

Mild Hearing Loss

And

Easier Listening

Author's notes

This book is written to be easily read. The chapters are short and self contained so each can stand alone.

Mild Hearing Loss & Easier Listening

Chapter

Introduction	3
In terms of Amplification – It’s All about Value	6
Mild Hearing Loss	8
Many Have a Hearing Loss	11
How We Hear	14
Causes of a Mild Hearing Loss	17
Comorbidity	21
Costs of a Mild Hearing Loss	24
Older Adults	30
Younger Adults	36
Impact of Hearing Aids	38
Tinnitus	41
Hearing Aid Styles and Technology	44
A New Hearing Aid’s Cost	50
Your First Hearing Aid	57
Easier Listening Easier Life	59
Communication Improvement Therapy	62
Connectivity and Connecting	67
Works Cited	68

Introduction

Adult mild hearing loss is one of the most prevalent, yet least appreciated, disabling condition challenging Americans and American society today. The description *mild* can be in the case of hearing loss misleading. Through the years, addressing mild hearing loss was at best weak because it was widely agreed that such a hearing loss had little impact and required only little attention. This has changed.

A hearing loss may be mild on an audiogram. However, its impact on the person with this loss may not be. Its effect on family and friends may also be more than expected for something described as *mild*.

This book will address the breakthroughs in hearing aid technology that have enabled amplification to be effective in more complex listening situations. The need for amplification in those competing noise environments has also been an important research finding.

I have worked with people with a mild hearing loss for more than 40 years. This group had in the past been told that nothing in terms of amplification could be done. Amplified sound was harsh. Feedback control was not effective so amplification had to be contained by plugging the ear with earmolds. Hearing aids in the past have not been as effective as they are now in competing noise listening environments.

Hearing aid technology has improved exponentially becoming more effective in more listening environments. Research has discovered the cognitive effects of doing nothing and has shown its cost. New hearing aid technology has enabled hearing aids to provide easier listening and as such become an important tool to slow cognitive decline.

In the past, hearing aids made sounds louder, but sounded mechanical and harsh. They made some speech clearer in some quiet situations but hearing conversation in most typical complex listening situations surrounded by competing noise was not made easier.

However, at this time, amplification was beneficial for those individuals with more severe hearing losses. They needed speech to be louder in order to be audible and clear even in relatively quiet environments. *Loud and clear* was the goal when choosing amplification. *Loud and clear* was the goal of amplification. This was the standard. The improvement in hearing attained by amplification had to be reliably measured. Random interfering noise needed to be eliminated as much as possible to make the test measurements clean. Hearing aids were judged in terms of their gain, output, response and output limitation. Amplification's effectiveness in noise was not a consideration both because hearing aid technology had little or no speech enhancement/noise attenuation capability and hearing loss was viewed through the prism of the audiogram.

At that time poor sound quality and limited ability to make speech clearer was expected. The emphasis of the hearing aid manufacturers during this time was to increase the amplification range and continue miniaturization. *Body* style hearing aids were replaced by *behind-the-ear* style hearing aids. Custom made *all-in-the-ear* hearing aids were introduced and their gain and output increased to compete with the larger *behind-the-ear* style instruments.

Since I became an audiologist, Americans have been living and working longer, listening needs and listening lifestyles have gotten more complex, everyday life more stressful and the world has become noisier. A greater understanding of the role of communication and the psycho/social impact of hearing loss and resulting isolation has

also occurred. We have begun to look at mild hearing loss as more complex and varied than we previously thought.

Audiologists seeing people every day and developing a relationship over years, decades and in some cases a lifetime, witnessed first-hand the decline of patient's hearing and its increasing pervasive impact on their lives. We have long appreciated that simply making everything louder would not be the answer. A mild hearing problem required a more holistic solution in order to slow the deterioration of communication that would occur as the hearing worsened over time. The mild hearing loss needed more than everything being made louder. The solution had to be effective in those situations that motivated patients with a mild hearing loss to seek assistance.

For many years, amplification was not a realistic solution for those with a mild hearing loss. Improving listening strategies, practicing lip reading skills, retraining the brain to more effectively separate speech from competing noise was not routinely offered as a solution. Just making speech louder for many with a mild hearing loss did not make listening easier.

In terms of Amplification – It's All About Value

The value of the hearing aids being considered and/or fit is something on the mind of almost everyone considering amplification. It's something hardly ever written about or discussed. While it may be somewhat fuzzing, it is worth understanding. The value of a set of hearing aids will depend on their usage, their cost vs benefit derived and the overall impact of amplification.. All these topics will be discussed in this book but let me give you a brief overview.

I recommended in my first book 35 years ago that those investigating amplification needed to ask themselves two questions. How well do you want to hear? Where do you want to hear?. Today with the amazing advances in hearing aid technology over those years, hearing aids have become more effective in more listening environments than ever before. The better matched the technology level of the hearing aid(s) is with the hearing aid wearer's hearing, listening lifestyle (*the level of social and work activity*) listening ability in complex listening environments (competing noise) ,the more time the hearing aid will be worn. It will also be less likely it will have to be replaced, for not having enough technology (*ability to enhance speech and attenuate noise ,naturalness of amplification and wearer comfort to loud environmental sounds*)or before it wears out.

For the person with this problem, the hearing loss may have a cost in terms of a threat to cognitive health, as source of anxiety and depression or as a cause of social isolation. It can also have an economic cost because of its effect on a job or career. This cost will vary according to the individual. For some, the cost of their hearing loss can be significant.

The benefit of wearing a hearing aid will be a subjective judgement. In order to make an informed judgment of a hearing aid's effectiveness and as a result of its technology

level, the person has to have an opportunity to experience the range of technology and judge which one is the best fit with the hearing loss and listening needs. My practice has developed a program that provides people with an opportunity to wear demonstrator hearing aids that have been programmed to their hearing loss with several levels hearing aid technology at no charge for a week or two.

The cost/benefit analysis of a set of hearing aids to be in term of a daily use. Compare the daily cost (*price amortized over the expected life of the hearing*) of the hearing aid with the daily benefit. In other words the question wearers would ask themselves is *Are the benefits from this hearing aid worth X dollars a day?*

The longer a product is worn providing benefits - the lower will be its daily cost. A product that costs \$1000 and is worn for 3 years will have a daily cost of about \$1. The product that costs \$1500 but is successfully worn for 6 years will cost 68 cents per day. On the other hand the hearing aid that cost \$300 but after 3 months the wearer becomes frustrated and its put away in a drawer actually had a daily cost of \$3.

This book will give you a way to compare hearing aids in a sea of confusing brochures that may accurately describe their technology but cannot provide any indication of how they would benefit your hearing.

Mild Hearing Loss

A mild hearing loss can be determined after testing a person's hearing. A hearing problem can be determined by asking that same person about their communication ability.

In order to talk about hearing test measurements needed to determine the level of a hearing loss, I need to briefly describe how hearing is tested. Hearing is usually evaluated in a quiet environment (a sound treated room is preferable). The initial audiological evaluation requires the person being tested respond to different frequency sounds (pure tones or notes) that are presented via headphones or inserts. Each ear is tested separately. The patient is asked to respond to the tones. Where the sounds are just barely heard they are called thresholds. These hearing thresholds are then plotted on a graph called an audiogram.

A mild hearing loss is usually determined when hearing thresholds are measured to be between 26 and 40 dB HL on an audiogram. Even this simple conventional definition is too simple for many because most audiograms showing a mild hearing loss tend to be sloping reflecting worsening hearing in the high test frequencies. As a result, hearing soft consonants and understanding speech will be more difficult. Speech understanding may be another way to define a mild hearing loss. Speech audiometry or testing is usually performed in this same quiet test environment. Two syllable spondee words or one syllable test words in a phonetically balanced list are used. The level where they are understood and percent of words understood are recorded. Like pure tone threshold testing, speech audiometry is simple, clean, repeatable and reliable. Its validity (value in real life listening situations and environments) is somewhat questionable.

This definition of mild hearing loss depending on thresholds and speech understanding in a quiet non-challenging listening environment is inadequate because it also overlooks understanding ability in the real life reverberant and competing speech listening conditions. It doesn't take into consideration a person's listening needs or lifestyle.

In the past, mild hearing loss in an adult was often thought to have little or no effect therefore requiring no intervention. The professional who usually held this opinion and recommended no action usually had normal hearing and could not appreciate the impact of a mild hearing loss.

No medical treatment is required for a mild hearing loss. However, it's wise to have a health check-up to see if the hearing loss is caused by some other medical condition which could be treated.

A mild hearing loss should not be just defined as a range of pure tone thresholds. Its impact based on listening need and listening lifestyle needs to be considered. Once listening ability in real life listening environments and situations is considered along with importance of connecting with others while socializing or at work, the pure tone thresholds on an audiogram become less important in determining if further help would be recommended.

How people feel or react to their new communication barrier and how it impacts their lives will determine the attention they focus on this problem. If the hearing loss increases stress, isolates and reduces enjoyment of life, it's time to stop thinking of it as benign and just to be ignored. An adequate solution needs to be found.

I have seen a number of people with a hearing problem but who have normal pure tone hearing thresholds. They may have a stressful listening lifestyle, high listening need or poor auditory processing ability. They truly have a real listening problem. Many have

been helped by a single communication improvement therapy session. Some have tried personal sound amplifiers PSAPs. They were unimpressed because they were simply amplifiers. PSAP's can't attenuate noise and enhance speech. Listening situations with competing speech was the reason those with a mild hearing loss sought help. Some were ultimately fit with hearing aids to have their problem alleviated and get easier listening.

Many Have a Mild Hearing Loss

There is a multitude of studies and surveys on mild hearing loss prevalence of children because of its significant impact on education, language and psycho-social development. However, statistics about adult mild hearing loss are scarce, probably because it has been perceived to have minimal impact.

Hearing loss is a major public health issue that is the third most common physical condition for American adults after arthritis and heart disease. About 20 percent of Americans, 48 million, report some degree of hearing loss. At age 65, one out of three people have a hearing loss. **Sixty percent of the people with hearing loss are either in the work force or in educational settings.** (1)

In adults, the most common causes of hearing loss are noise and aging. There is a strong relationship between age and reported hearing loss. In age-related hearing loss, known as presbycusis, changes in the inner ear that happen as you get older cause a slow but steady hearing loss. Initially, the loss may be mild and it is always permanent.

Adult onset hearing loss has been described by The World Health Organization (WHO) as the third leading cause of disability, with a mild impairment being the most prevalent. WHO estimated in 2012, 1 in 3 American adults over 65 years old have a mild hearing loss.(2) WHO further predicted the number of adults over 65 years old will triple between 2010 and 2050.

