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# Depression, Hearing Loss, and Treatment with Hearing Aids

By VICTOR BRAY, PhD

A review of the scientific literature suggests a complex but compelling association between hearing loss and depression. Adapted from a recent webinar sponsored by Hamilton® CapTel®, this article challenges hearing care professionals to begin re-envisioning hearing loss not as the “mental river” itself, but rather as a potentially important tributary or watershed that in turn has very real and substantial effects on “how things flow,” affecting quality of life (QoL) and healthy aging. New findings, some of which are included here, are providing a tantalizing glimpse into specific patient populations whose lives might be positively transformed with appropriately fit amplification or cochlear implants, assistive devices and captioned telephones, and/or auditory training and hearing care services. Similarly, the literature provides a strong case for the partnership of audiologists and mental health experts in the battle against chronic depression.

Picture a deep wide river running through a verdant landscape. This river—like any great river from the Mississippi to the Nile—has many creeks, brooks, and larger streams all contributing to its flow. When one of these systems is inundated with water, the flow of the larger stream can be affected, and flooding can occur. However, the large river’s flow is primarily dependent on its most important or larger tributaries, or even more likely the contribution of entire watersheds that contain these tributaries.

In the same way, one can view a person’s mental health as a deep river that flows through all the geographic depressions and waterfalls of our life’s landscape. Contributing factors like general health, cognitive status, satisfaction with employment, family relations, friendships, and many other things so important to every person all act as tributaries that supply a healthy flow to this mental river.

It seems obvious to most audiologists and hearing aid specialists who dispense hearing aids that hearing status has a *direct influence* on the “mental health river” of patients. Hearing loss and its impact on communication abilities—and its cascading influence on self-esteem, anxiety, cognition, social interaction/isolation, loneliness, and depression—is a reasonable, if not intuitive, cause-and-effect type of interaction (Figure 1). In fact, many professionals who dispense hearing aids are likely to have dozens of patients who they suspect might be suffering from chronic depression.

## Why Might Depression Be Associated with Untreated Hearing Loss?

Around the dawn of the 21st Century, there were a half-dozen landmark studies about problems associated with untreated hearing loss, all of which provided intriguing insights into the possible benefit of hearing aids and aural

rehabilitation. In 1990, Mulrow and colleagues<sup>1</sup> published a paper in the *Annals of Internal Medicine* about their work at the Audie L. Murphy Memorial Veterans Hospital and the University of Texas Health Science Center in San Antonio. Titled “Quality of Life Change and Hearing Impairment: A Randomized Trial,” the study looked at 194 participants, half of whom were assigned to a waiting list, and the other half assigned to the hearing aid treatment group. The two groups were assessed against each other over time, and the authors found that, “At baseline, 82% of subjects reported adverse effects on quality of life due to hearing impairment, and 24% were depressed. At 4-months follow-up and compared to those assigned to the waiting list, a significant change in score improvements for social and emotional function, communication function, cognitive function, and depression were seen in subjects who received hearing aids.” The authors stated:

“Our randomized controlled trial established that marked social, emotional, and communication difficulties are caused by hearing loss. Severe handicaps in these areas are found even when persons have only mild to moderate audiotically detectable hearing loss.”<sup>1</sup>

This field trial established that hearing aids are a successful treatment for reversing social, emotional, and communication dysfunctions caused by hearing impairment. Additionally, it suggested that hearing aids may lead to improvements in cognition and depression.

Two years later, in 1992, Mulrow and colleagues<sup>2</sup> demonstrated that, in 192 of the same participants, the quality of life benefit measures for social and emotional, communication, and depression were sustained at 8 and 12 months, whereas the cognitive changes reverted to the baseline values at 12 months. They concluded that “hearing aids provide sustained benefits for at least a year in these elderly individuals with hearing impairment.”<sup>2</sup>

Another significant study at the eve of the 21st Century was the 1999 National Council on the Aging (NCOA) report on “The Consequences of Untreated Hearing Loss in



