Can Routine Office-Based Audiometry Predict Cochlear Implant Evaluation Results?

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Abstract

Outcome Objectives: Determining cochlear implant candidacy requires a specific sentence-level testing paradigm in best-aided conditions. Correlation of the findings on routine audiometry with those of formal cochlear implant (CI) evaluation has not been performed. Our objective was to determine if findings on routine office-based audiometry could predict the results of CI candidacy evaluation.

Methods: The charts of all adult patients who were evaluated for CI candidacy at a tertiary care center from June 2008 through June 2013 were included. Routine, unaided audiologic measures (pure-tone hearing thresholds and recorded monosyllabic word recognition test (MWRT) results) were then correlated with best-aided sentence-level word discrimination test (SWDT) results using either Hearing in Nois Test (HINT) or AzBio sentences.

Results: The degree of hearing loss at 250-4000Hz significantly correlated with SWDT results. Additionally, 87% of patients who scored <30% in MWRT qualified for implantation using HINT sentences. Similarly, in patients whose MWRT scores were <35%, 81% and 93% met CI candidacy criteria when using AzBio sentence testing in quiet and noise respectively.

Conclusions: Routine office-based audiometry can be used to identify patients who would likely meet CI candidacy upon formal testing. For example, pure tone thresholds (250, 500, 1000 Hz) of ≥75dB and a MWRT score of ≤40% when evaluating using AzBio sentences collectively identifies a patient with high likelihood of meeting candidacy criteria. Utilization of these predictive patterns during routine audiometry may assist hearing health professionals in deciding when to refer patients for a formal CI evaluation.

Background

• The effectiveness of cochlear implantation in restoring hearing and improving quality of life are well documented
• Many individuals that may potentially receive benefit from a cochlear implant are not obtaining an implant1,2
• Some sources suggest fewer than 6% of Americans who could benefit from a cochlear implant have actually been implanted3
• We believe that there are a number of factors contributing to the under-utilization of cochlear implants:
  o Lack of practitioner familiarity with cochlear implantation1
  o Lack of suboptimal screening for hearing loss in primary care offices4
  o Difficulty in determining when a patient’s hearing loss is severe enough to warrant a CI referral based upon routine audiometric measurements
  o Introduction of newer, more challenging sentence level testing material
  o Improvement of existing sentence level testing material
  o Development of computerized tests using sentences that are easy to understand

Hypothesis

We hypothesize that findings on routine office-based audiometry are predictive of formal cochlear implant candidacy evaluation results.

Hearing Loss Evaluation

Routine office-based studies:
• Ear examination
• Pure-tone hearing threshold testing
• Monosyllabic word recognition testing→ patient repeats back words that they hear ("dog, cat, ball, tree, etc.")

Formal cochlear implant evaluation studies:
• Ear examination
• Review of prior hearing evaluations
• Repeat pure-tone hearing threshold testing
• Sentence-level word discrimination testing in best aided conditions - patient repeats back sentences that they hear ("The dog barked at the cat and chased it around the yard.")
  ▪ Using either HINT or AzBio sentence lists
  ▪ Without and possibly with background noise

Methods

• 147 patients who had undergone a formal cochlear implant candidacy evaluation at the University of Wisconsin Hospital from 2008 to 2013 were included in the study
• Pertinent data from their health records included:
  o Pure-tone hearing threshold test results
  o Monosyllabic word recognition test (MWRT) results (recorded voice)
  o Best-aided sentence-level word discrimination test (SWDT) results
  o Sentence-level testing material used: HINT vs. AzBio sentences
• Routine office-based audiometry study results were then correlated to the formal cochlear implant candidacy evaluation results:
  o Pure-tone tests vs. HINT/AzBio SWDT results
  o MWRT vs. HINT/AzBio SWDT results
• Test results were then additionally stratified according to the pattern of the hearing loss (down-sloping or flat) and correlated to the HINT/AzBio SWDT results
  o Down-sloping (high frequency loss) was defined as pure tone thresholds increasing by ≥30dB HL from lower to higher frequencies
  o Flat was defined as pure tone threshold values that were all within 30dB HL of each other
• The correlations were then plotted and Pearson correlation coefficients were generated
• Using 40.0% correct in SWDT as a threshold value (Medicare candidacy criteria), a benchmark value was obtained for the routine audiometric tests
• Using the plotted correlations and the benchmark value, the percentage of patients who would qualify for implantation according to Medicare criteria was calculated

Results

• Pure-tone hearing threshold results at 250, 500, 1000, 2000, and 4000Hz, and MWRT results all correlated with SWDT results (Table 1)
• The percentage of patients who would qualify for implantation according to Medicare criteria was calculated (Table 2) using the plotted correlations (Figure 1) and the benchmark values identified
• When stratified according to the pattern of hearing loss, the MWRT results correlated to SWDT results for both down-sloping and flat patterns of hearing loss (Table 2)

Table 1. The correlations of both pure-tone hearing threshold and MWRT results to the SWDT results. The closer a correlation score (Pearson) is to 1, the stronger the correlation. Results: statistically significant (p<0.05).

<table>
<thead>
<tr>
<th>Measure</th>
<th>Benchmark Value</th>
<th>Percent Qualified</th>
</tr>
</thead>
<tbody>
<tr>
<td>250Hz</td>
<td>54.71±8</td>
<td>83.3%</td>
</tr>
<tr>
<td>500Hz</td>
<td>62.47±8</td>
<td>79.3%</td>
</tr>
<tr>
<td>1000Hz</td>
<td>75.65±8</td>
<td>76.0%</td>
</tr>
<tr>
<td>2000Hz</td>
<td>88.67±8</td>
<td>81.5%</td>
</tr>
<tr>
<td>4000Hz</td>
<td>92.70±8</td>
<td>79.3%</td>
</tr>
<tr>
<td>MWRT</td>
<td>35.6%</td>
<td>81.5%</td>
</tr>
<tr>
<td>DS-MWRT</td>
<td>35.0%</td>
<td>68.8%</td>
</tr>
<tr>
<td>F-MWRT</td>
<td>40.6%</td>
<td>90.0%</td>
</tr>
</tbody>
</table>

Table 2. The benchmark values were first obtained by plotting out the respective correlations. Of the patients who scored at or below the benchmark value, the percentage who qualified for implantation was calculated. DS= down-sloping, F= flat.

Conclusions

• Findings on routine office-based audiometry can be used with good accuracy to identify patients who have a high likelihood of meeting audiological candidacy requirements for cochlear implantation
• Our results suggest that patients with the following findings have a high likelihood (80%) of meeting candidacy for CI:
  1. Bilateral sensorineural hearing loss AND is struggling with their hearing aids
  2. Significant (~65dB) low-frequency hearing loss (250-4000Hz)
  3. Performs poorly in monosyllabic word recognition testing (<35%)
• Utilization of these data by otolaryngologists, audiologists and hearing instrument specialists can guide appropriate referral of patients who are likely to benefit from cochlear implantation

References


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