Mild hearing impairment will increasingly affect adults in the future. The WHO prevalence statistics from 2012 calculated mild hearing loss for all adults 15 years or older to be 9% to 17%, In another WHO review in 2013, reported the global prevalence rate was 22.7% for men and 19.0% for women for adults over age 15. Increasing age increases prevalence. **Researchers expect that by age 71 and**

older, close to 1 in 2 adults will have a mild hearing loss. (3) Another study reported the prevalence of hearing loss when defined as a speech frequency pure tone average of more than 25 dB in the better ear was 63.1% (5)

It has been my experience that a high frequency hearing loss is most commonly the initial finding and can be a precursor of further deterioration of hearing in the middle and lower test frequencies. Mild hearing loss or high frequency hearing loss is not limited to older adults.

Noise exposure is the leading cause of hearing loss in younger adults. A prolonged noise exposure can cause a mild hearing loss. Continued exposure will cause further ear damage and worsen hearing further. Noise-induced hearing loss such as listening to very loud music, being in a noisy work environment, or using a lawnmower, can lead to hearing loss over many years. A noise induced hearing loss can also be sudden and caused by gunfire and explosions.

Loud music and recreational activities are significant noise sources which could lead to high frequency hearing loss for young people. Lipscomb (1972) reported on the prevalence of high-frequency hearing impairment among college students during a 2 year period. A failure criterion of 15 dB at any one of the frequencies (2000, 3000, 4000, and 6000 Hz.) in either ear was utilized. This criteria was much stricter than many other surveys. **The prevalence of high-frequency hearing impairment was 32.9 percent of 2,769 students in the first year and 60.7 percent of 1,410 students in the second year of the study.** This much higher prevalence of hearing impairment than was found in the present study is probably a result of the lower failure criterion of 15 dB and the inclusion of the additional test frequency of 6000 Hz. If today's optoacoustic emissions testing was utilized similar or even a higher prevalence levels may be found.

Another study found that hearing loss, specifically high-frequency hearing loss, was present in 8.5% of the youngest age group (20-29 years) and in 17% of the group aged 30 to 39 years suggesting that the prevalence of hearing loss is increasing among these younger age groups.(4) The authors of this same study when discussing the differences in prevalence based on audiometric data and prevalence based on personal reports suggested that individuals are substantially less likely to report or be aware of high-frequency hearing loss compared with bilateral hearing loss. (4). Self-reporting under-estimated prevalence of hearing loss.

HOW WE HEAR

It's a beautiful thing

The way we hear is magnificently intricate, yet at the same time a highly dependable system. We wake up every morning and we can hear. We go from one listening environment to another and our hearing adjusts. Our ears have protection mechanisms against noise. Only our modern industrial society's capacity to produce loud sounds has exceeded our ears internal protection capacity. We can process the weak consonant sounds that identify words in a sea of background noise. Our ears can sustain infectious or viral attacks and still recuperate. We can sustain head injuries and still maintain hearing because of a redundancy built into our hearing systems.

For these reasons we take our ears and hearing for granted. It is only when we experience a problem hearing do we come to truly appreciate it. I have worked with a number of people who have experienced a sudden loss of hearing in one ear. This doesn't happen very often and sudden hearing loss is extremely infrequent with both ears.

Losing hearing suddenly can have a dramatic emotional effect. We use hearing to validate the existence of life around us. In all our conscious hours we don't turn off our hearing. Hearing can be easily taken for granted because it's always there for us. Hearing equally well in both ears allows us to easily locate sounds and understand speech in complex listening situations. We hear life around us and a closing of this window to life can be very disturbing. Hearing is truly a precious sense and should be treated that way.

Transmission of Sound

When talking about how we hear, there needs to be some discussion about the anatomy of the ear. Also, some recognition needs to be given to the role that the neural auditory processing centers (brain and brainstem) play. The discussion will be introduced so that it coincides with the pathway for the transmission of sound.

Outer Ear

Invisible sound waves are directed into the ear canal by the outer ear. The soft structure on the side of our heads (Pinna) has the primary function of collecting sound waves and directing them into the outer ear canal until they reach the tympanic membrane (eardrum). This acoustical energy is then transferred into mechanical energy by the movement of the tympanic membrane. It is in the outer ear canal that cerumen (ear wax) can collect and possibly block the transmission of sound causing a temporary hearing problem.

Middle Ear

Attached to the inside of the tympanic membrane is the first of three little bones. These are the smallest bones in the body. They are called the ossicles. They are the malleus (hammer), incus (anvil), and stapes (stirrups). This transference of acoustic energy into mechanical energy takes place in the middle ear cavity. This cavity is lined with soft tissue. Sometimes this cavity can become filled with fluid. This can cause an earache, rupture of the ear drum and/or cause a hearing loss. There are a number of other problems that may occur in the middle ear. More will be discussed about this in subsequent chapters.

The purpose of this transference from acoustic to mechanical energy is to increase the intensity of the sound energy. The last of the ossicles, the stapes is joined to the

cochlea at the oval window. Sometimes the stapes becomes fixated (made immobile) because of a spongy growth of bone around its footplate. This disease process is called otosclerosis. It results in a conductive hearing loss (a type of hearing loss that means the problem is related to the conduction of sound and not the reception of sound).

Inner Ear

The cochlea is located in the inner ear. This snail shaped structure has approximately 20,000 hair cells that are surrounded by fluid. As the stapes moves, its footplate moves the fluid in the cochlea. When this occurs these hair cells are moved. The hair cells are frequency specific. This means that the location of the hair cell on the spiral shaped cochlea determines the frequency of a sound to be transmitted. It is in the cochlea that the mechanical energy becomes electrical energy. Also contained in the inner ear are the semi-circular canals. These help in our orienting ourselves in space and maintaining a balanced posture.

Auditory Pathway

These electrical impulses travel away from the ear toward the brain along the eighth auditory nerve. These neural firings proceed along the auditory pathway through the brainstem into the auditory processing centers of the brain. There has been a great deal of research about the brain and its sound processing capabilities. This is an exciting area of study for many audiologists. Many of the findings have been applied to new diagnostic tests.

Note: This material is also in my book – HEAR WELL AGAIN – WITHOUT TINNITUS.

CAUSES OF MILD HEARING LOSS

A mild hearing loss may be caused by a problem in the outer or middle ear (conductive), a problem in the inner ear (sensory), a combination of both (mixed) in the eighth auditory nerve, neural pathways, or brain (neural). Most often an adult mild hearing loss is sensorineural.

People, especially those over 65, may also have an auditory processing problem. This problem makes it difficult to understand speech in complex listening situations or to follow rapid speech. Normal aging patterns in the brain can cause an auditory processing problem.

A mild hearing loss can be conductive. This type of hearing loss is most amenable to medical treatment. The treatment for conductive hearing loss may range from cleaning the ears of a cerumen (earwax) impaction to treatment of an infection by the use of medicine, to surgery. A person with a conductive hearing loss may find that all sounds are too soft. If there is a cerumen blockage the hearing problem may have occurred rapidly. The conductive hearing loss may be related to an upper respiratory infection or head cold.

Most adults in America with a mild hearing loss have a sensorineural hearing loss that cannot benefit from medical intervention. This permanent mild hearing loss in adults is often caused by a combination of aging, noise exposure, medications, illnesses and genetics. Hearing loss begins to worsen from 30 or 40 years of age. With people living and working longer, more than half of all those struggling with a hearing problem are still working.

Presbycusis is the hearing loss that gradually occurs as we grow older. Hearing loss is a common disorder associated with aging. About 30-35 percent of adults between the ages of 65 and 75 years have a hearing loss. It is estimated that 40-50 percent of people 75 and older have a hearing loss.

Hearing in the higher frequencies is initially most affected by presbycusis. Presbycusis is most commonly caused by changes in the inner ear as a person ages. It can also result from changes in the middle ear or from complex changes along the nerve pathways leading to the brain. Presbycusis most often occurs in both ears, affecting them equally. Sometimes the hearing thresholds don't decline by the same amount at the same time for each ear. Following the hearing of countless adults, I have observed many to experience this uneven decline. They tend to have a leading ear in which the hearing declines first and then a lagging ear in which the hearing worsens later. This can be confusing because while, at a particular point in time the hearing loss is asymmetrical, it may not remain so.

Because the process of loss is gradual, people who have a mild hearing loss from presbycusis may not realize that their hearing is diminishing. The cumulative effects of repeated exposure to daily traffic sounds or construction work, noisy offices, equipment that produces noise, and loud music can worsen this sensorineural hearing loss and accelerate hearing decline.

Presbycusis may be caused by changes in the blood supply to the ear because of heart disease, high blood pressure, vascular (pertaining to blood vessels) conditions caused by diabetes, or other circulatory problems. The loss may be mild, moderate, or severe.

Sometimes presbycusis is a conductive hearing disorder caused by long standing abnormalities of the outer ear and/or middle ear such as reduced function of the tympanic membrane (the eardrum) or reduced function of the three tiny bones in the middle ear that carry sound waves from the tympanic membrane to the inner ear.(6)

Another common reason for hearing loss is exposure to noise. We live in a noisy world. Noise from our work or from recreational activities such as NASCAR, drag racing, loud music at rock concerts, night clubs, discos and from stereos - with or without the use of headphones and increasing use of portable MP3 players are causing noise induced hearing loss. According to the National Institute on Deafness and Other Communication Disorders (NIDCD):

- 10 million Americans have already suffered irreversible hearing damage from noise
- 30 to 50 million more are exposed to dangerous noise levels each day.

Loud noise has become so common in everyday life. Therefore, people have not appreciated the serious impact of noise-induced hearing loss (NIHL) until they're frustrated by a permanent communication problem or ongoing ringing in their ears. NIHL is a hearing disorder characterized by a gradual, progressive loss of high frequency hearing sensitivity over time, as a result of exposure to excessive noise levels.(7)

The National Institute of Health reports that about 15 percent of Americans aged 20 to 69 have high frequency hearing loss related to occupational or leisure activities. (8) Anyone who is exposed to loud noise is at risk of hearing damage. Genetic factors may make some individuals more susceptible (9), (10). Other things that have been linked

with an increased risk of noise induced hearing loss include smoking (11), (12), male gender, race, poor diet, diabetes, cardiovascular disease (13) and concomitant exposure to carbon monoxide or hydrogen cyanide (14).

Other causes of an adult onset of mild hearing loss can be:

Acoustic neuroma

Ménière's disease

Ototoxic medicine

Viral infections

Tumors - benign as well as malignant

Head trauma

Insecticides

Immunological disorders

Vascular disorders disrupting blood flow to the ear.