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Older Persons”<sup>33</sup> which was subsequently summarized for publication in the January 2000 *Hearing Review*.<sup>4</sup> In a large-scale national survey of older Americans, the study quantified the social, psychosocial, and functional effects of hearing loss, with the goal of assessing the effects of hearing loss on quality of life and comparing these effects to those who wear or do not wear hearing aids. The cross-sectional, self-assessment survey included 2,304 hearing-impaired people and 2,090 family members. The NCOA study concluded:

“Most users of hearing aids reported significant improvements in the quality of their lives since they began to use hearing aids. Half or more reported better relationships at home and improved feelings about themselves. Many also reported improvements in their confidence, independence, relations with children and grandchildren, and view about life overall... Along every dimension, family members of the hearing-impaired person were even more likely to report improvements. The majority of family respondents reported that use of hearing aids had resulted in improvements in terms of relations at home, feelings about themselves, life overall, and relations with children and grandchildren.”<sup>33</sup>

Kochkin and Rogin<sup>4</sup> went further, stating “The literature and this study clearly demonstrate that hearing loss is associated with physical, emotional, mental, and social well-being. Depression, anxiety, emotional instability, phobias, withdrawal, isolation, lessened health status and lessened self-esteem are not just ‘quality of life.’ For many people, uncorrected hearing loss is a serious ‘life or death’ issue.”

Shortly after, in 2000, Strawbridge et al<sup>15</sup> pub-

- Alcohol dependence
- Anxiety
- Chronic pain
- Comorbid chronic medical conditions
- Female gender
- Hypomania or Mania
- Nonresponsive to effective treatments for medical conditions
- Obstetric patients
- Psychosis
- Personal or family history of depression
- Recent childbirth
- Recent stressful events
- Substance misuse
- Unexplained somatic symptoms

Table 1. The 14 major risk factors for depression.

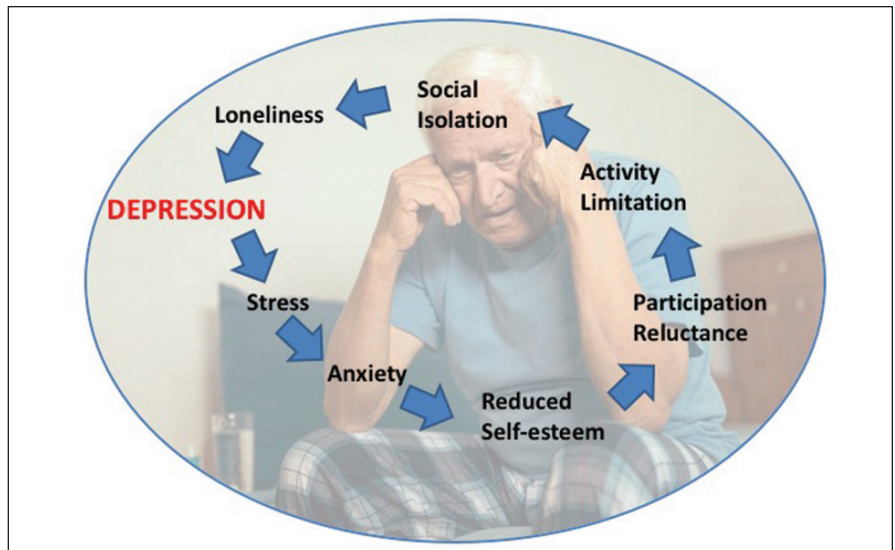


Figure 1. From their experiences with patients and the numerous studies about the consequences of untreated hearing loss, audiologists often describe for patients a “cascading cycle of depression” resulting from the person with hearing loss finding it difficult to communicate, leading to anxiety and communication difficulties, loss of self-esteem, and decreased participation and social engagement in those activities that tend to create joy and satisfaction in life.

lished data in the *Gerontologist* on over 2,500 adults participating in a longitudinal tracking process. They looked at several factors, including mental health, physical health, *activities of daily living* (ADL, eg, bathing, eating, dressing), and physical performance (eg, writing/handling small objects, standing up/sitting in a chair). The researchers found multiple negative outcomes and diminished functional status associated with hearing loss, including depression, loneliness, and altered self-esteem. They attributed this to a sequence of events whereby hearing loss reduces the ability to communicate, which then negatively impacts interpersonal relationships. The adjusted *odds ratio* (OR) for the impact of moderate or greater hearing loss were approximately 2 (ie, two-times the normal odds) for disabilities in ADL, physical performance disability, fair or poor mental health, and depression.

