing difficulty categories in the veteran sample. For each IOI-HA item, the critical difference scores were $<1.0$. This finding suggests that for any item on the IOI-HA, there is a 95 percent chance that an observed change of one response unit between two test sessions reflects a true change in outcome for a given domain.

Conclusions: The results of this study confirmed that the psychometric properties of the IOI-HA questionnaire are strong and are essentially the same for the veteran sample and the original private-pay sample. The veteran norms, however, produced higher outcomes than those established originally, possibly because of differences in the population samples and/or hearing aid technology. Clinical and research applications of the current findings are presented. Based on the results from the current study, the norms established here should replace the original norms for use in veterans with current hearing aid technology.

Key Words: Hearing aids, hearing loss, older adult, outcome assessment, patient outcome, treatment outcome, Veteran

Abbreviations: DSP = digital signal processing; IOI-HA = International Outcome Inventory for Hearing Aids

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There is increasing interest from clinicians, research investigators, administrators, and third-party payers in documenting treatment outcomes from the perspective of the patient using hearing aids (Bentler and Kramer, 2000; Cox and Alexander, 2002). The Department of Veterans Affairs (VA) is the largest single provider of hearing aids in the United States and spent over $125 million on hearing aids in the fiscal year 2007 (Beck, 2008). Hearing aid outcomes thus are of considerable interest to the VA and veterans.

Several self-report measures are available to determine the magnitude of hearing aid outcomes in a variety of domains such as benefit, satisfaction, activity limitations, and participation restriction. None of the available self-report measures comprehensively evaluates all of these domains. Investigators typically use a battery of self-report measures to evaluate hearing aid outcomes, which can make comparisons between studies difficult. The International Outcome Inventory for Hearing Aids (IOI-HA [Cox et al, 2000]), thus, was developed to compare data from a variety of hearing aid investigations using different methodologies (Cox et al, 2003). Originally, the IOI-HA was developed to be used as a supplemental measure to a battery of hearing aid outcome measures (Cox et al, 2000), but more recently it has emerged as an independent hearing aid outcome measure owing to the brevity in administration and scoring, the inclusion of comprehensive outcome domains, the strong psychometric properties, and the available normative data (Cox and Alexander, 2002; Cox et al, 2003).

The IOI-HA consists of seven items that target the following broad hearing aid outcome domains: (1) hours of daily use (USE), (2) benefit (Ben), (3) residual activity limitations (RAL), (4) satisfaction (Sat), (5) residual participation restriction (RPR), (6) impact on others (IoTh), and (7) quality of life (QoL). As implied, Item 1 (USE) provides an estimate of average hours of daily hearing aid usage. Item 2 (Ben) assesses how much improvement the hearing aids have provided, compared to before the hearing aids were worn, in a given listening situation. Item 3 (RAL) focuses on residual activity limitations, or the difficulty the hearing aid user continues to have in a given listening situation despite using the hearing aids (see Hickson and Scarinci, 2007, for a detailed review of activity limitations). Item 4 (Sat) inquires about the magnitude of hearing aid satisfaction, or the internalized fulfillment the hearing aids have provided despite the inherent obstacles that can occur from using hearing aids (Cox and Alexander, 1999; Humes, 1999). Item 5 (RPR) measures residual participation restriction, or the effect that residual hearing difficulties have on the ability of the hearing aid user to participate in various activities, such as attending a party (see Hickson and Scarinci, 2007, for a detailed review of participation restriction). Item 6 (IoTh) evaluates the impact that the residual hearing difficulties of the hearing aid user have on others. The final item (QoL) appraises how much the hearing aids have improved the quality of life of the user.

Each of these seven items has five response choices that semantically are equidistant and that are different for each item. For each response scale, the left anchor term is the worst outcome and the right anchor term is the best outcome. Each item is scored from 1 to 5, with 1 indicating the poorest outcome and 5 indicating the best outcome. A global score is calculated as the sum of the scores for all items. Higher scores indicate better outcomes (Cox and Alexander, 2002).