Idiopathic disorders, such as multiple sclerosis, Meniere's disease and others. (15)

More will be said about these in the next chapter on co-morbidity

Comorbidity

If it's not one thing it's another

Comorbidity has been defined as the simultaneous appearance of two or more psychiatric or physical illnesses, e.g. alcohol dependence and depression. There is comorbidity with hearing loss as well. For example:

- **Cerebro-cardio vascular disorders** – Inadequate blood flow and blood vessel trauma to the inner ear can cause a hearing loss especially in the lower frequencies. When controlling for age, hypertension, diabetes, smoking, and hyperlipidemia, **low-frequency hearing loss was significantly associated with the following cardio and cerebrovascular disorders:**
 - **Intracranial vascular pathology (stroke and transient ischemic attacks)**
 - **Peripheral vascular disease**
 - **Coronary artery disease**
 - **Myocardial infarction**

As reported by Siemens,(16) researchers concluded that those with cardiovascular disorders may be more prone to hearing loss and therefore in need of hearing evaluations. They also found an association between low-frequency hearing loss and numerous cardiovascular and cerebrovascular events.

The negative influence of impaired cardiovascular health on both the peripheral and central auditory system, and the potential positive influence of improved cardiovascular health on these same systems, has been found through a sizable body of research conducted over more than six decades. The most significant

positive relationship between improved cardiovascular health and improvements in those auditory systems has been found in older adults. (17),(18),(19),(20).

- **Hearing loss and cancer treatments** - Recent studies have revealed a strong link between hearing loss and cancer treatments especially among certain chemotherapy medications. (21)

Certain chemotherapy medications or radiation therapy can cause ototoxicity, which may be manifested as temporary or permanent hearing loss depending on the type treatment and the extent of hearing damage. Ototoxicity resulting in sensorineural hearing loss (SHL) refers to drug or chemical damage to the inner ear where cochlear hair cells vibrate in response to sound waves. This damage may affect vital hearing and balance information to the brain resulting in hearing loss, tinnitus, and/or loss of balance.

Platinum-based chemotherapy medications, particularly cisplatin and carboplatin, are considered the primary “culprits” when it comes to ototoxicity. Other potentially ototoxic chemotherapy drugs include Bleomycin, Vincristine, Vinblastin, Bromocriptine, and Methotrexate Nitrogen mustard¹. Chemotherapy from the “platinum” group is frequently used to treat brain, head and neck cancers, as well as lung, bladder and ovarian cancers in adults. (22)

- **Hearing loss and diabetes** - “Hearing loss is about twice as common in adults with Type 2 diabetes (which accounts for 95% of all diabetes cases in the U.S) compared to those who do not have the disease.” (23)

Researchers have discovered a higher rate of hearing loss in people with diabetes. Using tests that measure participants’ ability to hear at the low, mid,

and high frequencies in both ears, the results indicate a link between diabetes and hearing loss at all frequencies with a somewhat stronger association in the high-frequency range. Mild or worse hearing of low- or mid-frequency sounds was about 21 percent in 399 adults with diabetes compared to about 9 percent in 4,741 adults without. Mild or greater hearing impairment at high frequencies was found in 54 percent of those with diabetes compared to 32 percent in those without.

Another significant study examined hearing data from participants in the National Health and Nutrition Examination Survey between 1999 and 2004. Of the more than 5,000 individuals who took part, **hearing loss appeared in 15% of those without diabetes and more than 30% in those diagnosed with diabetes.** The research team's report concluded that screening for hearing loss would allow for early medical intervention that could improve hearing for adults with diabetes. (24)

Diabetics (are) 2.15 times as likely as people without the disease to have hearing loss...broken down by age, people under 60 had 2.61 times the risk while people over 60 had 1.58 times higher risk. (25)

“It is possible that diabetic patients can have normal or near normal hearing at the time of the initial identification of diabetes, only to suffer from a progressive form of sensorineural hearing loss.”(26)

Cost of a Mild Hearing Loss

The cost of a mild hearing loss in adults can vary greatly. This cost is more related to how much the hearing loss affects the person and becomes a communication, lifestyle and/or psychological problem.

Hearing loss can have a range of consequences that differ from person to person. When the hearing loss becomes a problem there usually are some social, psychological and physical problems as a result of the hearing loss. The psychological implications of hearing loss may include everything from embarrassment and problems concentrating to depression and low self-esteem. Physical consequences may vary from headaches and tense muscles to stress and increased blood pressure. Furthermore, there are also social consequences which occur as a result of untreated hearing impairment, such as isolation and communication problems. (3)

For some, even a mild or marginal hearing impairment can result in reduced emotional well-being and greater perceived limitation. (27),(28),(29) Lutman and his group concluded that, for some individuals, an average loss of 15 dB HL was significantly disabling for everyday speech.(30) Speech audiometry is often used to assess a client's speech intelligibility using materials and presentation levels that better represent everyday speech. But, in the case of mild hearing loss, the relationship between pure-tone thresholds, various speech audiometry results, and self-reported hearing difficulty is unclear and conflicting.

It was found that **speech performance could not be predicted by pure-tone thresholds, and speech-in-noise results could not be predicted by speech in quiet measures.** Participants with similar speech understanding scores in quiet showed large variability in speech-in-noise tests. One could not be predicted from the other. (31)

Lutman demonstrated that older adults with mild hearing impairment showed worse speech measures performance but reported less disability than younger adults. (32) Dubno et al measured speech recognition in quiet and in noise and showed that age was not a contributing factor. For speech in noise understanding, the participant's hearing loss, age, the speech material used, and the level of presentation of the speech all played a significant role. (33)

Self reporting has made it increasingly clear that everyday hearing difficulties cannot be predicted from standard audiometric testing, and that the true measure of hearing loss lies in the client's reporting how they experience their hearing loss. I have found that the best indication of how patients experience their hearing loss does not depend on the audiogram but in what they tell me about their activities, participation, listening needs and listening lifestyle.

Hearing loss is the third most prevalent chronic health condition facing seniors. The prevalence of hearing loss and accompanying costs will continue to rise. One out of three older Americans has this condition. Over the next 15 years, 78 million people will move into the 50+ age bracket and the incidence of hearing loss will indeed escalate well beyond the current 1 in 10 affected persons. (34) Over 30 million people are estimated to be exposed to injurious levels of noise each day. Data indicate that people are losing hearing earlier in life and that men are more frequently affected in the 35 - to 60-year-old age group (35) Half of the 28 million Americans with hearing problems are under the age of fifty and are active in the work force.(36)

Several studies have been conducted on the link between depression and hearing loss. (37) Recent findings indicate that of the groups studied, women of all ages and adults age 18 to 69 with hearing loss are more likely to experience "significant

depression” than hearing loss sufferers over 70.1 (38). Many of those with a mild hearing loss will be in the younger age groups.

Hearing loss can lead to depression in so many people because communication, which is vital to social interactions, becomes a source of stress when they have to strain to hear others speak and frequent misunderstandings result in embarrassment. After a while, people with untreated hearing loss begin to avoid social situations particularly if they involve noisy surroundings like parties or crowded restaurants where understanding speech is even more difficult. *Withdrawal tends to progress until the person gradually quits on life, choosing to remain in silent isolation rather than struggle to hear and communicate publicly.* Cutting oneself off from society and activities is a red flag for depression. (37)

In a study conducted on **Generation X and Baby Boomer patients with untreated hearing loss, participants were found more likely to develop depression and other psychological issues than their hearing peers.** (39) Another large study of adults 50 and older with untreated hearing loss found they were more likely to experience depression and other emotional or psychological problems. Those with an untreated hearing loss were significantly less socially active than their peers who wore hearing aids (40) Patients with untreated hearing loss find it more difficult to communicate with others, leading to the avoidance of social interaction with friends and family. *Isolation is a known contributor to depression.* (41)

Through the years I have helped many people hear well again. I have come to now know first-hand some of the deleterious psycho-social effects of the increasing difficulty hearing. Here is a sample of what I’ve heard from my patients when first interviewed.

Anxiety – *Will I be able to hear conversation in this restaurant or will I have to nod my head and hope I'm not embarrassing myself? ...Will I understand my grandchildren when they come to visit?... Will I still enjoy playing bridge even though I sometimes miss the bid?... When I listen with my kids to their records will I have any idea what the lyrics are because the music is louder and the singing is too fast... Will the ringing get worse...*

Frustration – *I wish they would just talk slower. ... Does this restaurant have to be so noisy? ... I'm sick of saying "what" all the time. ...Why can't my husband realize how much his hearing loss hurts him?*

Anger – *Sometimes I hate when that telephone rings. They talk so fast and many times with an accent and I just don't know what they are saying. ... I wish my family had my hearing for a day. They would finally understand what I go through. ...That store clerk who mumbled made me look stupid and embarrassed me.*

Fear – *They'll all stare at me with a hearing aid ... I'll look old.*

Depression – *This hearing loss and my constant head noises really gets wearisome. ... What did I do to deserve this ... I was planning on enjoying this vacation but that isn't happening. ... I don't think anything can help me.*

Loss of self-confidence – *I used to take charge at the meetings, but now, because I can't hear well, I sit back and try to follow part of the discussion. ...I liked listening to my friend's jokes but now I cringe because sometimes I can't hear the punch lines.*

Loss of self-esteem – *I hope they didn't think I was stuck up. I just couldn't hear what she was saying. ... I bet they thought I was disinterested...I kept nodding my head and looking for help.*

Isolation – *With this hearing loss I just want to be left alone. I would rather read a book than go out to the movies with friends. ... Why can't I eat in the dining room (at the life care center) at a table for 2 or sitting by myself. All that chatter drives me crazy.*

Fatigue – *Hearing on the phone drains me. ... It is so tiring reading my newspaper and trying to listen for anyone talking to me down the hall.*

Loss of memory – *I can't believe I didn't remember what she said. Maybe I didn't hear her.... How can I remember what I didn't hear?*

Denial – *I don't have a hearing problem if they would slow down and stop mumbling.*

Loss of companionship, friendship – *Now that the kids are grown and we're able to spend more time together, I'd like to talk to him more but it's too difficult... I miss the long talks...I wish he would meet me halfway and get some help.*

Increase stress within the family – *I seem to always be reminding my wife to turn around and face me when she's talking. Instead she's talking to me from down the hall or while walking away to another room... He's always blaming me because he can't hear. Why do I have to come down the hall to talk to him? Why can't he get up? Facing him and cooking at the same time is impossible...*

Loneliness – *I hate being alone but going out with my friends is just too difficult. ...I wish going out to a movie with my family was more fun. ... I miss the good times we had.*

Estimating the personal cost of a hearing loss is necessary when determining an appropriate cost of a new hearing aid(s). It is almost impossible to look at the entire cost of the hearing aid and compare it to the psycho-social cost over a five to six year life of the hearing aid. It would be better to estimate how much is alleviating these effects worth per month or per day. An appropriate hearing aid with enough technology and fitting range should be effective for at least 5 years. With many now starting to be water resistant, this expected product life may increase significantly – seven years or more. If you thought alleviating your problem hearing was worth a dollar a day, an out-of-pocket price for latest generation of moisture resistant hearing aids would be \$2500.

