



Children's National™

Noise Induced Hearing Loss (NIHL)

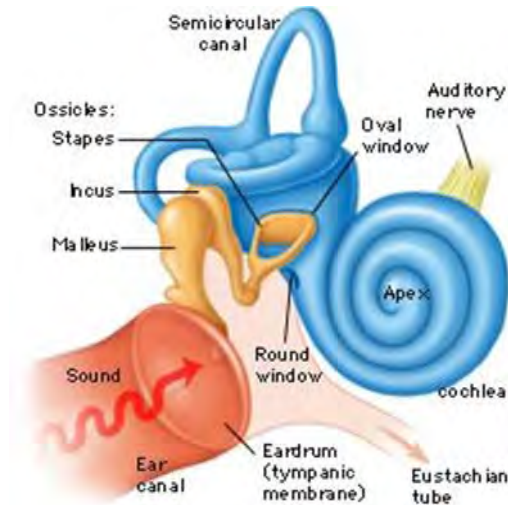
Dr. Tracey Ambrose, AuD, CCC-A



Importance of Hearing in Children

- Hearing plays an essential role in communication, speech, language development, and learning.
- Even minimal/ mild hearing loss or fluctuating loss can have profound, negative effects on speech development, language comprehension, communication, classroom learning, and social development.
- Children with mild to moderate hearing loss, on average, do not perform as well in school as their normal hearing peers.
 - This gap in academic achievement widens as students progress through school.
- <http://www.cdc.gov/healthyschools/noise/>