Cox et al (2003) developed IOI-HA norms on male and female patients with symmetrical hearing sensitivity who wore bilateral hearing aids obtained in a private-pay setting. Separate norms were established by grouping these patients into two categories based on their self-reported, unaided hearing difficulties. The participants were asked, “How much hearing difficulty do you have when you are not wearing a hearing aid?” (Cox et al, 2003). The responses ranged from 1 (severe) to 5 (none). These responses were used to categorize hearing aid users into either a mild-to-moderate category or a moderately severe+ category. Both group norms and individual norms were established. The original IOI-HA normative data were based on digitally programmable analog, single-memory, single-channel hearing aids. Cox and colleagues, however, suggest that new IOI-HA norms may need to be developed as hearing aid technology advances.

In a recent study, Cox, Alexander, and Gray (2005) found that hearing aid outcomes of veterans, a nonpay, predominately male population, are different from those of a private-pay population. In particular, their results suggest that a veteran sample reported higher hearing aid expectations and higher hearing aid benefit and satisfaction than private-pay patients.

Because most hearing aids that are fitted today are multiple-channel, multiple-memory hearing aids with digital signal processing (DSP) and because data suggest that veterans may have different hearing aid outcomes than non-Veterans, the IOI-HA was evaluated in a veteran sample. The specific purposes of this study were as follows: (1) to establish the psychometric proprieties of the IOI-HA in a veteran sample and (2) to develop normative data on male veterans fitted bilaterally with multiple-channel, multiple-memory hearing aids.

**METHOD**

**Participants**

A total of 131 male veterans, with a mean age of 74.3 years (SD = 7.4, range 55 to 87 years), completed this study. The mean audiometric thresholds are illustrated in Figure 1, with the error bars representing one
standard deviation. As seen in the audiogram, the participants had a mild to severe hearing loss bilaterally. All participants were fitted with multiple-memory, multiple-channel, DSP hearing aids at the James H. Quillen VA Medical Center, Mountain Home, Tennessee, between 2005 and 2007. At the time of the fitting, 95 participants were first-time hearing aid users, and 36 were experienced hearing aid users. All the hearing aids had manufacturer-specific noise-reduction algorithms, and most hearing aids had the option of a directional microphone (except for the completely-in-the-canal styles). The hearing aids were fitted and were verified using real-ear insertion measures via the National Acoustics Laboratories–Non Linear 1 fitting algorithm (Byrne et al., 2001). No special consideration was made to control for hearing aid style, microphone configuration, compression processing, or use of remote control. All hearing aid fittings were bilateral, and the same make and model were used for both ears. None of the participants were charged for the cost of the hearing aids; however, some veterans may have been charged a nominal copayment for their audiology appointment.

**Procedures**

A total of 250 veterans fitted with binaural hearing aids were randomly selected from a clinic database and were mailed two copies of the IOI-HA. At the time of the IOI-HA mailing, the participants had worn their current hearing aids at least six months but no longer than two years. The participants were asked to complete one copy of the IOI-HA immediately and the second copy two weeks later. A reminder letter was sent to participants who mailed in the first completed copy of the IOI-HA two weeks after receipt of the questionnaire. Business-reply envelopes were provided for the participants to mail the completed IOI-HA questionnaires to the laboratory. A total of 131 participants completed both copies of the IOI-HA (52.4% response rate) and were used in the analyses. The mean time between completion of the first and second IOI-HA was 33.1 days (SD = 18.8).

**RESULTS**

**Psychometric Properties**

Because of potential differences between a veteran sample and a private-pay sample, key psychometric properties of the IOI-HA were evaluated to ensure that the fundamental measures of validity and reliability of the IOI-HA were adequate in the veteran sample. First, a factor analysis was conducted to confirm the subscale structure of the IOI-HA. Second, internal consistency reliability was evaluated to assess the internal reliability of the IOI-HA, or the ability of the items to measure the same attribute.

Finally, test–retest reliability of the IOI-HA, or the stability of IOI-HA responses over time, was determined. To our knowledge, test–retest reliability had not been assessed previously.

**Factor Analysis**

A principal component analysis with varimax rotation was conducted, which resulted in a two-factor solution. The factor loading value for each item included in each of the two factors is listed in Table 1 along with the factor loadings found by Cox and Alexander (2002), shown in parentheses. The factor analysis resulted in the identical factor solution with both the veteran sample and the Cox and Alexander sample. The factor loadings were similar between the two samples. All the factor loadings were high and >0.70. Factor 1 items related to “me and my hearing aids” (Items 1, 2, 4 and 7), and Factor 2 items related to “me and the rest of the world” (Items 3, 5, and 6 [Cox and Alexander, 2002, p. 33]). The percent of the variance accounted for by this solution was 36.7 percent for Factor 1 and 34.1 percent for Factor 2, which was similar to the variance accounted for with the same two-factor solution determined by Cox and Alexander (Factor 1 = 46.7%, Factor 2 = 22.1%).