Older Adults

Older adults with a mild hearing loss often have more difficulty hearing and understanding speech in competing background noise along with possible cognitive costs that those younger with the same level of hearing loss. Being an older adult for some is a state-of-mind, lifestyle and/or physical well being. It has been said *Seventy is the new sixty*. With the amazing increase in the number of my patients over 85 and 90 years, it can be said that *eighty is the new seventy*. There has been a long standing focus on the degree of hearing loss when fitting amplification. Now the work required to hear and understand speech in real life competing noise environments to stay connected needs also to be a consideration.

A communications barrier, if it is significant, can also have psycho-social effects. Isolation caused by this hearing loss/auditory processing difficulty can have significant deleterious effects. Auditory processing may be worse than indicated by the pure tone thresholds for many older adults. Their working hard to listen to conversation when in an environment with competing noise may have a cognitive cost.

Most patients I see daily report having a problem hearing in complex listening environments. They rely on visual cues to augment auditory information, have a reduced enjoyment of music, and feel isolated because they have difficulty understanding speech when the speaker is unfamiliar.

Compromised auditory processing ability makes it difficult to listen to conversation when socializing in the presence of background noise or reverberant environments. The auditory nervous system appears to become less flexible with age, meaning that processing conversation, especially with background noise or competing speech, can be increasingly challenging.

People are living longer than ever. It is common for a patient 85 years or older to be seen at my practice. We are becoming more acutely aware of auditory processing difficulties due to aging. Older people are more socially active than ever with very demanding listening lifestyles.

This was not the case when I first started as an audiologist. At that time a 75 year old patient was considered old. This person typically either lived a quiet life by himself or with a spouse or lived in a more challenging listening environment with children and grandchildren. In the latter situation, isolation, frustration, anger and depression often occurred because of the limited auditory processing ability and ineffective hearing aid technology. Social interaction was often avoided because of the limited enjoyment it offered.

Rarely will an older patient complain primarily of their inability to hear in quiet. Most just don't need speech to be made louder. Rather, the chief complaint of these older adults is that they can have difficulty hearing speech and can't understand it because the background noise is interfering. They are also finding it difficult to understand rapid speech and multiple talkers. TV with dialogue competing with sound effects and background music can be especially problematic.

Today, a ninety year old may be more active than his younger 75 year old predecessor. He may be living and socializing with groups in a life care environment. He may travel regularly and entertain family and friends in a restaurant or party.

Today, an older person's challenging listening environments may include a:

- Meeting or church
- Dining room or restaurant
- Inside a traveling car, train or airplane

- Noisy public place like an airport or train station
- Theater or cinema
- Cocktail party
- Court room
- Doctor's office or hospital
- Shopping Mall

The effects of an unattended longstanding hearing loss no matter how mild can be significant. Multiple studies indicate hearing loss can be linked to the onset of dementia and Alzheimer's disease. Leaving hearing loss untreated could pose a serious risk that has not been widely shared with the hearing-impaired population. Providing this information will encourage patients and their loved ones to make more informed and timely decisions about their hearing care. There have been some landmark studies that have shown hearing loss may have a cognitive cost.

Dr Frank Lin, of Johns Hopkins and colleagues studied 639 individuals age 36 to 90 without dementia. Participants were followed for the development of dementia and Alzheimer's disease through to May 31st, 2008. Of the participants, 125 had mild hearing loss, 53 had moderate hearing loss and 6 had severe hearing loss. During a midpoint follow-up of 11.9 years, 58 individuals were diagnosed with dementia, including 37 who had Alzheimer's disease.

The risk of dementia was increased among those with hearing loss of greater than 25 decibels, with further increases in risk observed among those with a *moderate or severe* hearing loss as compared with a *mild* hearing loss. For participants age 60 and older, more than a third (36.4 per cent) of the risk of dementia was associated with hearing loss. The risk of developing Alzheimer's disease specifically also increased

with hearing loss, such that for every 10 decibels of hearing loss, the extra risk increased by 20 per cent.

Researchers from the Perelman School of Medicine at the University of Pennsylvania showed that **a decline in hearing ability may accelerate gray matter atrophy in auditory areas of the brain and increase the listening effort necessary for older adults to successfully comprehend speech.** They found that the gray matter density of the auditory areas was lower in those with decreased hearing ability, suggesting a link between hearing & brain volume.

"As hearing ability declines with age, interventions such as hearing aids should be considered not only to improve hearing but to preserve the brain," said lead author Jonathan Peelle, PhD, research associate in the Department of Neurology. (51) "People hear differently, and those with even moderate hearing loss may have to work harder to understand complex sentences."

Older adults (60-77 years of age) with normal hearing for their age were evaluated to determine whether normal variations in hearing ability impacted the structure or function of the network of areas in the brain supporting speech comprehension. People with hearing loss were shown to have less brain activity on functional MRI scans when listening to complex sentences. Poorer hearers also had less gray matter in the auditory cortex, suggesting that areas of the brain related to auditory processing may show accelerated atrophy when hearing ability declines.

Frank R. Lin, MD, Ph.D conducted a study commonly cited by medical professionals on the topic of hearing loss and cognitive decline. The study observed 1,984 adults with a mean age of 77.4 years over the course of six years, tracking the progression of their hearing loss in relation to their cognitive function. Dr. Lin concluded that while further research was needed to identify the mechanics of how and why hearing loss

and cognitive decline are related, there is little doubt that hearing loss is a factor in loss of mental acuity in older adults. The study also indicated that the more severe the hearing loss, the greater the likelihood of developing a cognitive disorder, and the steeper the decline in mental function. However, even subjects with mild hearing loss were found more likely to experience cognitive failures. (50)

In January 2014, Dr. Lin and his team released new results regarding changes in the brains of adults with normal hearing to those of adults with hearing loss. After undergoing magnetic resonance imaging (MRI) exams every year for ten years, 51 of the 126 participants examined whom had at least a 25-decibel (dB) hearing loss from the start displayed accelerated rates of gray matter shrinkage when compared to the 75 participants with normal hearing. Those with hearing impairments lost more than an additional cubic centimeter of brain matter annually and experienced greater shrinkage of tissue in the structures responsible for processing sound and speech. The atrophy affected the middle and inferior temporal gyri, which play key roles in memory and sensory integration. Similar damage to these regions can be seen in patients with Alzheimer's disease. (52)

Early diagnosis and treatment of hearing loss slows the progression of dementia and Alzheimer's disease. As evidence continues to mount that hearing loss is a contributing factor in the development of dementia and Alzheimer's disease, it is imperative to inform patients of the profound consequences of ignoring their hearing loss. People with hearing loss on average wait seven years from when they are diagnosed to seek treatment, even though the sooner hearing loss is detected and treatment begins, the more hearing ability can be preserved. Considering early diagnosis and medical intervention also slows the progression of dementia and

Alzheimer's disease, it is more important than ever for physicians to encourage patients to get their hearing loss treated sooner rather than later.

Treatment with hearing aids not only help improve a patient's hearing – they may be the key to preventing brain atrophy and cognitive dysfunction.

Younger Adults

Noise exposure is the leading cause of hearing loss in young and middle aged adults. I am seeing an increasing number of younger adults who are having difficulty hearing speech in complex listening environments (reverberation, competing speech and other noise). The effects of noise exposure on hearing can be immediate or take a long time to notice. This noise induced hearing loss (NIHL) can be temporary or permanent, and it can affect one ear or both ears.

Exposure to harmful noise can happen at any age. People of all ages can develop NIHL. **Approximately 15 percent of Americans between the ages of 20 and 69—or 26 million Americans—have hearing loss that may have been caused by exposure to noise at work or in leisure activities.**

This NIHL can be caused by a one-time exposure to an intense “impulse” sound, such as an explosion, or by continuous exposure to loud sounds over an extended period of time, such as noise generated in a woodworking shop. Recreational activities that can put you at risk for NIHL include target shooting and hunting, snowmobile riding, listening to MP3 players at high volume through earbuds or headphones, playing in a band, and attending loud concerts. Harmful noises at home may come from sources including lawnmowers, leaf blowers, and woodworking tools.

Researchers at the University of Wisconsin School of Medicine and Public Health researchers found that hearing loss in middle-aged adults is associated with being male, having a noisy job, and having certain cardiovascular disease risk factors. One in seven middle aged adults was found to have a hearing loss with the average being 49.

The prevalence of hearing impairment was 14.1 percent and the average word recognition in quiet was 89.6 percent, but 63.5 percent in competing message or noisy environments.

Researchers also found cardiovascular markers associated with hearing problems. Participants also had significantly higher odds of a parental history of hearing impairment and that this is a highly heritable condition. "Hearing impairment is a common condition in middle-aged adults. Cardiovascular disease risk factors may be important correlates of age-related auditory dysfunction," they said.

The authors conclude that if hearing impairment is detected early, "it may be a preventable chronic disease" because the same healthy lifestyles changes that improve cardiovascular health may also prevent or delay hearing loss.

At least 29 million Americans have a hearing impairment. "Population-based epidemiological prevalence estimates range from 20.6 percent in adults aged 48 to 59 years to 90 percent in adults older than 80 years," the authors report. "The severity of this condition has been shown to be associated with a poorer quality of life, communication difficulties, impaired activities of daily living, dementia, and cognitive dysfunction."

The study was published online Monday in the Archives of Otolaryngology-Head & Neck Surgery, one of the JAMA/Archives journals. The paper will appear in the May print issue of the journal. (54)

Impact of Hearing Aids

- Hearing aids improve overall quality of life for most users.
- Hearing aid users enjoy better overall health than non-users.
- Hearing aid users are perceived by their families to have better cognitive functioning than non-users and to be less introverted.
- The most beneficial effects of hearing aids are found in the users' social lives, taking part in group activities, and family relationships.
- Hearing impaired people with hearing aids have greater self-confidence, stronger self-image and better communicative functioning, resulting in overall higher self-esteem, than those without aids.
- Hearing aids help to reduce deterioration in psychological functioning as a result of hearing impairment.
- Hearing aids can reverse social, emotional and communication dysfunctions caused by hearing impairment.
- Hearing aid users are more likely than non-users to engage in activities involving other people.
- Hearing aids improve most aspects of emotional life and hearing aid users have greater warmth and less negativity in personal relationships than non-users.
- **Hearing devices make a difference (49)**

Hearing aids have been associated with stigma and prejudices. One misperception is that they don't work. It has now been documented that they do help, and it is no surprise that 94 percent said they would recommend that others with hearing loss seek treatment with hearing aids.

