Bedside Sound Generators as a Tool for Tinnitus Management

Background

Up to 58% of tinnitus patients report tinnitus-related sleep disturbance (Jastrebof & Hazell, 2004; Benton, 2011), which may result from the strengthening of the tinnitus signal caused by abnormal internal auditory gain related to near-silent sleep environments. As tinnitus signal strength increases, negative engagement of the limbic and autonomic nervous systems increases, resulting in sleep-disturbing physiological arousal and alertness.

Sound enrichment restores lateral inhibition and decreases abnormal internal auditory gain, thereby reducing tinnitus signal strength and the resulting physiological arousal and alertness. Bedside sound generators are routinely recommended for bedtime sound enrichment to facilitate falling and staying asleep. The soothing quality of nature sounds also facilitates the relaxation response.

Landscomb (2006) reported that mean scores on the Pittsburgh Sleep quality Index (PSQI) improved significantly \((p < .01)\) among a group of 35 tinnitus subjects who used bedside sound generators. She also reported that the specific sound chosen by the individual subject was based primarily on “liking” the sound rather than on evaluating its actual effectiveness. Landscomb focused on the specific sounds the subjects preferred to use; we chose to examine sleep improvement ratings reported by device users and health factors that may affect those ratings.
Methods

Questionnaires were mailed to 526 device users randomly selected from a pool of 986. Each subject had 6-12 months experience using a specific commercially available device (Marsona 1288A). A total of 230 questionnaires were returned (43.7% return rate), of which 36 were excluded because of unilateral tinnitus (11) or multiple/absent responses (25). All 184 included subjects (35.0% useable return rate) were male and reported bilateral tinnitus. Subjects were asked to rate their subjective sleep improvement using a 1-10 scale where 1 meant “no sleep improvement at all” and 10 meant “as much sleep improvement as you can imagine.”

Hearing Loss and Sound Enrichment Benefit

We reasoned that sound enrichment can only be effective if the sound is audible. In this group of 184 subjects, hearing status was evidenced by hearing aid use. There were 140 hearing aid users (“H-Aid=YES, 76.1%) and 44 non-aid users (“H-Aid=NO”, 23.9%). Figure 1 reveals that the differences in mean right- and left- ear pure-tone thresholds for the two groups of subjects was substantial.
We calculated the binaural 3-frequency averages (.5, 1, and 2 kHz) and the binaural 4-frequency averages (1, 2, 3 and 4 kHz) using standard weighting [(5 x better ear = poorer ear)/6/]. Figure 2 reveals the large differences in values between the two groups. Mann-Whitney Rank-Sum tests revealed that the binaural 3-frequency and 4-frequency averages for the H-Aid=YES group were significantly greater than those for the H-Aid=NO group (p < .02). Cohen’s $d$ for each comparison also is shown for the two comparisons.

![Figure 1. Mean pure-tone thresholds for two groups of tinnitus subjects.](image)

![Figure 2. Mean 3- and 4-frequency averages for two groups of subjects.](image)
Sleep-Disrupting Health Disorders

Multiple sleep-disrupting health disorders are fairly common among the general population. We selected five specific sleep disorders that we felt were among the most common we typically encountered.

1. **Obstructive sleep apnea (OSA):** According to Fairbanks et al (2003), sufferers may experience dozens of arousal-inducing episodes per night. Heistand (2006) found that in a group of 1506 subjects, 31% of men and 21% of women met OSA risk criteria.

2. **Chronic obstructive pulmonary disorder (COPD).** Hypo-ventilation may lead to hypoxemia, especially during REM sleep. Low blood oxygen levels may lead to an increased number of arousals and increased sleep disruption. Weitzenblum et al (2010) reported that COPD affects approximately 10% of men over age 40.

3. **Nocturia** related to benign prostatic hypertrophy (BPH) or prostate cancer (CA). Bal et al (2012) reported that 70% of BPH patients reported nocturia and resulting sleep interruption with daytime sleepiness. Namiki et al (2011) found that in a group of 581 men with prostate cancer, 189 (32%) reported one void per night and 345 (59%) reported two or more voids per night.

4. **Chronic pain.** Covarrubias-Gomez & Mendoza-Reyes (2013) reported that in a group of 311 subjects with chronic pain unrelated to cancer, scores on the Pittsburgh Sleep Quality Index categorized 276 (89%) as “poor sleepers.”
5. Restless legs syndrome (RLS). Lin et al (2013) reported that in a group of 1185 sleep clinic patients, 18 (1.5%) were diagnosed with primary RLS. Montplaisir et al (1997) found that in a group of 133 RLS patients, 85% reported difficulty falling asleep and 86% reported difficulty staying asleep.

Table 1 reveals the number and percentage of subjects who experienced these common sleep-disrupting health disorders. Four subjects had “Overlap Syndrome” in which both Sleep Apnea and COPD co-exist. Various ICD-9-CM “Organic Sleep Disorders” codes beginning with “327” all were categorized as “Other specific Sleep disorders.