**Internal Consistency Reliability**

Internal consistency reliability was evaluated via Chronbach’s α, and the following values were obtained: (1) α = 0.83 for the total scale, (2) α = 0.84 for the Factor 1 subscale, and (3) α = 0.75 for the Factor 2 subscale. These results suggest that the IOI-HA has good internal
consistency reliability in a veteran sample (Hyde, 2000). Cox and Alexander (2002) report similar results with their sample (Chronbach’s $\alpha = 0.84$ for the Factor 1 subscale, Chronbach’s $\alpha = 0.67$ for Factor 2).

Test–Retest Reliability

Guttman split-half coefficients were used to assess the test–retest reliability. The results showed the following: (1) $\lambda = 0.94$ for the total scale, (2) $\lambda = 0.94$ for the Factor 1 subscale, and (3) $\lambda = 0.89$ for the Factor 2 subscale. The test–retest reliability scores for the IOI-HA total scale and individual subscales are high, suggesting that the IOI-HA is stable over time.

Normative Data

In the current study, both individual and group IOI-HA norms were developed based on veterans wearing multiple-memory, multiple-channel DSP hearing aids. For a patient, each IOI-HA item response can be compared to the individual norms to determine whether or not the outcome for the domain measured by that item is acceptable. Likewise, the mean IOI-HA item responses from a group of hearing aid wearers (e.g., a clinic sample) can be compared to the group norms to determine whether or not the average results for each outcome domain are suitable.

Duplicating the analyses of Cox and colleagues, individual and group norms also were subdivided into categories based on the veterans’ responses to the question “How much hearing difficulty do you have when you are not wearing a hearing aid?” A total of 53 veterans were placed into the none-to-moderate hearing difficulty category ($2 = \text{none}$, $7 = \text{mild}$, and $44 = \text{moderate}$), and 79 were categorized as moderately severe+ ($53 = \text{moderately severe}$ and $26 = \text{severe}$).

Table 1. Factor Loading Values for Each International Outcome Inventory for Hearing Aids Item for Each Factor from the Veteran Sample and the Cox and Alexander (2002) Sample (in Parentheses)

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hours of daily use (USE)</td>
<td>0.83 (0.73)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Benefit (Ben)</td>
<td>0.77 (0.81)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Residual activity limitations (RAL)</td>
<td>0.82 (0.62)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Satisfaction (Sat)</td>
<td>0.79 (0.86)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Residual participation restriction (RPR)</td>
<td>0.74 (0.79)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Impact on others (Ioth)</td>
<td>0.81 (0.82)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Quality of life (QoL)</td>
<td>0.75 (0.84)</td>
<td></td>
</tr>
</tbody>
</table>

None-to-Moderate Category: Group Normative Data

The means and standard deviations for scores on each IOI-HA item are listed in Table 2 (left side), along with the data from the original, private-pay sample. These mean item scores from the two samples were compared using one-way analyses of variance. All item scores from the veteran sample were significantly higher than scores from the private-pay sample except for the item related to daily hearing aid use (Item 1). Specifically, veterans had significantly higher scores on Item 2 (Ben, $F(1, 122) = 4.86, p < .05$), Item 3 (RAL, $F(1, 122) = 8.96, p < .01$), Item 4 (Sat, $F(1, 122) = 24.23, p < .001$), Item 5 (RPR, $F(1, 122) = 8.40, p < .01$), Item 6 (Ioth, $F(1, 122) = 4.67, p < .05$), and Item 7 (QoL, $F(1, 122) = 26.33, p < .001$).

None-to-Moderate Category: Individual Normative Data

Individual norms are reported in terms of the middle 50 percent of the response range for each item, as was done by Cox et al (2003). Table 3 lists the individual norms on the IOI-HA items for veterans and private-pay individuals. The left side of the table displays the norms for individuals in the none-to-moderate hearing difficulty category. The ranges that were different between the samples are listed in boldface. Veterans had higher outcomes than the private-pay sample most notably on satisfaction (Item 4) but also on items related to residual participation restriction (Item 5).