In 2003, Stig Arlinger<sup>6</sup> published an excellent review on the negative consequences of uncorrected hearing loss in the *International Journal of Audiology*. His findings were that uncorrected hearing loss represents an auditory disability involving reduced speech recognition ability, especially in difficult listening environments, and reduced ability to detect, identify, and localize sounds. Arlinger stated that this affects the lives of both the hearing-impaired person and significant others, and the hearing-impaired person is not always aware of all of the consequences. Arlinger noted that “Uncorrected hearing loss gives [rise] to a poorer quality of life, related to isolation, reduced social activity, a

feeling of being excluded, and increased symptoms of depression.” He also found a significant correlation between uncorrected hearing loss and reduced cognitive function. However, he was careful to note that “there is no clear proof that hearing loss is the cause of reduced cognitive function, but indirect evidence from some studies supports this hypothesis.”<sup>36</sup>

### What Is Depression and How Does It Affect People?

Most of the studies above touch upon many aspects related to depression, often bringing into the discussion self-esteem, stress, anxiety, isolation, loneliness, activity limitations, participation restrictions, and even cognitive function.

According to the American Psychiatric Association, depression—also known as *major depressive disorder* (MDD)—is a common and serious medical illness that negatively affects how you feel, the way you think, and how you act. Depression causes feelings of sadness and/or a loss of interest in activities once enjoyed. It can lead to a variety of emotional and physical problems, and can decrease a person’s ability to function at work and at home. From a clinical standpoint, we should also know that:

- Depression is a chronic disease that must be monitored.
- The pathophysiological cause of depression is unknown.
- There are no laboratory tests or clinically useful biological markers for depression.
- The causes of depression may involve a combination of genetic, biological, psy-

chological, and environmental factors.

This last point is particularly important, as we could tend to focus on depression as a psychological disorder that can result from the presence of untreated hearing loss and/or will go away with treated hearing loss. As alluded to earlier, and will be shown in more detail later, the story is *much more complex*. In fact, many studies point to depression involving a combination of biological, genetic, environmental, and psychological factors.

For example, a number of studies cite the 14 major risk factors shown in **Table 1**. Of these 14 factors, two are directly tied to hearing loss:

- 1) Hearing loss is a chronic medical condition and often presents itself with other chronic medical conditions, also known as *comorbidity*, and
- 2) Hearing loss, balance loss, and tinnitus are *stressful conditions*, especially when sudden-onset is involved (as can be the case, particularly in younger people).

### Chronic Medical Conditions, Hearing Loss, and Depression

**Dual-sensory loss and depression.** Three recent studies suggest that healthcare practitioners should be aware that the combination of vision loss plus hearing loss (ie, *dual-sensory loss*) creates an even greater risk for depression. Armstrong and colleagues<sup>7</sup> in 2016 reported a 31% rate of depression for people with dual sensory (vision loss + hearing loss), compared with 25% for vision loss, 17% for hearing loss, and 11.6% for neither. This is fairly consistent with data from a 2017 Swedish study by Turunen-Taheri et al<sup>8</sup> which reported an increased OR of 2.38 for depression for dual loss versus hearing loss alone. Similarly, the recent Tromsø study in Norway by Cosh et al<sup>9</sup> showed that study participants with hearing loss exhibited depression and anxiety effects at baseline, while the vision loss/dual loss groups showed effects over time. The researchers ultimately concluded that different sensory loss groups have different mental health profiles. As clinicians working with people who report hearing problems and often have vision loss, we should be aware that patients with a dual-sensory impairment might have 2-3 times the likelihood of depression than the general population.

**Chronic illness in the elderly, hearing loss, and depression.** Huang and colleagues<sup>10</sup> looked at 9 chronic illnesses linked to depression in a 2010 meta-analysis of 31 publications. They found an increased OR for depression of 2.13

for chronic lung disease, 1.87 for stroke, 1.94 for vision loss, 1.71 for hearing loss, and increased risk of depression for several other medical conditions like cardiac disease and hypertension, arthritis, and diabetes.