Hearing loss is among the most severe disabilities in terms of the effects on the individuals' social and personal relationships. Improving hearing is essential for an individual's social relationships.

Even though consumer studies cannot comment on whether the individuals were appropriate hearing aid candidates, or if their recollection of the advice given was accurate, the numbers reporting that hearing aids were not (yet) recommended are significant. One reason for advising against hearing aids may be that hearing aids are deemed less beneficial for those with mild hearing loss, although some studies have shown this not to be the case. (44), 45),

People with hearing loss delay a decision to get help because they are unaware of the fact that receiving early treatment for hearing loss has the potential to literally transform their lives. Research by the National Council on the Aging on more than 2,000 people with hearing loss as well as their significant others demonstrated that hearing aids clearly are associated with impressive improvements in the social, emotional, psychological, and physical well-being of people with hearing loss in all hearing loss categories from mild to severe. Specifically, hearing aid usage is positively related to the following quality of life issues.

Hearing loss treatment was shown to improve:

- Earning power
- Communication in relationships
- Intimacy and warmth in family relationships
- Ease in communication
- Emotional stability
- Sense of control over life events
- Perception of mental functioning

- Physical health
- Group social participation (47), (2)

One study found that quality of life increases significantly with hearing aids. After just 4 months, an increase in the number and quality of social contacts was observed along with a significant reduction in all aspects of hearing related disabilities. (48)

When you look at the list of benefits that occur from wearing effective amplification and learn of the low daily cost of hearing aids, you'll realize that hearing aids can be a very cost effective investment.

Tinnitus

If you have a mild hearing loss and tinnitus, you are not alone. People with tinnitus are widespread. Estimates of prevalence varies. It has been estimated between 30 million and approximately 50 million US adults have tinnitus, with 16 million US adults reported having frequent tinnitus in the past year.

These are truly fast-paced and stressful times. The pace in which we work, live and do business may often lead to the development of a number of health disorders. Among these disorders include tinnitus, which is characterized by a noise or ringing in the ears. It's a common concern today, and is believed to affect around one in five people. However, doctors are quick to point out that it isn't a condition itself, but rather a symptom of an underlying health disorder or ailment. It may be an indicator of diseases such as Meniere's Disease, an injury to the inner ear, hearing loss, cardiovascular disorders, and depression.

The most common cause for tinnitus is hearing loss. As we age, or because of trauma to the ear (through noise, drugs, or chemicals), the cochlea becomes damaged and is no longer sending the normal signals to the brain. The brain then becomes confused and essentially develops its own noise to make up for the lack of normal sound signals. This then is interpreted as a sound, tinnitus.

This tinnitus can be made worse by anything that makes our hearing worse, such as ear infection or excess wax in the ear.

Tinnitus caused by ear trauma is usually noticed in both ears, because both ears are usually exposed to the same noises, drugs, and other influences. Loud noise exposure is a very common cause of tinnitus today, and it often damages hearing as well. Unfortunately, many people are unconcerned about the harmful effects of

excessively loud noise from firearms, high intensity music, or other sources. Ten million Americans have suffered irreversible noise-induced hearing loss, and 30 million more are exposed to dangerous noise levels each day.

There are a number of non-auditory conditions that can cause tinnitus, as well as lifestyle factors. Hypertension and thyroid problems can cause tinnitus without any specific auditory problem. Stress and fatigue may cause tinnitus, or can contribute to an exacerbation of an existing case. Poor diet and lack of exercise that may cause blood vessel and heart problems may also either cause it or exacerbate an existing condition.

A number of medications may cause or worsen tinnitus. Generally, the higher the dose of medication, the worse tinnitus becomes. Often the unwanted noise disappears when you stop using these drugs.

Tinnitus has been shown to have a direct impact on emotional well-being, hearing, ability to sleep and to concentrate—in turn influencing basic life functions, such as socialization and relaxation. It can interfere with an individual's ability to perform adequately on the job or contribute to psychological disorders, such as depression, disorder, anxiety, isolation and anger. The constancy of tinnitus and the perceived lack of control can provoke fear, which exacerbates the problem leading to an ever-increasing cycle of distress in the person suffering from tinnitus.

Tinnitus can cause fatigue, stress, sleep problems, trouble concentrating, memory problems, depression and anxiety. Disrupted sleep is the most significant complaint, and affects between 25-50% of tinnitus patients. Poor attention and concentration are commonly reported.

About 42% of survey respondents reported that tinnitus interfered with their work. Tinnitus often has negative effects on personal relationships. Tinnitus can be worse in quiet or noise. Sleep problems and tiredness will result. Tinnitus can cause difficulties listening/concentrating in class, pain, distress, worry, anxiety and helplessness.

Most of the people suffering from tinnitus usually have a hearing loss due to damaged delicate parts of the inner ear - the cochlea and its associated parts. These nerve fibers tend to discharge synchronously in the auditory system so that the audio system cannot discriminate between sounds. Historically, when digital amplification has helped improve hearing it has not been able to significantly lessen tinnitus. This is changing.

The reason why many feel that a tinnitus cure is next to impossible is because the root cause of this ear noise often is unidentified. There are theories about the physical changes in the inner ear or neural pathways or the brain that cause tinnitus but nothing more.

New breakthrough wide range amplification and hearing aid technology sometimes with *sound therapy* has emerged after years of research and development. It is game changing because hearing devices with this new technology have been able to alleviate and even *eliminate* tinnitus. **Tinnitus elimination is now for the first time within the reach of many sufferers.**

Even if these new devices only lessen tinnitus, their impact can be increased with dietary changes, avoidance of loud noise, more relaxed hearing, successful mediation of stress and its physical effects. Today tinnitus for many people is manageable.

Hearing Aid Styles & Technology

IT'S ABOUT STYLE

For some with a *mild to moderate* hearing loss, the newest barely visible *open ear* and *receiver-in-the-canal* style hearing aids are an attractive first option. These hearing instruments can be so light that the wearer forgets they're there. Their open ear feature eliminates the occlusion effect or plugged up feeling.

Open-ear style digital hearing aids with speech/noise management technology offer significant assistance. A person with a high frequency hearing loss will most often find people to be loud enough but not clear enough. Difficulty understanding others from the next room or in a meeting will occur more often, especially when there is some interference from background noise. Listening difficulty occurs in a car, at the movies, while shopping in the mall or at a restaurant. This individual may not have a problem understanding one-on-one conversations. When in a quiet setting this person may also hear internally generated head noise called tinnitus.

Open ear hearing aid



While similar to *open ear* style, the receiver-in-the-canal (R-I-C) hearing aids are different because as the name implies the receiver is placed in the ear canal. This can be a major advantage over other styles, if there is a selection available of different strength receivers that will expand the fitting range from mild to even profound level hearing losses. *One model R-I-C hearing aid can fit from a mild to a*

profound hearing loss. For some it has been reported that such receiver placement produces a higher fidelity sound. However, it is at this time too early to clearly determine the sound advantages of the R-I-C when compared to open ear style hearing aids

Receiver-in-the-canal hearing aid



A person with a *moderate* hearing loss may sometimes misunderstand conversations on the telephone. For this person, conversation will be more difficult because of the interference caused by surrounding noise while riding in a car, crowd noise and reverberation while shopping in the mall or with others socializing at nearby tables at a restaurant.

In addition to R-I-C style hearing aids, custom-made, one-piece hearing aid styles may also be a good choice.



all-in-the-ear

all-in-the-canal

completely-in-the-canal

The barrier of a *moderate to severe* hearing loss is more formidable. It is present most of the time even in relatively quiet listening settings. Speech is often unclear. Soft voices may not be loud enough especially if there is competing background noise. This *moderate to severe* hearing loss may cause constant frustration especially in noisy or complex listening environments

Meetings and lengthy telephone conversations will be avoided. All the previously mentioned hearing aid styles except for the *open ear* may be appropriate for this level hearing loss. Choice of style may depend on other factors besides the strength.

Behind-the-ear hearing aids may be the best choice when the hearing loss is *severe to profound* and worse. Another situation to recommend fitting a *behind-the-ear* hearing aid is when the wearer has had bouts of middle ear fluid running from the ear canal into the outer ear even after the most diligent care and aggressive medical intervention.

Behind-the-ear style



Courtesy Siemens



Courtesy Sonic Innovations

Courtesy Siemens



Deep insertion completely-in-the-canal style hearing aids have an attractive discrete benefit. They take advantage of the pinna channeling hearing into the canal and require less amplification when compared to behind-the-ear instruments/

IT'S ABOUT TECHNOLOGY

Today's hearing aid technology that is available from any of the six major hearing aid manufacturers (responsible for 90% of sales worldwide) is remarkable. They invest up to \$100,000,000 each on research and development.

Advances in feedback reduction technology are responsible for the proliferation of receiver-in-the-canal and open-ear hearing aids. They are so light that many wearers report they are barely felt. They are so small and with replaceable color casing to match skin or hair make them barely noticeable.

Feedback cancellation ability has advanced so the ear canal can be left open and eliminate the plugged up feeling. Wear's voices sound more natural to themselves with an open ear canal fit and advanced hearing aid technology. More effective speech enhancement-noise reduction technology makes conversational speech more natural and clear to them as well..

Some of these hearing aids listen to the environment while worn and not just estimate the level of noise but classify the acoustic listening environment, predominant input sound and adjust to these acoustic properties and listening conditions.

These hearing aids could analyze your listening conditions and select the optimum settings and adjust to changing listening environments, speakers and speaker distance automatically and seamlessly. Some of these breakthrough devices could recognize speech coming from behind, as from the back seat of a car, and emphasize it and attenuate other interference even if in front. Some of these hearing aids can be moisture proof and dust proof. Some *receiver-in-the-canal* style hearing aids could have a complete selection of removable receivers so they are able to have enough gain and output to provide enough amplification for a mild hearing loss to a profound

hearing loss. This range would accommodate 95% of all hearing losses. They have several levels of hearing aid technology to best fit your listening need, hearing loss and auditory processing ability.