Table 2. Normative Data from the Veteran Sample and from the Cox et al (2003) Private-Pay Sample for Comparison with Group Data

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>None to Moderate</th>
<th>Moderately Severe+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Veteran (N = 53)</td>
<td>Private Pay (N = 71)</td>
</tr>
<tr>
<td>----</td>
<td>-------------------------------------</td>
<td>------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>1</td>
<td>Hours of daily use (USE)</td>
<td>3.6 1.0</td>
<td>3.7 1.2</td>
</tr>
<tr>
<td>2</td>
<td>Benefit (Ben)</td>
<td>3.8 1.0</td>
<td>3.4 1.0</td>
</tr>
<tr>
<td>3</td>
<td>Residual activity limitations (RAL)</td>
<td>3.9 0.8</td>
<td>3.4 1.0</td>
</tr>
<tr>
<td>4</td>
<td>Satisfaction (Sat)</td>
<td>4.2 1.0</td>
<td>3.2 1.2</td>
</tr>
<tr>
<td>5</td>
<td>Residual participation restriction (RPR)</td>
<td>4.1 0.7</td>
<td>3.6 1.1</td>
</tr>
<tr>
<td>6</td>
<td>Impact on others (Ioth)</td>
<td>4.2 0.9</td>
<td>3.8 1.1</td>
</tr>
<tr>
<td>7</td>
<td>Quality of life (QoL)</td>
<td>4.0 0.8</td>
<td>3.2 0.9</td>
</tr>
</tbody>
</table>
and impact on others (Item 6). On the other hand, veterans reported fewer hours of daily hearing aid use (Item 1) than the private-pay patients.

**Moderately Severe+ Category: Group Normative Data**

The right side of Table 2 lists the means and standard deviations for scores on each IOI-HA item from both samples in the moderately severe+ hearing difficulty category. The comparison of the mean item scores between the two samples showed that the veteran sample had significantly higher outcomes on items related to benefit (Item 2, \(F[1, 150] = 5.52, p < .05\)) and satisfaction (Item 4, \(F[1, 150] = 7.83, p < .01\)). No other significant differences were found between the scores for any other item.

**Moderately Severe+ Category: Individual Normative Data**

The right side of Table 3 displays the individual norms on the IOI-HA items for veterans and private-pay individuals in the moderately severe+ category. The ranges that were different between the two samples are indicated in boldface. As seen from the table, the norms between the two samples were slightly different on four items. Veterans reported better outcomes than the private-pay sample in the domains of benefit (Item 2), residual activity limitation (Item 3), satisfaction (Item 4), and quality of life (Item 7).

**Critical Difference Scores**

Because the IOI-HA was administered on two occasions, critical difference scores and 95 percent confidence intervals were calculated. The critical difference scores were computed using the standard error of measurement on the IOI-HA item scores and on the global score for each test occasion to determine the standard error of the difference (Demorest and Walden, 1984). These were calculated separately for the none-to-moderate category and for the moderately severe+ category. Table 4 lists the critical difference scores for each category. The critical difference score for any item in either hearing difficulty category was less than 1.0, which is less than the one-unit interval on the IOI-HA response scales. This finding indicates that there is a 95 percent probability that a real change has occurred whenever an individual veteran changes a response on any IOI-HA item between two test sessions. The critical difference values for the global scores also were computed and are listed in the bottom of Table 4.

**DISCUSSION**

Differences in hearing aid outcomes between groups of veterans and private-pay individuals have been demonstrated (Cox et al, 2005). Because of these reported differences, a focus of the current study was to confirm that the IOI-HA was appropriate for veterans by demonstrating that basic psychometric

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### Table 3. Normative Data from the Veteran Sample and from the Cox et al (2003) Private-Pay Sample for Comparison with Individual Data