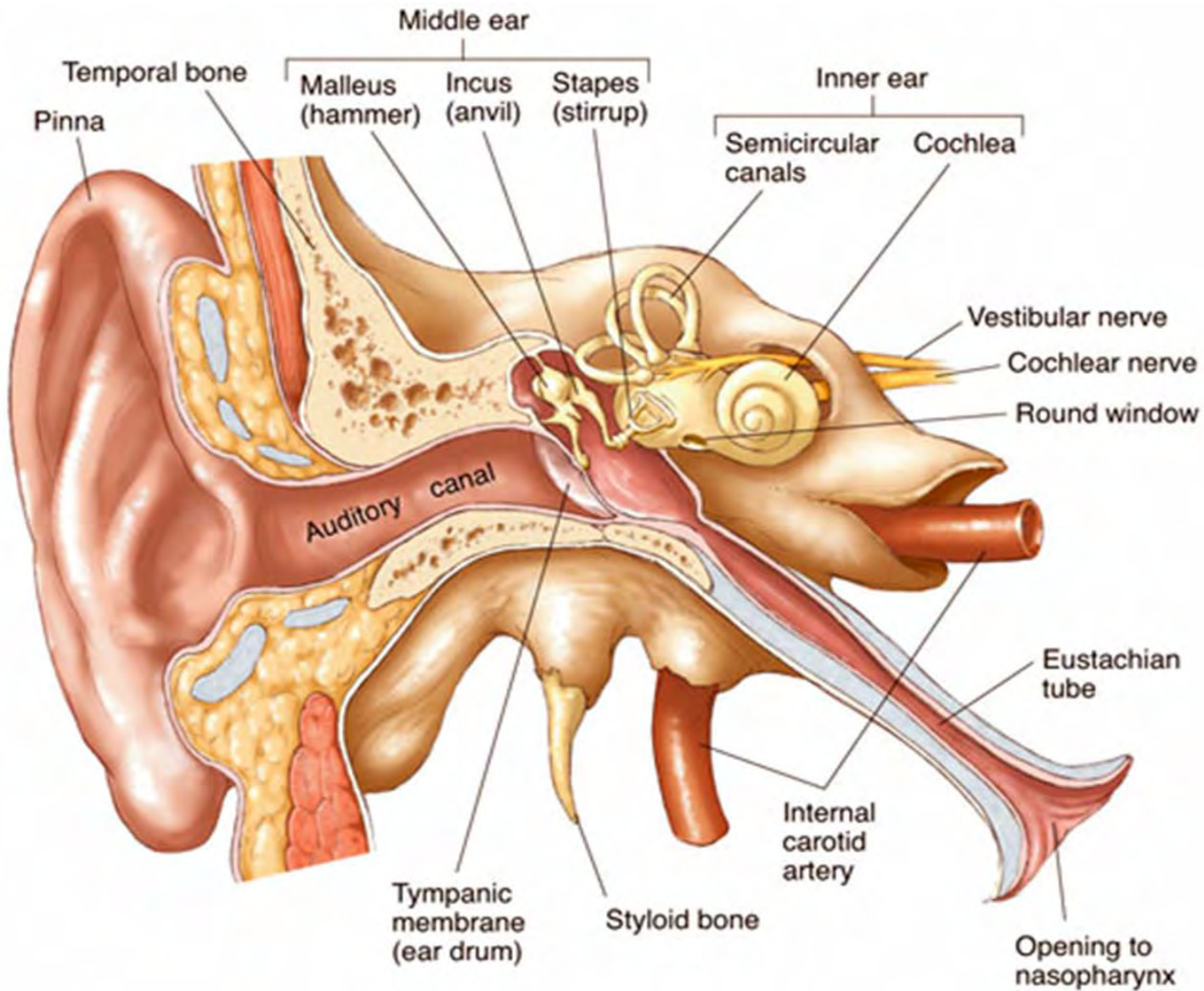
Transduction of sound



- Sound produces vibration of air molecules on the tympanic membrane
- TM vibrates the Malleus, Incus, Stapes to footplate on oval window and enter fluid filled inner ear cavity
- Mechanical (sound vibration) energy is converted to electrical energy in the cochlea by the inner hair cells and sent to the auditory (8th) nerve