A 2002 study by Gaynes et al,<sup>11</sup> which looked at the impact of depression on *quality of life* (QoL) across the nation's National Health and Nutrition Examination (NHANES) survey, found that depression was associated with poorer hearing-related QoL, and the magnitude of the effect was comparable to arthritis, diabetes, and hypertension.

The “take-away” here is that hearing loss does not exist in a vacuum; we should always think of our patient's health and wellness (or illnesses) as more than just hearing loss. As healthcare providers, results that indicate a hearing loss underscore the need to be clinically attentive for presence of depressive disorders and/or the increased possibility of MDD when associated with other chronic conditions.

### Large-scale Studies About Hearing Loss and Depression

Similar to the Gaynes study on depression and hearing-related QoL, more-recent research studies have been published looking at large populations. The reader is referred to the webinar for a more in-depth discussion of these studies and the pros and cons—as well as caveats—of their interpretation. In particular, hearing care professionals should become familiar with the following larger-scale studies.

In 2014, Li and colleagues<sup>12</sup> published in *JAMA Otolaryngology-Head and Neck Surgery* a study of 18,318 adults from the NHANES database, and found many possible variables (or potentially confounding factors) statistically correlated to depression, including gender, age, educational level, poverty income ratio, living alone, body mass index, smoking status, and other factors previously mentioned above. The prevalence of moderate-to-severe depression was 5.9% in the general population and nearly two times higher (11.4%) in those with self-reported hearing loss. After accounting for the covariates, hearing impairment was significantly associated with depression, particularly in women and in adults younger than age 70 years.

In 2016, Hsu and colleagues<sup>13</sup> conducted a 12-year follow study of the Taiwan National Health Insurance Database (NHRID) for the presence of depression and hearing loss, analyzing over 5,000 patients with sensorineural hearing loss (SNHL) and over 20,000 patients

without SNHL. They found a dozen comorbidities significantly associated with hearing loss, of which four were also significantly associated with the risk of depression:

- 1) Chronic artery disease;
- 2) Alcohol-related illness;
- 3) Anxiety, and
- 4) Stroke.

Risk for depression increased with age, and in women more than men. The article succinctly framed hearing loss and its risk associated with depression as a serious public health concern:

“Unipolar depressive disorders, the most common neuropsychiatric condition, and adult-onset hearing loss, the most common sense-organ disorder, are the first and second leading nonfatal causes of year loss due to disability in high income countries.”<sup>13</sup>

However, the researchers stressed that, despite a strong association between depression and SNHL, the underlying etiologic mechanisms have not been well established. Effects of SNHL include declined QoL and social isolation, which may lead to depression; on the other hand, it's also possible there is a biomedical link between auditory damage and depression (eg, via neurotransmitters and/or neurological pathways). Further research is needed to determine the etiopathology between hearing loss and depression.

### Does Treatment with Hearing Aids Reduce Depression and Anxiety?

If hearing loss is strongly associated with depression, then are hearing aids a possible method for treating depression in this patient population? While the data is intriguing, and new research continues to shed light on this question, we need to pay attention to what the current body of literature actually says.

In a 2013 study using the NHANES data, Mener and colleagues<sup>14</sup> evaluated over 1,000 subjects in their 70s who completed audiometric testing and the HPQ-9 screening tool for depression. They found that nearly 60% of the participants had a >25 dB hearing loss, and 4% met the criteria for MDD, while 7% met criteria for any depressive disorder. While greater hearing loss was not found to be significantly associated with greater odds of depression in this population of age-70 adults, the use of hearing aids cut the depression rate by around 40% compared to the non-hearing aid users. As with all cross sectional and correlational studies such

as these, the authors were careful to point out that the direction of any association between hearing loss or hearing aid use and depression could not be determined by the study. One explanation hearing care professionals might be predisposed to accept is that audiological treatment helps promote social engagement and thereby reduces depressive symptoms—and this could certainly be true. However, another possible explanation is that individuals without depression may just be more likely to obtain hearing aids than depressive individuals. Again, more research is needed.