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>None to Moderate</th>
<th>Moderately Severe+</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Veteran ((N = 53))</td>
<td>Private Pay ((N = 71))</td>
</tr>
<tr>
<td>1</td>
<td>Hours of daily use (USE)</td>
<td>3–4</td>
<td>3–5</td>
</tr>
<tr>
<td>2</td>
<td>Benefit (Ben)</td>
<td>3–4</td>
<td>3–4</td>
</tr>
<tr>
<td>3</td>
<td>Residual activity limitations (RAL)</td>
<td>3–4</td>
<td>3–4</td>
</tr>
<tr>
<td>4</td>
<td>Satisfaction (Sat)</td>
<td>4–5</td>
<td>2–4</td>
</tr>
<tr>
<td>5</td>
<td>Residual participation restriction (RPR)</td>
<td>4–5</td>
<td>3–4</td>
</tr>
<tr>
<td>6</td>
<td>Impact on others (Ioth)</td>
<td>4–5</td>
<td>3–5</td>
</tr>
<tr>
<td>7</td>
<td>Quality of life (QoL)</td>
<td>3–4</td>
<td>3–4</td>
</tr>
</tbody>
</table>

### Table 4. Critical Difference Scores from the Veteran Sample on Two Administrations of the International Outcome Inventory for Hearing Aids

<table>
<thead>
<tr>
<th>#</th>
<th>Item</th>
<th>None to Moderate ((N = 53))</th>
<th>Moderately Severe+ ((N = 79))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hours of daily use (USE)</td>
<td>0.40</td>
<td>0.32</td>
</tr>
<tr>
<td>2</td>
<td>Benefit (Ben)</td>
<td>0.38</td>
<td>0.32</td>
</tr>
<tr>
<td>3</td>
<td>Residual activity limitations (RAL)</td>
<td>0.34</td>
<td>0.31</td>
</tr>
<tr>
<td>4</td>
<td>Satisfaction (Sat)</td>
<td>0.39</td>
<td>0.32</td>
</tr>
<tr>
<td>5</td>
<td>Residual participation restriction (RPR)</td>
<td>0.29</td>
<td>0.34</td>
</tr>
<tr>
<td>6</td>
<td>Impact on others (Ioth)</td>
<td>0.34</td>
<td>0.36</td>
</tr>
<tr>
<td>7</td>
<td>Quality of life (QoL)</td>
<td>0.32</td>
<td>0.28</td>
</tr>
<tr>
<td></td>
<td>Global Score</td>
<td>1.75</td>
<td>1.62</td>
</tr>
</tbody>
</table>
properties of the IOI-HA were similar to those found by Cox and Alexander (2002) using a private-pay sample. A secondary purpose of this study was to establish group and individual normative data for veterans who were fitted with technologically advanced hearing aids compared to the sample from which the original IOI-HA norms were developed.

The psychometric properties of the IOI-HA in the current study were nearly identical to those found originally, confirming that the IOI-HA is a valid and reliable measure of global hearing aid outcomes. The current findings also support that the IOI-HA is an appropriate hearing aid outcome measure for veterans. The psychometric properties of the IOI-HA were extended by determining the short-term test–retest reliability of the questionnaire. The test–retest reliability coefficients exceeded 0.80, suggesting that the IOI-HA is highly stable when two administrations of the questionnaire are given within one month.

Group norms are used to provide a reference when evaluating the outcomes for a group of hearing aid users. Likewise, to investigate the outcomes of a single hearing aid user, individual norms are used. In the current study, both group and individual norms were established for veterans and then compared to the original, private-pay norms. The group normative data will be considered first (Table 2).

Overall, veterans reported higher outcomes than the private-pay sample. In particular, the veterans who reported unaided hearing difficulties as none to moderate in degree had significantly higher outcomes for all domains except for hours of daily hearing aid use, although the differences were small. Veterans in the moderately severe+ category, however, reported higher outcomes only on benefit and satisfaction domains.

There are at least two major variables that differ between the current study and the Cox et al study. First, participants in the current study were issued hearing aids of advanced technology that included multiple memories, multiple channels, directional microphones, and noise-reduction algorithms. Several studies have demonstrated that DSP hearing aids with these features provide better hearing aid outcomes across a variety of domains over single-channel, analog hearing aids with a single memory (Marriage et al, 2004; Shi et al, 2007).