<https://physiologyofaudition.wikispaces.com/Physiology+of+Audition>



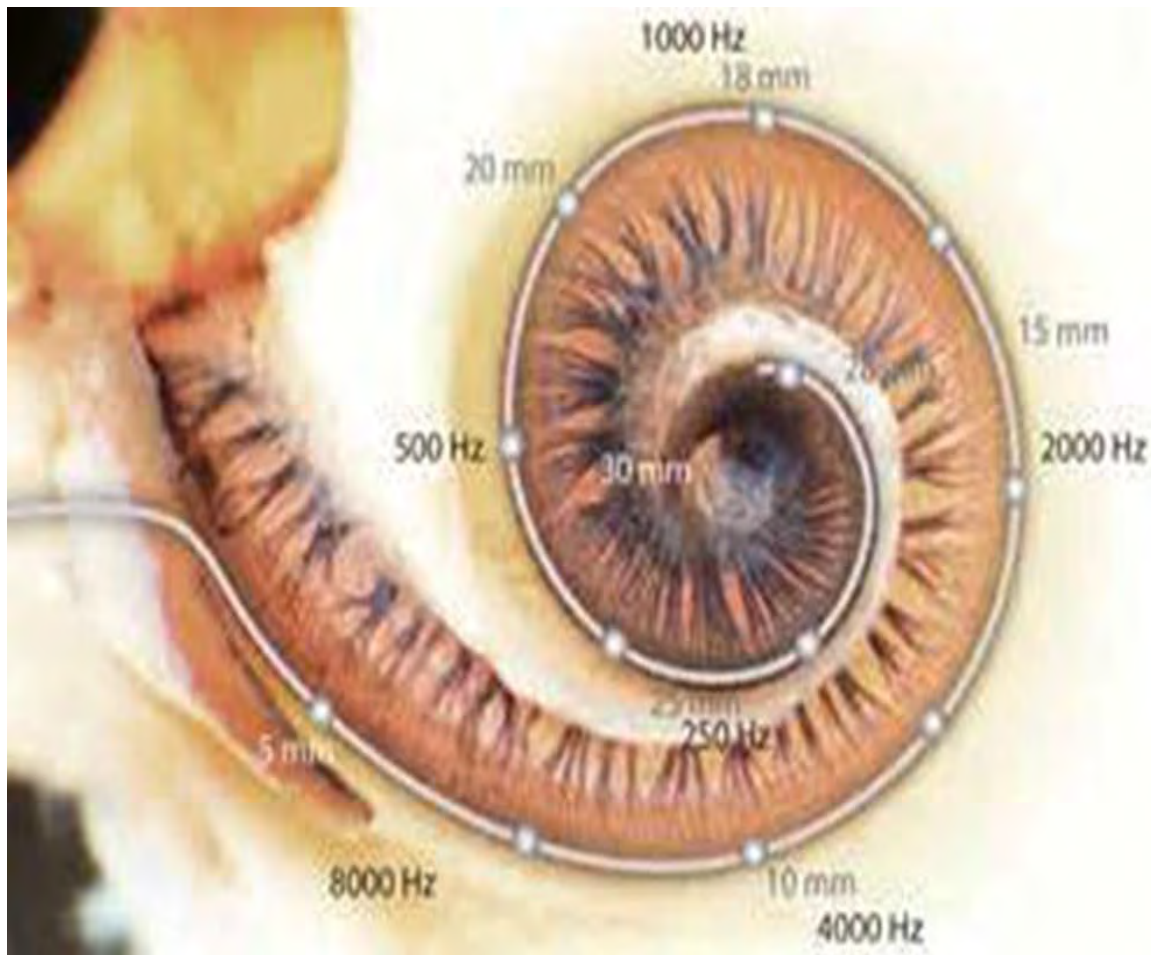
Organ of Hearing

- The cochlea is the snail shaped sense organ inside the bony labyrinth of the temporal bone that translates sound into nerve impulses to be sent to the brain.