Other studies provide positive evidence for hearing aids improving depressive symptoms, but at the same time, amplification doesn't always appear to be the total solution. For example, in 2010, Acar et al<sup>15</sup> in Turkey investigated the effects of hearing aids on cognitive function and depressive signs in 34 patients with a mean age 70 and a mean hearing loss of 57 dB HL. New hearing aid users were measured with the *Geriatric Depression Scale* (GDS) and *Mini Mental State Examination* (MMSE) at pre-fitting and at 3 months post-fitting. Significant improvements in psychosocial and cognitive conditions, as well as social communication and exchanging information, were observed. The conclusion was that for elderly people, the effects of hearing aids on presbycusis—due to significant improvement in psychological state and mental functions—is a good solution.

A common result in some studies is often not explicitly discussed: although there may be a statistically significant positive effect for hearing aid use, the group mean scores at pre- and post-treatment are sometimes in the nominal range for either the absence or presence of depression. Or, in other cases, the results pose interesting questions about how, why, or just how much improvement of the condition occurred. While hearing aids are helpful for improving depression for *some* individuals, they may not be a panacea or “magic bullet.” Other factors besides (or in addition to) hearing loss may be involved. From a clinical standpoint, this means we should be cautious about what we say relative to the treatment of depression via amplification.

For example, Castiglione and colleagues<sup>16</sup> in 2016 evaluated 125 people (median age: 74) who were placed into 1 of 6 groups, depending on if they were new or experienced, bilateral or unilateral hearing aid, cochlear implant (CI) or hearing aid, or hearing-impaired or normal-hearing. They found that each of the treatment

## The importance of this finding—as well as the findings of the two previous studies—is that significant depression does exist in some of your patients, and they can respond positively as a result of the audiological treatment you provide.

groups demonstrated improvement after auditory rehabilitation or training on long-term memory tasks, level of depression, and cognitive status scores. Their conclusion was that auditory rehabilitation by CI or hearing aid was effective among older adults with different degrees of hearing loss, and positive improvements were seen in terms of social isolation, depression, and cognitive performance. However, it was clear that the strongest effect was for only some individuals, particularly CI users.

A 2016 study conducted in the United States by Choi et al<sup>17</sup> published in *JAMA Otolaryngology-Head and Neck Surgery* evaluated the effects of hearing aids and CIs on depressive symptoms in 113 adults who had a mean age of 70 years. One of the intriguing results of the study was a statistically significant effect on depressive symptoms for the two groups; however, the most extensive improvements in GDS scores were observed in the patients with *higher baseline* GDS scores—prompting the question if the statistically significant effect of the study reaches a *clinically meaningful decrease* in depression for all the treatment groups. Whatever the case though, there were *clearly some individuals who experienced a dramatic improvement toward the non-depressive score due to treatment*. The importance of this finding—as well as the findings of the two previous studies<sup>15,16</sup>—is that significant depression does exist in some of your patients, and they can respond positively as a result of the audiological treatment you provide.

Anxiety has also been studied with regard to hearing loss and depression. Two studies, one conducted in The Netherlands and the other in the United States, evaluated anxiety and its relationship to hearing loss. In the Netherlands study,<sup>18</sup> increased anxiety and depression were found to be associated with increased rumination and catastrophizing about hearing loss. In the US study,<sup>19</sup> increased anxiety was found to be associated with increased hearing loss in the elderly. However, we are once again reminded that, in these cross-sectional studies using correlations to determine adjusted ORs, we cannot establish the temporal link between hearing loss and anxiety. So, the same question about depression

remains for anxiety: Does hearing loss precede and increase anxiety, or does anxiety precede and increase hearing loss, or is there some common, underlying unknown linkage that couples hearing loss, depression, and anxiety?

### Can Treatment with Hearing Aids Reduce Loneliness?

The relationship between untreated hearing loss and loneliness and social engagement was the subject of three very interesting studies. In 2011, Pronk et al<sup>20</sup> in Amsterdam evaluated just over 1,800 people, of which about 1,000 had either self-reported hearing loss or documented hearing loss for speech in noise. In the database analysis, both groups with hearing impairment showed a significant adverse association with both emotional loneliness and social loneliness. In commenting on their longitudinal study results, the adverse effects of social loneliness were found in the hearing aid non-users, but not in the hearing aid users. Interestingly, the adverse effect of emotional loneliness was found in men, but not women.