Some can be equipped with some of the most effective tinnitus sound therapy ever developed. Some of these hearing aids could connect by Bluetooth wireless technology directly to your cell phone, home phone, TV or MP3 player. With the touch of a button, you could connect to the induction loop of the theater or facility to hear the amplified program directly.

There are even some digital hearing aids that could transpose a sound (bird or s sound) to a frequency where there is enough hearing. **Amazingly, all these advances can come in the same digital hearing aid.**

Range of Technology

Within a hearing aid manufacturer's selection of their instruments are several different levels of technology available in all hearing aids styles offered. When selecting a level of technology, there needs to be an honest self-appraisal of the difficulty hearing while in noise or in a group, your listening needs and lifestyle.

In general a higher level of hearing aid technology may be required for a successful fit if the patient has:

- more difficulty understanding conversation while in a group,
- a more active listening lifestyle,
- auditory processing difficulty (ability to hear speech while in competing noise as well as the ability to understand rapid speech) that is worse than would be predicted just by the audiogram or speech discrimination in quiet,
- difficulty adjusting the hearing instruments,

Today's breakthrough hearing aid technology has capabilities that couldn't have been imagined just a couple of years ago. The newest development introduced by several manufacturers are wireless remote microphones that can maximize speech-to-noise ratio from a distance of up to 40 feet.

A New Hearing Aid's Cost

The cost of a new hearing aid will depend on a number of factors such as the wearer's

- hearing loss
- ability to hear in noise
- listening need
- listening lifestyle
- comfort with technology
- ability to adjust
- need for aftercare
- level of hearing aid technology
- your definition of your hearing problem
- how much you're willing to spend on a solution
- how you buy the hearing aids
- where you buy the hearing aids
- their comfort
- their appearance.

Don't worry. I'm going to go through these one by one and provide a path to hearing aids that meet your needs.

When reviewing this list, the first thing that stands out is the last item. It is the least important one because miniaturization has made most products barely noticeable, everyone is wearing something in their ear and, finally, who cares. The manufacturers typically price the hearing aids according to their levels of technology and not their style.

The best place to start is a hearing evaluation. This should not only determine your hearing thresholds and plot them on an audiogram but other aspects of your hearing as well.

For example, if:

1. people are too soft and or unclear, then speech audiometry is also needed.
2. hearing and understanding speech in competing noise is also a problem, a speech-in-noise screening is a good idea. If the screening indicates there may be more difficulty hearing aid understanding speech with competing noise, further central auditory processing may be needed.
3. you have tinnitus (ringing in the ear or ears and/or other head noises) and you want to explore the possibility of relief, you may also need a tinnitus evaluation.

All this testing can be done in one session and will take an hour or less. It should be done by an audiologist and will probably be covered by your health insurance. Spend the time. It will be worth it. You need to understand your hearing loss before you look for a solution. If testing has shown that you have a hearing loss, tinnitus and/or a problem hearing in noise, hearing aids should be explored.

Understanding your listening need and lifestyle is important. People may have the same audiograms but different listening needs. In general, if you have a problem hearing speech in complex listening conditions and a desire or need to hear conversations in these situations, simple amplification will not be as effective as more advanced hearing aid technology which may cost more.

When purchasing a hearing aid, there may be a strong desire to try to get by with the least expensive device. While not everyone needs the most sophisticated hearing aid technology, they should select a level of technology that is appropriate for their listening lifestyle, hearing loss and auditory processing ability.

Deciding on The Hearing Aid Technology Level to Purchase

Just Listen

I developed a hearing aid program that enables people to evaluate several level of technology and compare their effectiveness in real world listening situations they find problematic. It's called Just Listen. You can learn more about this unique program .at hearwellagaincenters.com/justlisten.

If such as opportunity is not available, here is a short check-list that may help in selecting technology. Just add the points to guide you to the technology level of the device you purchase.

Listening lifestyle

Quiet – lives by oneself or with one other, doesn't engage in socializing in groups or complex listening situations such as a restaurant **1 point**

Moderately demanding - lives with others, sees others in the family in a wide array of listening environments, such as church, restaurants, shopping malls **2 points**

Demanding – lives in a life care community or with others in an active family, works outside with others, needs to understand conversation in competing office background noise and babble. Goes to restaurants, shopping malls, attends meetings. **3 points**

Extreme – works in an office, meets clients in restaurants, travels by train or plane so frequents train stations, airports, attends meetings, socializes regularly in restaurants, works out in clubs, uses Bluetooth™ phone regularly. **4 points**

Level of hearing loss

Mild or normal hearing loss	1 point
Moderate hearing loss	2 points
Moderate to severe hearing loss	3 points
Severe hearing loss	4 points
Profound hearing loss	5 points

Age

40 years old or younger	1 point
50 years old +	2 points
60 years old +	3 points
70 years old +	4 points
80 years old +	5 points

Tinnitus

None	1 point
Mild Random	2 points
Moderate interfering	3 points
Severe Constant	4 points
Severe Debilitating	5 points

Slope of audiogram

Flat	1 point
Gently downward sloping	2 points
Precipitously sloping	3 points

Speech discrimination score obtained in a test

Excellent	1 point
Good	2 points
Fair	3 points
Poor	4 points

Optional

If your speech understanding in competing noise was tested or you have worn hearing aids in noisy listening environment and your **Hearing Speech in Noise is**

Excellent	1 point
Good	2 points
Fair	3 points
Poor	4 points

Major hearing aid manufacturers have several levels of hearing aid technology –

Level of Hearing Aid Technology

If your point total is	16 points+ (HIGHEST)
	12- 16 points (INTERMEDIATE)
	8 – 12 points (BASIC)
	Less than 8 points (ENTRY)

Many times I'll ask a patient two questions when we discuss technology. How well do you want to hear? + Where do you want to hear well? These answers will help how much technology may be needed. Then I'll ask for the patient to prioritize price, appearance and function. If price is the highest priority and the patient wants to hear in environments that may require higher levels of technology, further discussion of technology level may be necessary and/or look at aftercare options to reduce cost.

The effectiveness of the hearing aid technology in important listening situations may determine the length of time a hearing aid is worn before it is replaced. The length of time of the hearing aid's usefulness will help the wearer decide if the low cost hearing aid was indeed a bargain or a costly mistake.

It is almost impossible to look at the entire cost of a hearing aid and compare it to the psycho-social benefit it provides over its five or six year life. It would be better to estimate how much is alleviating these effects worth per month or per day.

If you have a mild high frequency hearing loss, moderate auditory processing problem, active listening lifestyle, need improvement in a wide range of listening situations, want to alleviate your hearing problem and at the same time spend your money wisely, which option would you choose?

1. You purchase an inexpensive personal amplifier (PSAP) that looks like a hearing aid and promise results that sound too good to be true. You try a couple of PSAPs because they don't live up to their promises but you don't want to give up. You spend a total of \$200. Since they did not contain any feedback reduction technology, it required your ear to be occluded. You hate having your ear being plugged by these instruments. They are too large and noticeable and in any competing noise are ineffective. You don't have the time or make the effort to pack

them up and mail them back. Each PSAP keeps ending up in the drawer and you order another described in a different ad.

Your daily cost would be around \$15 since for you wear each one only a week before you order another. You are still left without a solution.

2. You choose a hearing aid in the intermediate hearing aid technology range, that is moisture resistant, a receiver-in-the-canal style that has a wide fitting range to accommodate hearing changes and it feedback reduction ability to keep your ear open and not plugged. You choose a limited number of aftercare visits because an *unbundled* option is offered. These choices will ensure your hearing aid will be worn most of the time and last about six years. The hearing aid cost \$1300.

Your daily cost would be less than 60 cents.

The next thing to consider is how and where you purchase it. You can be fit locally by a hearing health care professional or purchase your hearing aid on-line. If you decide on-line, there are usually two general choices:

1. Go to a web site that offers a hearing aid with an unknown brand from an unknown manufacturer. The price may be the most attractive of the options but have the greatest possibility to waste your money. Think about it. You will be talking to someone you will never meet in an unknown location. You don't have any idea of this person's fitting experience and qualifications. His task after receiving your hearing test and talking to you on the phone is to help you pick out your hearing aid, program it and ship to you. Aftercare will be limited to mailing this hearing aid

back at your expense and have this same person re-adjust it. It will be mailed back. You should receive it in a week. Hopefully only one set of adjustments will be needed and you will have time to wear it in a wide variety of listening environments before your trial period is complete and you have to decide to keep it or send it back. You never have any face-to-face time with an audiologist. As I said, while initially very attractively priced, this option has the most pitfalls and possibly the highest daily cost.

2. Go to a web site that has a network of hearing healthcare professionals available for fitting and including limited aftercare. They have a selection of brands and styles. You may have to pay for the hearing aids before an appointment is made with the local professional for fitting. Some networks may not require this and instead have the fitting decisions and product chosen after consulting in-person with the local network member.

The savings using this option will not be as great as the first option. When compared to being fit by a local professional with the same amount of aftercare available, this option may provide little or no financial savings.

If you choose to have your hearing helped locally and be possibly fit with a hearing aid, the next question is where? Your basic choice is a local professional who has a history and a reputation or a big box retailer that offers savings but their hearing aid fitters have unknown qualifications and fitting experience. This is vital as hearing aids are typically in need of adjustment to optimize their effectiveness.

Your First Hearing Aid

Most people who I see for their first hearing fitting have a very mild (most thresholds within the range of normal) to moderate sensorineural hearing loss. They typically have good speech discrimination scores in quiet test conditions with no competing noise. Their hearing conversation in background noise or dialogue on TV is usually their most significant hearing problem. Their hearing can be normal below 1K Hz

If you have a mild hearing loss and are looking for your first hearing aid, I suggest that it ...

- not occlude your ear. Blocking your ear with either a hearing aid or earmold will cause an insertion hearing loss. Amplification of sounds below 1 K Hz will be necessary to compensate. However, occluded amplified sounds will sound harsh, speech will not be natural and your voice will be too loud.
- be an *open-ear* or *receiver-in-the-canal* style.
- have compression technology that will enable soft speech be amplified more than loud sounds. This compression should be adjustable.
- have multiple microphones and be able to amplify speech in front more than noise behind.
- be programmable so the response, gain and output can be adjusted to your hearing loss and your sensitivity to loud sounds.

This technology need not be expensive. This hearing aid could be purchased at a lower cost after unbundling the aftercare charges from the hearing aid price. By paying for aftercare services if and when they are needed, the amortized cost could be as little as 30 cents a day. This is a bargain compared with many PSAPs (personal sound

amplifiers) that usually end up in the drawer since they aren't programmable, don't have advanced compression technology, have only one microphone and no directionality . They usually occlude the ear with the resulting *occlusion effect*.