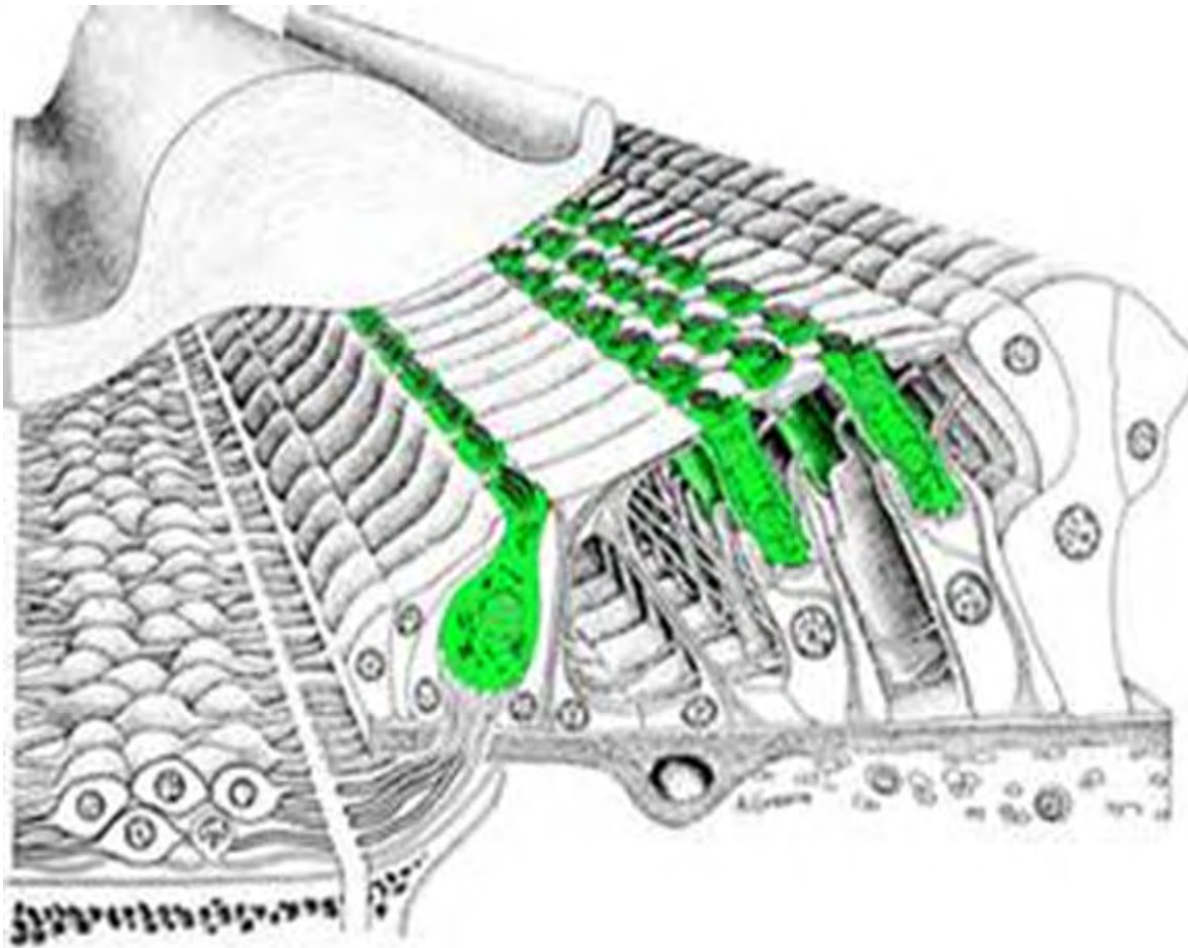


www.ncheatingloss.org/coch.htm?fromnncshhh

Tonotopic Arrangement



Outer and Inner Hair Cells



Sound vs. Noise

- Sound is fluctuations in the pressure of air (or other medium) which affect the human body.
- Vibrations that are detected and processed by the human ear are classified as sound.
- The term 'noise' is used to indicate unwanted sound.



Noise Induced Hearing loss (NIHL)

- Gradual loss of hearing caused by exposure to loud noise over a long period of time
- Sudden loss of hearing due to exposure to extremely loud sound



Noise Induced Hearing Loss

**This type of hearing loss is
preventable but not reversible**



Pathophysiology of NIHL

- Through animal studies:
 - Anatomic changes with distorted stereocilia of inner and outer hair cells
 - Severe cases with absence of organ of Corti and rupture of the Reissner membrane
 - Cochlear inflammatory response is initiated in response to acoustic trauma
 - Involves recruitment of leukocytes to inner ear.



Temporary Threshold Shift (TTS) vs Permanent Threshold Shift (PTS)

- TTS
 - Decreased stiffness of stereocilia
 - Disarrayed and floppy
 - Inefficient message transmission
- PTS
 - Fusion of adjacent stereocilia and loss of stereocilia
 - Injury can progress from loss of adjacent supporting cells to complete disruption of organ of Corti.

Histopathologically

- Primary site of injury appears to be rootlets that connect to stereocilia at the top of hair cells.
 - Loss of stereocilia leads to hair cell death.
 - Death of sensory cell can lead to progressive degeneration and loss of primary auditory nerve fibers.