In 2016, Sung et al<sup>21</sup> at Johns Hopkins tracked 145 people using hearing aids or CIs in their *Studying Multiple Outcomes after Aural Rehabilitation Treatment* (SMART) research. Their findings were that greater loneliness was associated with people with hearing loss, with greater loneliness for people at a younger age and those with greater hearing loss. Additionally, they found that increased depressive symptoms, decreased hearing-related QoL, increased communication difficulties, and poorer emotional well-being were all moderately or highly correlated with loneliness. Sung et al noted that their findings underscore the potential impact of hearing impairment on loneliness in adults and the need to address hearing loss as a potentially modifiable risk factor for loneliness and healthy aging.

Also in 2016, audiologist Barbara Weinstein, PhD, and colleagues<sup>22</sup> published study results evaluating 40 adults about the effect of hearing aid use on emotional loneliness and social loneliness. Their findings were also of a significant decline in the perceptions of loneliness following 4-6 weeks of hearing aid use:

participants who were lonely decreased from 45% pre-treatment to 28% post-treatment with hearing aids. While these findings were of statistical significance, it should be noted that even in the presence of marked hearing loss, more than half the subjects were not lonely, and after treatment with hearing aids, more than one-quarter of the subjects were still lonely. Thus, while we can see a very nice (and important) treatment effect for the group, we should remember that there is individual variation within the group and there are many other demographic, health status, and living arrangement aspects that impact loneliness. The authors concluded that, through intervention, hearing aids improve verbal communications and may restore the possibility for social networking, thereby having a positive effect on QoL and social interactions.

### Sudden SNHL and Depression

We have seen in many studies the benefits to mental health status via hearing healthcare intervention, even if that intervention may only be a small part of the overall dynamics of depression, anxiety, and loneliness in the lives of patients. However, one type of hearing loss—*sudden sensorineural hearing loss* (SSNHL)—has been shown to be particular suspect for causing adverse emotional responses, including depression.

Two population-based studies, using Taiwan’s NHIRD records, illustrate this. Tseng et al<sup>23</sup> evaluated 1,717 persons with SSNHL against a matched group of 6,868 persons without SSNHL. After going through the statistical adjustment process to control for the influence of many covariates (eg, age, sex, comorbidities, etc), they established that SSNHL patients were 2.17 times more at risk for depressive disorders, and that depressive disorders were stronger for younger age groups (ie, people <60 years).

Another NHIRD population study from Taiwan by Lin et al<sup>24</sup> evaluated 25,547 people newly diagnosed with depression and a matching number of people without depressive disorders. They found that people with depressive disorders were 1.45 times at greater risk for developing SSNHL than the control group (anxiety preceding, not following, depression). This may be because the people who had depressive disorders and SSNHL were also more likely to have diabetes mellitus, chronic kidney disease, and hyperlipidemia (related to high cholesterol). So, again, comorbidities were found to significantly elevate risk for depression.

Looking at these two studies, SSNHL and depression are associated, and SSNHL is a larger risk factor than stable or slowly progressing SNHL. However, while it seems quite understandable that depressive symptoms may result from SSNHL, especially in younger people, there may again be some underlying unknown factors associated with depression (and/or other comorbidities) which can lead to SSNHL.

In a recent Korean study, Roh et al<sup>25</sup> evaluated patients’ psychological stress for prediction of treatment response for idiopathic sudden hearing loss treatment following courses of oral prednisone and intra-tympanic steroid injection. After 3 months of treatment, the 50 patients in the study were sorted into one group with recovery of hearing and another group without recovery of hearing. They found that the *non-recovery group* showed significantly higher levels of pre-treatment depression, anxiety, and stress response (ie, depression being a predictor of poorer SSNHL recovery). More specifically, they found two factors that significantly predicted treatment response after statistical control for other variables: 1) depression sub-score of the SRI-MF (the strongest factor) and 2) duration of the hearing loss (the second strongest factor). The authors concluded that there are several physiological factors known to be related to recovery from SSNHL, including age, level and configuration of hearing loss, and