The advantages of a hearing aid over a PSAP is that the hearing aid can be fit locally by a hearing healthcare professional while a PSAP is dropped in the mail. The hearing aid can be adjusted in response to the wearer's experience. The hearing aid is fit on a trial basis.

Easier Listening, Easier Living

When I first started as an audiologist, hearing aid performance was measured in terms of its gain, output and response. Correspondingly, their effectiveness was determined by how much the hearing aids improved the wearers pure tone thresholds and speech discrimination score as well as lowered the minimal loudness level of speech necessary to be understood. The measurements were easy to obtain and repeatable. They were adequate at that time because of the limitation of hearing aids.

Hearing aids were pre-digital and were miniature amplifiers that could not change their amplification as listening conditions and needs changed. Measuring the impact of hearing aids was easy, clean, reliable, repeatable but not valid. People whose aided results in the test environment were impressive were dissatisfied with amplification and put them away when possible. Where they needed amplification the most, such as hearing conversation with others, it was least effective.

Except for those with severe and profound hearing losses who desperately needed amplification to have any chance of hearing and understanding speech even in quiet, hearing aids were not products that many sought and used. They were rarely recommended for those with a mild hearing loss.

People had to be counseled to persist in their use of hearing aids. Even in two eared losses, the majority of hearing aid fittings were monaural because they were not pleasant and natural sounding. This is a major reason why I became interested in counselling and earned a doctorate in deafness rehabilitation – a counselling degree.

Faced with the limitations of miniaturization and the low usage of hearing aids by those with moderate and mild hearing losses, the hearing aid manufacturers and hearing

healthcare professionals began a 50 year journey of discovery and development that has led to today's products.

Today's hearing aids can respond to changes in the listening environment as well as to speech and speakers. They can keep the amplified sound natural and clear. With breakthroughs in feedback control, they no longer have to seal the ear and, as a result, they have eliminated the *occlusion effect* (feeling plugged, amplification sounding mechanical, wearer's voice unnatural) which was a major reason past hearing aids ended up in a drawer.

Now the emphasis of measuring hearing aid performance evolved from only being reliable and repeatable but to also include being valid. The impact of a particular hearing aid and its settings is more important than the acoustic measurements.

The goal of amplification has changed from *loud and clear* to *listening easier* as the hearing aid technology has evolved to be more effective in more demanding listening environments. The goal now is for people with a hearing loss to not have to work so hard keeping up with conversations in a wide variety of listening situations that they find themselves.

From the studies at Johns Hopkins and the University of Pennsylvania, easier listening will not only improve a person's life but will produce neurological benefits as well. With the goal of amplification progressing to easier listening, listening lifestyle and listening need become as important as the thresholds found on the audiogram. They are now factors to consider.

When selecting the prospective hearing aids strength and appropriate style, in addition to the pure tone threshold and speech discrimination results on the audiogram, age should be a factor to be considered. Age provides a basic estimate

of a person's auditory processing ability. A fifty year-old's auditory processing ability could be expected to be better than of an 85 year old.

Listening lifestyle and living arrangements need to be also considered to get the best hearing aid choice that will achieve easy listening. A 75 year old who lives by herself and leads a quiet solitary lifestyle will probably need less aggressive speech enhancement/noise reduction hearing aid technology than if she lives in a life-care community with active socialization.

Amplification is more effective than ever. If appropriately chosen to meet a person's listening need and lifestyle, hearing aids can be more beneficial than ever.

Communication Improvement Therapy

Communication Improvement Therapy can be very effective for those with a mild hearing loss. Its goal is to reduce the deficits or problems caused by the hearing loss. Hearing loss acquired in adult life can have a serious impact on quality of life. This impact results primarily from deficits in the activities of speech perception and communication and the limitations imposed by these deficits on participation in social interactions, in employment, in leisure pursuits, and in the enjoyment of sound. The goal of rehabilitation is to restore quality of life by eliminating, reducing, or circumventing these deficits and limitations. These goals can be achieved in usually one or two sessions of about an hour for adults with a mild hearing loss.

This goal can be addressed through a combination of:

- speechreading instruction and practice ,
- instruction in the use of their hearing aid's technology and adjustments available to maximize the listening environment,
- multi-media perceptual training to improve speech understanding in competing noise and
- counseling to enhance participation, and deal both emotionally and practically with residual limitations.
- training in the management of acoustic environments

This concept of communications improvement therapy is summed up in the following definition: the reduction of hearing-loss-induced deficits of function, activity, participation, and quality of life through sensory management, instruction, perceptual training, and counseling. (42)

Sounds have to be audible in order to be clearly heard. Hearing aids with accessories (43) are the primary tool for those who need to hear high frequency soft consonants to understand speech. We address deficits of function through sensory management. The immediate goals are to provide audibility of the sounds of speech while preserving comfort and perceived sound quality and to do so over as wide a range as possible of talker spectrum, talker distance, talker effort, and interfering noise and reverberation.

Breakthroughs in hearing aid technology make amplification a possibility for those with a mild hearing loss. This was not the case years ago. The immediate outcomes of sensory management vary dramatically from individual to individual. This of course depends on whether the hearing aids are worn for a sufficient amount of time. Some don't want to use amplification.

For those with hearing aids, instruction on their care and use is a key component. Development of adjustment strategies and practice making these adjustment is key to wearing amplification. The immediate goal is for the adult with the hearing impairment to become a knowledgeable and effective user of the hearing aid. All users of these devices need to understand the nature of their hearing loss, the potential benefits of hearing aids, as well as the limitations of this technology. They need to learn how to maintain and operate their devices effectively and to deal with the associated inconveniences.

Developing listening strategies to optimize listening conditions is next. This should be included whether the person with the mild hearing loss choose amplification or not.

In Initial Session there usually is

- Review of audiogram
 - Its relationship with their hearing difficulties

- Answering any questions about patient's hearing problems
- Review of patient's listening lifestyle, listening needs and listening goals
- Briefly introduce auditory processing
 - And the role of levels of hearing aid technology
- Fitting of hearing aid if patient decides to try amplification.
- Instruction on operation and insertion of hearing aid
- Instruction on the care and cleaning of the hearing aid(s)
- Introduction to speech-to-noise ratio. If time remains, a review of basic listening strategies with possible handout
- Review of listening strategies with introduction of sound level meter app and typical listening environment noise levels
- Practice

Listening Strategies

Any discussion of listening strategies has to begin with an understanding of speech-to-noise ratio. If you were listening to conversation in a quiet setting, you would not have to employ any strategies to improve the relative strength of the conversation over competing noise since there not be any. Of course, this is not the case in the majority of listening situations that are problematic for those with a mild hearing loss.

Speech-to-noise ratio is a quick way to show and appreciate the relative loudness of the speaker you are trying to hear and compare it to the competing background noise that is interfering. For example, soft conversational speech can range from 45 dB to 50 dB depending on the person speaking. Conversational speech can range from 55 dB to 60 dB.

In terms of expected noise levels in a typical day competing noise levels can vary a great deal. For example,

- the noise level in a quiet room with forced air heating and air conditioning can be 50 dB to 55 dB
- a table in a busy restaurant can be surrounded by 70 to 75dB or more of competing background noise
- Inside a car the noise level may be 65 dB to 70 dB with the windows closed
- In the stands at a high school basketball game individuals may have to cope with 75 dB or more of competing noise
- Walking in a busy section of town, 75 dB to 90 dB of competing noise can be expected from the cars, trucks and buses going by and construction etc.

If you are walking around a busy section of town you may find yourself surrounded by 75 dB of competing noise, a person talking to you will be talking louder (65 dB) in response to the noise. So you can see that the speech-to-noise ratio of this person on the sidewalk talking to you from two to three feet away may be – 10 dB or the speech is 10 dB quieter than the traffic noise.

On the other hand, the speech-to-noise ratio of a person standing at the lectern with a microphone in a quiet meeting room may be + 20 dB. There is a wide variation in listening environment, that easily occurs in a typical day.

I could mention a number of other examples but it is more important for you to become totally familiar with the several concepts I have introduced in this chapter and integrate them into your life and apply them to your own listening situations.

- Speech-to-noise ratio is a way to quickly be cognizant of background noise and its relative strength to what you want to hear
- Lowering competing noise will increase the speech to noise level
- Shortening the distance the speaker is from you will increase the speech-to-noise ratio
- Contextual cues can be helpful to assist in understanding
- Everyone speech-reads so looking at the speaker should help

Try to control your listening environment so that interference from background noise is minimized

Connectivity and Connecting

The concept of a hearing aid's connectivity and its ability to enable wearers to connect with others may be different. They are looked at differently by the younger and middle aged hearing aid wearers and the older wearers. Wireless Bluetooth™ technology available in many hearing aids today has made the connectivity of the hearing aids with other Bluetooth™ devices such as I Phones™ or Androids™, MP3 players, TV's with Bluetooth™ transmitters etc. is a very attractive feature for those who use their mobile phone as a portal to the Internet, entertainment center and with the thousands of apps available countless other tasks. These are the younger and middle aged hearing aid wearers. Hearing aids with less technology may be adequate but optional ancillary Bluetooth™ equipment may be desired.

This Bluetooth™ connectivity is of little interest to older patients. However, reconnecting or keeping connected with others is important to the older hearing aid wearers. To accomplish this their hearing aids must have sufficient speech enhancement/noise reduction technology. There is a high probability that the older wearers will have auditory processing difficulty. It is not as likely in the younger ones.

Why Do Hearing Aids Cost So Little?

Often when I am talking about amplification with a patient or group, I am asked to explain why hearing aids cost so much. I used to try to explain their cost in terms of the manufacturer's costs of distribution, research and development, sales and marketing, manufacturing and warranty coverage as well as my operating costs including post fitting aftercare. I usually lost the patient after the first sentence. That was not my intention but it usually was the result.

Today's hearing aids are truly amazing. I have witnessed the step-by-step incremental improvement in amplification over the past 40+ years. Past generation instruments could only help in relatively quiet listening situations. In contrast, today's hearing aids can amplify conversation in the complex listening environments with competing speakers, environmental noise and reverberation. They can keep the amplified speech sounding natural and clear. Acoustic feedback is managed so efficiently that it is no longer required that the ear be occluded. Open ears are typical when wearing hearing aids. Today's hearing aids are Blue Tooth™ capable so wearer connectivity is simple.

Today's hearing aids can make listening easier. Hearing and understanding speech in a wide range of listening environments with competing conversation, reverberation and environmental noise interference was not possible with previous generations of hearing aids. Easier listening can have tremendous benefits for the older person struggling to remain involved. Easier listening with today's hearing aids for many can...