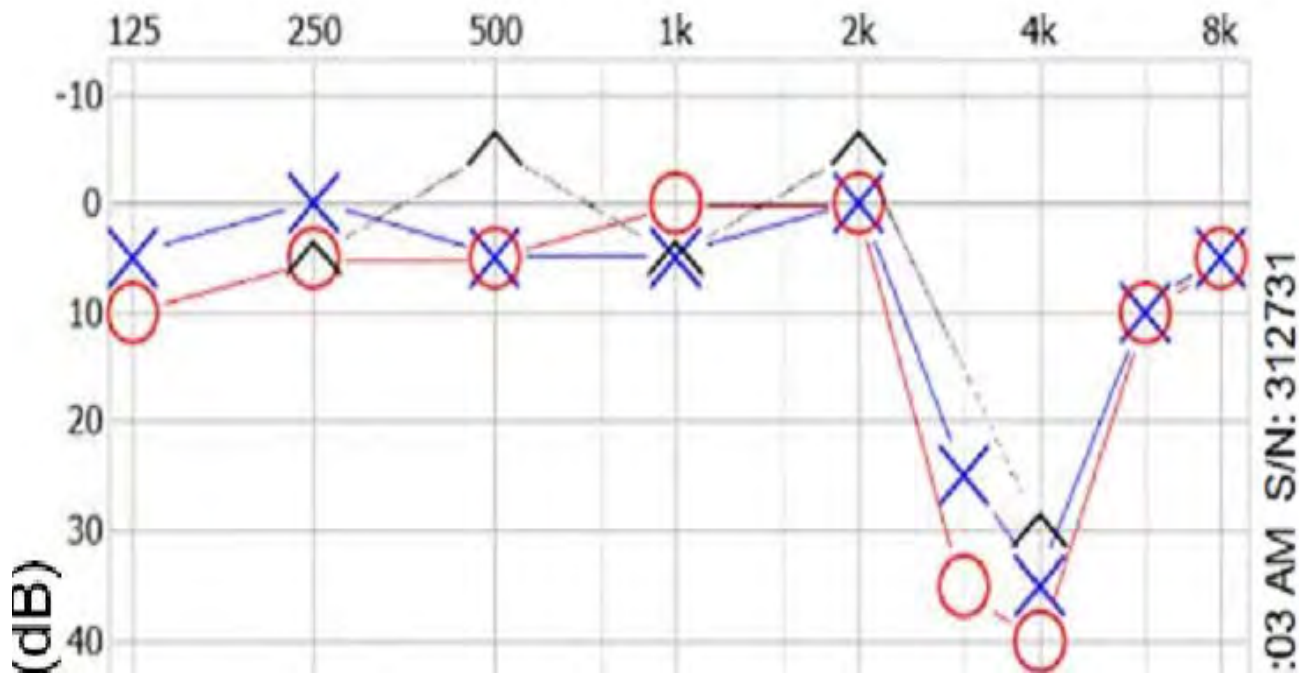
Future Research...

- Src-protein tyrosine kinase (PTK) signaling cascade has been shown to be involved in sensory cell death in cochlea (obtained from Chinchilla research).
 - Trials with Src-PTK inhibitors (KXI-004, KXI-005, and KXI-174) placed on round window membrane found beneficial in NIHL prevention.

<http://emedicine.medscape.com/article/857813-overview#a5>

Configuration

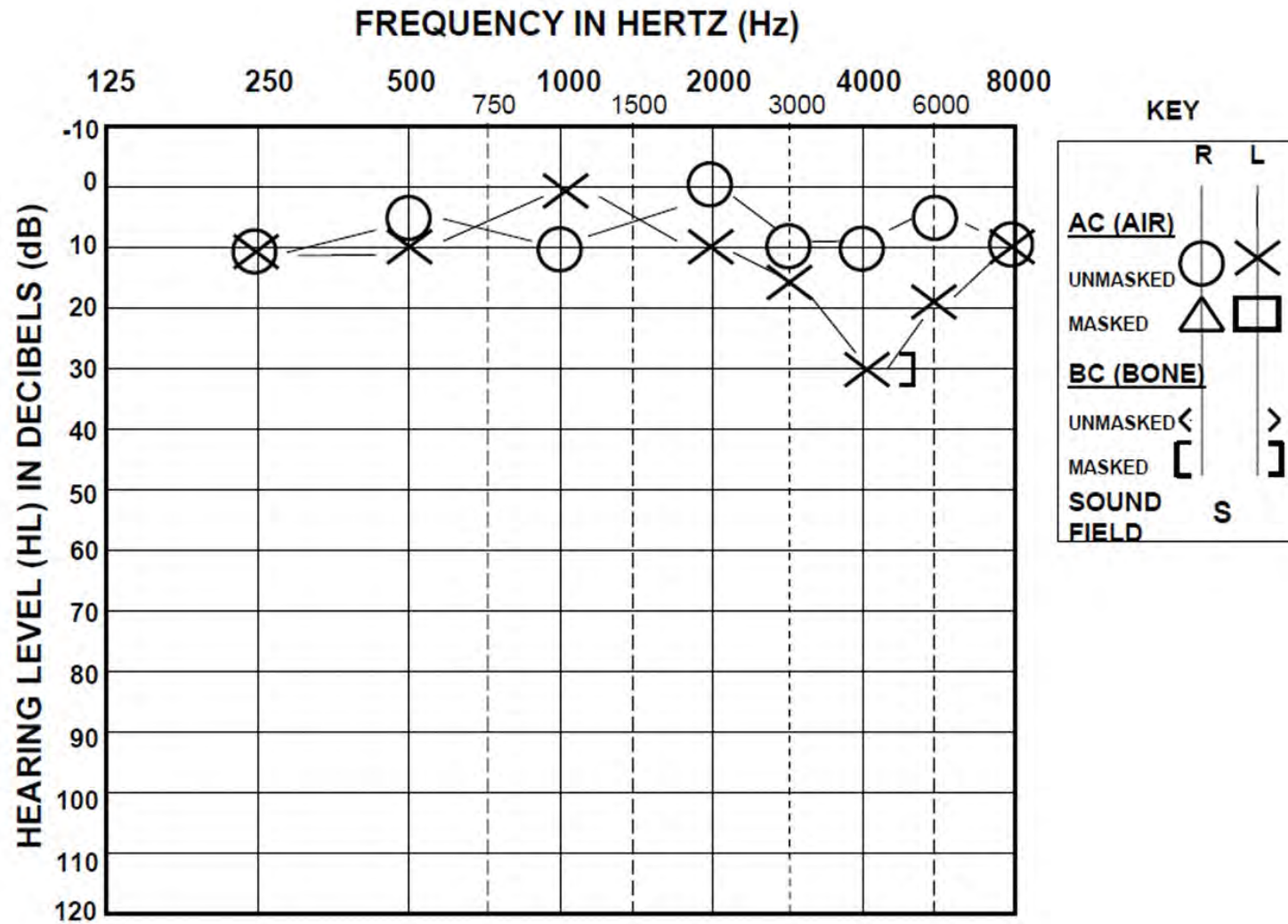
- NIHL typically starts at 4 kHz and creates a “notch” in the audiogram.
 - Known as Noise Notch