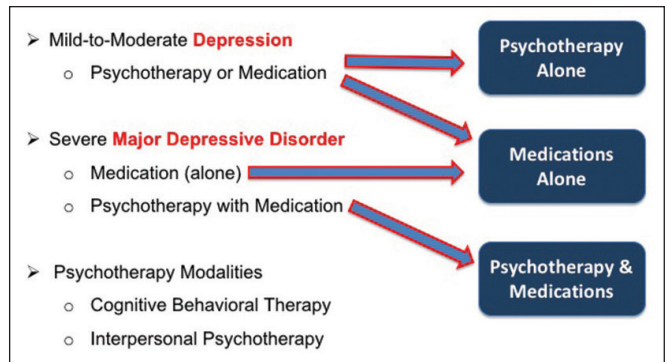


Figure 2. The two major treatment pathways for depression: psychotherapy and medication.

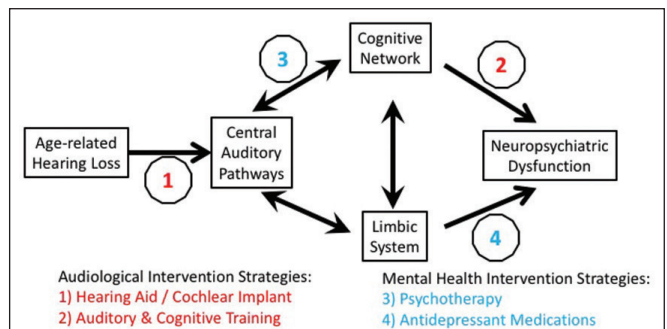


Figure 3. Possible targets of therapeutic intervention for patients with hearing loss who are at risk for neuropsychiatric dysfunction. In this model, audiologists would be involved in amplification management (1) and computerized auditory rehabilitation/cognitive remediation (2). The mental health professional would be involved in psychotherapy (3) and antidepressant medications (4). Adapted from Rutherford et al.<sup>26</sup>

associated vertigo. However, none of these factors are modifiable in the treatment processes. They recommended further research of the potential use of psychiatric measures, including stress management intervention, in the treatment of SSNHL.

### Models Explaining the Connection Between Hearing Loss and Depression

Medical guidelines for treatment of depression include dual and competing approaches (Figure 2). For mild-to-moderate depression, either a psychological approach or a biomedical/pharmaceutical approach in therapy may be successful. For severe MDD, medication is recommended often in combination with psychotherapy. The most-common and successful pharmacological approach employs serotonin and norepinephrine reuptake inhibitors (SSRIs and SNRIs). The most-common and successful type of therapy used is Cognitive Behavioral Therapy (CBT).

This duality of successful treatment paths brings up some interesting questions, because one involves *communication-based therapy*, while the other involves *biological-based medication*. Knowing this duality exists, we should be aware that depressive symptoms in our patients could have an underlying cause that may not be strictly related to our profession’s prevalent (audiologic) model: hearing loss causes a cascading sequence of communication impairment, social isolation, and depression as diagrammed in Figure 1. Something else may be in play regarding depressive symptoms.

Recent modeling by Rutherford and colleagues<sup>26</sup> in their March 2018 *American Journal of Psychiatry* article, “Sensation and Psychiatry: Linking Age-Related Hearing Loss to Late-Life Depression and Cognitive Decline,” presents a multimodal representation of the clinical and behav-

ior mediators linking age-related hearing loss to neuropsychiatric dysfunction. In essence, their model considers both a *downstream (audiology-based) explanation* and an *upstream (neuropathology-based) explanation*.

Rutherford et al describe a possible downstream/audiologic impairment model in the same way most hearing care professionals would: Degenerative changes in the inner ear structures and/or altered neural processing of auditory input cause people to avoid or withdraw from social situations, especially where background noise makes communication difficult, resulting in social isolation and reduced contact with family and friends. Social isolation has been linked to reduced QoL and numerous adverse physical and mental health outcomes in older adults and to the development of depressive symptoms.

They also describe a possible upstream/biomedical impairment model: Upstream common causes—such as within-brain inflammation, vascular pathology, and other systemic neurodegenerative processes—may lead to hearing loss, depression, and cognitive impairment via central nervous system (CNS) functional decline. In addition, neuropathology studies have reported the presence of pathophysiologic features of Alzheimer's disease (ie, plaques and tangles) in multiple central auditory regions, such as the cochlear nuclei, inferior colliculi, thalamus, and primary auditory cortex, while sparing peripheral structures.