Second, the population sample (i.e., veterans vs. private pay) differed between the two studies. The veteran sample differed from the private-pay sample in the following ways: (1) the veteran sample included only males, and (2) veterans were not charged for the cost of the hearing aids. Cox et al (2003) did not find gender differences on IOI-HA responses, and therefore, having an all-male sample most likely did not contribute to the differences seen between the two samples. Another population sample difference may be associated with the financial cost for obtaining the hearing aids. Whereas the veteran sample did not pay for hearing aids, the private-pay patients in the original sample may have spent thousands of dollars for their hearing aids. The relation between payment and outcome measures, however, is not clear (Cox and Alexander, 2001; Cox et al, 2005). Although not a part of the current study, personality differences between veteran and private-pay hearing aid users have been reported and may have contributed to the differences between the studies (Cox et al, 2005).

Clinically, the individual normative data may be of more practical use to the hearing health care provider than group normative data. To use the individual norms, the clinician first needs to determine the unaided subjective hearing difficulty category for a given patient. The most recent version of the IOI-HA includes the hearing difficulty question as “Item 8” on the questionnaire. When administering this version of the IOI-HA, Item 8 is not included in the global score and is used only for normative purposes. The clinician then would select the appropriate category of norms to use for comparison, either the none-to-moderate category or the moderately severe+ category, based on the patient response to Item 8. For each item, the patient response can be compared to the current individual normative data listed in Table 3. A response that falls within or exceeds the normative range would be consistent with a good result for the given hearing aid outcome domain and may not require follow-up. A patient response that falls below the normative range would be consistent with poorer-than-expected hearing aid outcomes for that particular domain, indicating the need for follow-up. The clinician also may decide to evaluate this problem domain further by administering a comprehensive self-report measure targeting the given domain more specifically. Benefit, for example, could be explored in more detail by administering the Abbreviated Profile of Hearing Aid Benefit questionnaire (Cox and Alexander, 1995). The information gained from comparing individual IOI-HA responses to the individual normative data could assist clinicians in determining the need for and selecting an appropriate intervention strategy such as hearing aid adjustments, audiologic rehabilitation, and/or counseling.

In addition to the normative data, the critical difference scores reported here can be used to compare IOI-HA outcomes for an individual on two occasions (see Table 4). Recall that the IOI-HA critical difference scores for both hearing difficulty categories are less than 1.0 and the response scale for each IOI-HA item is measured in one-unit intervals. The critical difference for any IOI-HA item for an individual, therefore, is rounded to 1. Two possible applications for using critical difference scores would be to compare two hearing aid fittings (e.g., hearing aid A

IOI-HA in Veterans/Smith et al
vs. hearing aid B) or to assess the outcomes with a given hearing aid over time for an individual. The clinician can be 95 percent confident that an individual item score that differs by one response unit reflects a true outcome change in that domain. For a given patient, a change in score on at least two items indicates a more comprehensive change in outcomes for this individual (i.e., significant change in global score). To use critical difference scores for group data, however, the appropriate hearing difficulty category should be selected, and the actual values listed in Table 4 should be used.

**SUMMARY AND CONCLUSIONS**

In summary, the purposes of the current study were as follows: (1) to confirm the psychometric properties of the IOI-HA in a veteran sample and (2) to establish normative IOI-HA data in veterans using current hearing aid technology. The results of the current study demonstrated that the psychometric properties of the IOI-HA are similar to those found originally (Cox et al, 2000) and the IOI-HA is appropriate to use with veteran hearing aid users. The test–retest reliability also was determined and suggested that the IOI-HA is highly stable over the short term. Individual and group normative data were developed for the veteran sample with current hearing aid technology and were compared to the original normative data developed by Cox and colleagues (2003). These comparisons suggested better outcomes for this veteran sample than was reported for the original, private-pay sample with analog single-memory, single-channel hearing aids. The critical difference scores to detect true changes in IOI-HA outcomes over two test sessions also were calculated and can be used clinically to compare hearing aid outcomes on two separate occasions. Because hearing aids currently fitted today are advanced in technology compared to those for which the original norms were developed, we suggest that the normative data developed here replace the original norms for clinical and research purposes in VA audiology clinics. Further investigation is needed to determine whether or not these norms are appropriate for private-pay patients.

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**NOTE**

1. The updated English-norms version of the IOI-HA, which includes the eighth item used for normative purposes only, can be found on the University of Memphis Hearing Aid Research Laboratory Web site: http://www.ausp.memphis.edu/harl.

**REFERENCES**