- Lessen anxiety, stress and depression
- Improve relationships
- Help to reconnect, increase involvement and reduce isolation
- Increase energy by making communication easygoing
- Slow cognitive decline

How much would you pay to get all these benefits each and every day? Would you pay \$10 a day? If you were purchasing pharmaceuticals to treat anxiety, depression, provide you with more energy, sharpen your listening ability and awareness, enable you to be more involved with family and friends and participate more in activities you have been avoiding, would \$20 a day be a rational price for these benefits?

The *right* hearing aid can provide significant assistance. The *right* hearing aid doesn't have to be the most expensive instrument. The *right* hearing should make listening easier. Depending on the wearer's listening lifestyle, hearing loss and ability to understand speech in competing noise, as well as choice of technology level and the amount of aftercare desired, the right hearing aid can start at less than 40 cents a day. Even the most expensive instrument can be less than a dollar a day. The question that needs to be asked is - *Why do hearing aids cost so little?* As America ages and everyday life gets noisier, the cost of not hearing increases more and more. Struggling to remain connected is so unnecessary because it is affordable.

Works Cited

1. www.hearingloss.org/content/basic-facts-hearing-loss
2. http://www.deaflixx.com/Technology/sudden_temporary.html
3. Barbra Timmer, MACAud, MAudSA, MBA, It May Be Mild, Slight, or Minimal, But It's Not Insignificant, Published on April 9, 2014 Research | April 2014 Hearing Review
4. Prevalence of Hearing Loss and Differences by Demographic Characteristics Among US Adults Data From the National Health and Nutrition Examination Survey, 1999-2004 Yuri Agrawal, MD; Elizabeth A. Platz, ScD, MPH; John K. Niparko, MD
5. J Gerontol A Biol Sci Med Sci. 2011 May;66(5):582-90. doi: 10.1093/gerona/glr002. Epub 2011 Feb 27. Hearing loss prevalence and risk factors among older adults in the United States. Lin FR1, Thorpe R, Gordon-Salant S, Ferrucci L.
6. https://my.clevelandclinic.org/health/diseases_conditions/hic_What_is_Presbycusis
7. <http://www.betterhearing.org/hearingpedia/hearing-loss-prevention/noise-induced-hearing-loss>
8. <http://american-hearing.org/disorders/noise-induced-hearing-loss/>
9. Davis RR, Kozel P, Erway LC. 2003. Genetic influences in individual susceptibility to noise: a review. Noise & health 5: 19-28
10. Konings A, Van Laer L, Van Camp G. 2009. Genetic studies on noise-induced hearing loss: a review. Ear and hearing 30: 151-9
11. Palmer KT, Griffin MJ, Syddall HE, Coggon D. 2004. Cigarette smoking, occupational exposure to noise, and self reported hearing difficulties. Occupational and environmental medicine 61: 340-4
12. Wild DC, Brewster MJ, Banerjee AR. 2005. Noise-induced hearing loss is exacerbated by long-term smoking. Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery 30: 517-20
13. Daniel E. 2007. Noise and hearing loss: a review. The Journal of school health 77: 225-31

14. Fechter LD. 2004. Promotion of noise-induced hearing loss by chemical contaminants. Journal of toxicology and environmental health. Part A 67: 727-40
15. Hearing Review, December 2003, Sudden Sensorineural Hearing Loss special issue
16. https://mysiemens.siemens-hearing.com/_data/DOCUMENT_LIBRARY/Hearing%20Loss%20and%20Cardiovascular%20Disorders.pdf
17. Better Hearing Institute. Heart Disease and Hearing Loss Linked press release. 2013 (<http://www.prnewswire.com/news-releases/heart-disease-and-hearing-loss-linked-so-get-your-hearing-checked-for-world-heart-day-bhi-advises-224502101.html>)
18. David R. Friedland, MD, Ph.D. http://www.enttoday.org/details/article/496955/Low-Frequency_Hearing_Loss_May_Indicate_Cardiovascular_Disease.html
19. The Laryngoscope. Department of Otolaryngology and Communication Sciences, Medical College of Wisconsin. Audiometric pattern as a predictor of cardiovascular status: development of a model for assessment of risk. 2009. Friedland DR, Cederberg C, Tarima S. (<http://www.ncbi.nlm.nih.gov/pubmed/19235737>)
20. American Journal of Audiology. The Influence of Cardiovascular Health on Peripheral and Central Auditory Function in Adults: A Research Review. Raymond Hall, Stacey Kerschen. 2010 (<http://aja.pubs.asha.org/article.aspx?articleid=1757459>)
21. https://mysiemens.siemens-hearing.com/_data/DOCUMENT_LIBRARY/Hearing%20Loss%20and%20Cancer.pdf
22. American Tinnitus Association. Ototoxic Brochure by League for Hard of Hearing. 2012.
23. National Institutes of Health News. Hearing Loss is Common in People with Diabetes. 2008 (<http://www.nih.gov/news/health/jun2008/niddk-16.htm>)
24. https://mysiemens.siemens-hearing.com/_data/DOCUMENT_LIBRARY/Hearing%20Loss%20and%20Diabetes.pdf

25. Fox News.com. Diabetes may be linked to hearing loss, study finds. 2012 (<http://www.foxnews.com/health/2012/12/03/diabetes-may-be-linked-to-hearing-loss-study-finds/>)
26. Hendricks, J. et al (2006). Progressive sensorineural hearing impairment in maternally inherited diabetes mellitus and deafness (MIDD). *Otology Neurotology*.27 , 6, 802-808.
27. Scherer MJ, Frisina R. Characteristics associated with marginal hearing loss and subjective well-being among a sample of older adults. *J Rehabil Res Dev*. 1998;35:420-6. - See more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4LJ6OKPK.dpuf>
28. Monzani D, Galeazzi GM, Genovese E, Marrara A, Martini A. Psychological profile and social behaviour of working adults with mild or moderate hearing loss. *Acta Otorhinolaryngol Ital*. 2008;28(2):61-6 - See more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4LJ6OKPK.dpuf>
29. Bertoli S, Bodmer D, Probst R. Survey on hearing aid outcome in Switzerland: associations with type of fitting (bilateral/unilateral), level of hearing aid signal processing, and hearing loss. *Int J Audiol*. 2010;49(5):333-46 - See more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4LJ6OKPK.dpuf>
30. Lutman M, Brown EJ, Coles RRA. Self-reported disability and handicap in the population in relation to pure-tone threshold, age, sex and type of hearing loss. *Br J Audiol*. 1987;21(1):45-58. - See more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4LJ6OKPK.dpuf>
31. Duquesnoy AJ. The intelligibility of sentences in quiet and in noise in aged listeners. *J Acoust Soc Am*. 1983;74(4):1136-44 - See more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4LJ6OKPK.dpuf>
32. Lutman M. Hearing disability in the elderly. *Acta Otolaryngol Suppl*. 1990;476:239-48. - See more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4LJ6OKPK.dpuf>
33. Dubno JR, Dirks DD, Morgan DE. Effects of age and mild hearing loss on speech recognition in noise. *J Acoust Soc Am*. 1984;76(1):87-96 - See more at:

<http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4LJ6OKPK.dpuf>

34. www.aarp.org
35. Wallhagen, M.I.; Strawbridge, W.J.; Cohen, R.D.; et al. An Increasing prevalence of hearing impairment and associated risk factors over three decades of the Alameda County Study. *American Journal of Public Health* 87(3):440-442, 1997.
36. <http://www.audiologyonline.com/articles/white-paper-addressing-societal-costs-6832-6832>
37. https://mysiemens.siemens-hearing.com/library/library.asp?filter=comorbidity&doc_type_code=&submit=Search
38. JAMA Otolaryngology – Head & Neck Surgery. Hearing Impairment Associated with Depression in US Adults, National Health and Nutrition Examination Survey 2005-2010. 2014
(<http://archotol.jamanetwork.com/article.aspx?articleid=1835392#Abstract>)
39. NCBI.NLM.NIH.gov. Psychological profile and social behavior of working adults with mild or moderate hearing loss. 2008
(<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2644978/pdf/0392-100X.28.061.pdf>)
40. National Council on Aging. The Consequences of Untreated Hearing Loss in Older Persons. 1999 (<http://www.ncoa.org/assets/files/pdf/center-for-healthy-aging/NCOA-Study-1999.pdf>)
41. *Psychology Today*. Social Isolation: A Modern Plague. 2009
(<http://www.psychologytoday.com/blog/the-depression-cure/200907/social-isolation-modern-plague>)
42. *Trends Amplif.* 2007 Jun; 11(2): 63–71. doi: 10.1177/1084713807301073
PMCID: PMC4111411
43. Boothroyd A. Hearing aid accessories for adults: the remote FM microphone. *Ear Hearing.* 2004;25: 22–23 [PubMed]
44. <http://www.hear-it.org/Many-positive-impacts-of-using-hearing-aids>
45. Davis A, Smith P, Ferguson M, Stephens D, Gianopoulos I. Acceptability, benefit and costs of early screening for hearing disability: a study of potential screening tests and models. *Health Technol Assess.* 2007;11(42):1-294. - See

more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4kAfFv5C.jpeEj6jT.dpuf>

46. Dillon H. Hearing Loss: The Silent Epidemic. 17th National Conference of the Audiological Society of Australia. Perth, Australia; 2006 - See more at: <http://www.hearingreview.com/2014/04/may-mild-slight-minimal-insignificant/#sthash.4kAfFv5C.jpeEj6jT.dpuf>
47. <http://www.betterhearing.org/hearingpedia/counseling-articles-tips/impact-treated-hearing-loss-quality-life>
48. <http://www.audiologyonline.com/releases/hearing-aids-bring-enormous-benefits-6559>
49. <http://www.hear-it.org/Hearing-aids-improve-quality-of-life>
50. https://mysiemens.siemens-hearing.com/_data/DOCUMENT_LIBRARY/Hearing%20Loss%20and%20Dementia.pdf
51. University of Pennsylvania – Perelman School of Medicine, Jonathan Peele, PhD. 2011 (www.sciencedaily.com/releases/2011/08/110831115946.htm)
52. Johns Hopkins Medicine. Hearing Loss Accelerates Brain Function Decline in Older Adults. 2013
(http://www.hopkinsmedicine.org/news/media/releases/hearing_loss_accelerates_brain_function_decline_in_older_adults)
53. Noise-Induced Hearing Loss NIH Pub. No. 99-4233. March 2014
54. <http://www.med.wisc.edu/news-events/hearing-loss-common-in-middle-age-but-could-be-preventable/30654>