In terms of treatment for patients, Rutherford et al<sup>26</sup> state that the obvious therapeutic implication for the association of age-related hearing loss, cognitive decline, and the development of late-life depression is to treat the hearing loss to avoid these adverse outcomes (Figure 3). Appropriately fit hearing aids amplify speech for improved communication, resulting in improved psychosocial functioning and QoL. In addition, emerging evidence suggests that restoring auditory input via hearing aids or CIs extends beyond improved hearing to better cognitive functioning and reduced depressive symptoms. Naturalistic assessments of neuropsychiatric status before and after hearing treatment have shown improvement on short- and long-term global cognition, memory tasks, and depressive symptom scores.

What all this means is that hearing loss and neuropsychiatric dysfunction could be related, and as previously stated, age-related hearing loss could eventually be found to have a downstream effect on the central auditory circuits in both the cognitive control network

(controlling executive functions like attention, reasoning, creativity, etc) and the limbic system (controlling emotion, motivation, long-term memory, etc). Rutherford et al<sup>26</sup> propose that, in combination with hearing aids and aural rehabilitation, it may also be valuable to target neural mediators and behavioral outputs to maximize functionality. For example, focusing on the cognitive control network, computerized cognitive training might be used to target executive dysfunction in older adults with hearing loss. In a parallel focus on the limbic system network, treatment with antidepressant medication has been shown to normalize pathological decreases in prefrontal cortex and striatal function, increase limbic activity, and disordered connectivity between these regions.

*What does this imply? In the very near future, audiologists and mental health experts could be working together to co-manage patients with depression.* The audiologist would be responsible for combined, auditory training and cognitive training, which has been shown to improve cognition in adults with hearing loss,<sup>27</sup> while a psychotherapist would be responsible for psychotherapy (eg, CBT) and/or medications (Figure 3).

### Should We Screen for Depression?

Currently, we know that depression is a significant obstacle to quality of life, is present and widespread in the population, and has increased prevalence in persons with hearing impairment. So, should hearing care professionals be on the alert for depressive disorders in their patients and screen for depression? *The answer is an unequivocal “yes!”*

McCarron and colleagues,<sup>28</sup> writing in the October 2016 *Annals of Internal Medicine*, tackle the topic of depression in the clinic. In their review, they clearly state that clinicians should consider screening patients with identified risk factors (which include comorbid chronic conditions and recent stressful events). They recommend use of the PHQ-2, a widely used and efficient screening tool for depression that has only two questions:

- 1) *Over the past 2 weeks have you felt depressed or hopeless?*
- 2) *Over the past 2 weeks have you felt little interest or pleasure in doing things?*

Patients with a positive (yes) response to one or both of the questions fail the screening and should be referred. If the reader is interested, a more in-depth screening can be performed using the 9-question PHQ-9 or the Geriatric

Depression Scale (GDS)<sup>29</sup> which are commonly used in primary care populations. For either, hearing care professionals should have training from and a working relationship with a mental health specialist, gerontologist, or similar licensed professional to whom they can consult with and refer patients.

### Conclusion

As described at the beginning of this article, depressive disorders can be thought of as the result of a disruption in the “mental health river,” which is apropos since streams and rivers actually *do* flow through geographic depressions, which are low points in our collective landscapes or environments. All these various streams and waterways—influenced by our physical health, mental stability, family and spousal relationships, employment status, etc—feed into the mental health river and contribute to its overall flow. As long as all the streams are functioning normally, the water does not back up and overflow. But, any one stream, or combination of streams, can become overloaded, resulting in flooding and possible damage. Hearing loss is certainly *one of the streams* that can overflow, affecting depressive symptoms and interfering with mental health.

For some individuals, treatment for hearing loss can lower the level of depression. So, as clinicians who care about the overall health and wellbeing of our patients, we should gain an awareness for when depressive disorders are present in our patients. The good news is that we can certainly help alleviate some depressive disorders through effective remediation processes which include amplification and auditory training. Additionally, when indicated, we can choose to include possible co-management with mental health professionals.

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