Table 1 reveals the number of subjects having 1, 2 and 3 or more of these common sleep-disrupting health disorders. Of interest is that 36% of these subjects had been diagnosed with two or more sleep-disrupting health disorders.

<table>
<thead>
<tr>
<th>Sleep Disrupting Disorder</th>
<th>Count</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic Pain</td>
<td>67</td>
<td>56%</td>
</tr>
<tr>
<td>BPH / Prostate Cancer</td>
<td>58</td>
<td>48%</td>
</tr>
<tr>
<td>Sleep Apnea*</td>
<td>36</td>
<td>30%</td>
</tr>
<tr>
<td>COPD*</td>
<td>13</td>
<td>11%</td>
</tr>
<tr>
<td>Restless Legs Syndrome</td>
<td>4</td>
<td>3%</td>
</tr>
<tr>
<td>Other Specific Sleep Disorders</td>
<td>19</td>
<td>16%</td>
</tr>
</tbody>
</table>

Table 1. Number and percentage of subjects experiencing specific sleep-disrupting health disorders.

Mental Health Status

Mental health patients compose up to 40% of all patients with disturbed sleep (Ford & Kamerow 1989; Walker, 2001). Benton (REFS) reported that 69% of tinnitus patients treated at
the Atlanta VA Medical Center previously had been diagnosed with at least one mental health disorder, and full 48% of those patients had been diagnosed with 2 or more mental health disorders. Table 2 provides the number and percentage of subjects diagnosed with specific mental health disorders. Fully 51% of these subjects had been diagnosed with two or more mental health disorders. The most common diagnoses are highlighted.

<table>
<thead>
<tr>
<th>Disorder(s)</th>
<th>#</th>
<th>Disorder(s)</th>
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<th>Disorder(s)</th>
<th>#</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anxiety Only</td>
<td>4</td>
<td>Depression Only</td>
<td>22</td>
<td>PTSD Only</td>
<td>22</td>
<td>PTSD + Depression + Anxiety</td>
<td>3</td>
</tr>
<tr>
<td>Bipolar Only</td>
<td>1</td>
<td>Depression + Anxiety</td>
<td>4</td>
<td>PTSD + Anxiety</td>
<td>2</td>
<td>PTSD + Depression + Others</td>
<td>5</td>
</tr>
<tr>
<td>Anxiety + Bipolar</td>
<td>1</td>
<td>Depression + Mood Disorder</td>
<td>1</td>
<td>PTSD + Bipolar</td>
<td>2</td>
<td>PTSD + Neurosis</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Depression + Neurosis</td>
<td>1</td>
<td>PTSD + Depression</td>
<td>28</td>
<td>PTSD + Panic Attacks</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 2. Number and percentage of subjects with specific diagnosed mental health disorders.

The percentage of subjects reporting each numerical sleep improvement rating and the arbitrarily assigned sleep improvement categories are shown in Figure 3a and Figure 3b. As shown, 79% of device users reported moderate or high sleep improvement.
Figure 3a. Numerical sleep-improvement ratings reported by 184 subjects

Figure 3b. Sleep-improvement ratings reported by 184 subjects for four arbitrarily assigned sleep-improvement categories.

The sleep-improvement ratings were subjected to statistical analysis. Not surprisingly, there was a significant relationship between sleep-improvement rating and weekly number of devices used ($r = 0.473, p < .001$): subjects who reported greater sleep improvement used their devices more often than those who did not. This finding begs the question: did subjects use their devices more often because they achieved greater sleep improvement, or did they achieve greater sleep improvement because they used the devices more often? The current study cannot answer that question.
A 2 x 2 x 2 (Mental Health Status x Aided Status x Sleep Health Issue) ANOVA was completed. Only the main factor of Mental Health Status was significant: $f(1, 186) = 10.572 (p = .001)$. As shown in Figure 4, the mean sleep-improvement rating of subjects with diagnosed mental health disorders (MH=YES) was significantly higher than that of those without (MH=NO). Cohen’s $d$ revealed that the effect of mental health status on sleep improvement ratings was small (0.29).

![Figure 4](image_url)

**Figure 4.** Mean sleep improvement ratings for subjects with diagnosed mental health disorders (MH=YES) and subjects without (MH=NO).

Although the difference in mean sleep-improvement ratings was significant ($p = .001$), Cohen’s $d$ (0.29) revealed the effect of mental health status on sleep improvement ratings was small.

**DISCUSSION**

Bedside sound generators provide substantial sleep improvement for most users (79%). Subjects with mental health diagnoses reported significantly greater sleep improvement than those without, although the effect was small. This finding most likely is a result of poorer sleep baseline that frequently occurs in those with mental health diagnoses (REF). Neither common
sleep-disrupting health disorders nor hearing status as evidenced by hearing aid use had any no significant effect on sleep improvement ratings.

These findings confirm the anecdotal reports of sleep improvement among tinnitus sufferers when bedside sound generators are used. Use of standardized sleep measures for both baseline and post-device usage may provide greater insight into both the nature of sleep improvement provided by these bedside sound generators.

REFERENCES