:03 AM S/N: 312731



Recreational Shooting





Normal Cochlear



Damaged Cochlear

www.yourhearingcenter.com

Why 4 kHz notch?

- Human hearing is more sensitive at 1-5 kHz
- Acoustic reflex (muscle response) attenuates loud noises below 2kHz
- Nonlinear middle ear function with increased intensities



World Health Organization (WHO)



In February of 2015, the World Health Organization (WHO) released research indicating that the amount of children and teenagers with noise induced hearing loss is increasing at an unprecedented rate.

Survey from 1994 and 2006 showed 2.2% increase in patients reporting NIHL (from 3.5% to **5.2%**)

<http://www.who.int/pbd/deafness/en/noise.pdf?ua=1>

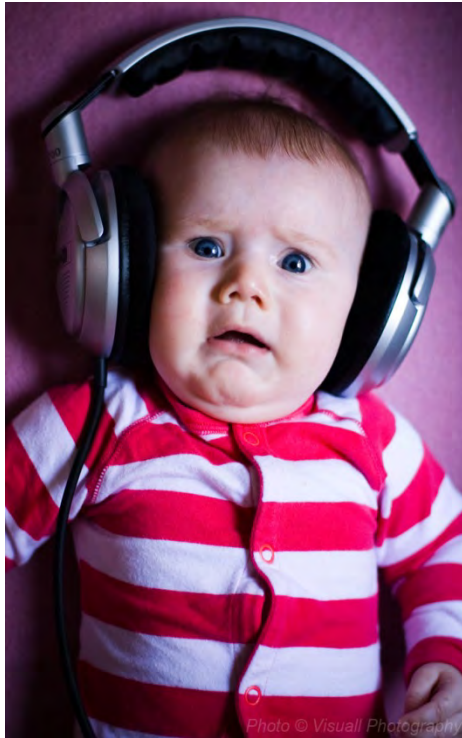


Worldwide

Approximately 1.1 billion teenagers and young adults are at risk for noise induced hearing loss due to the unsafe listening practices with personal audio devices (including smartphones), and exposure at noisy entertainment venues (nightclubs, bars and sporting events).

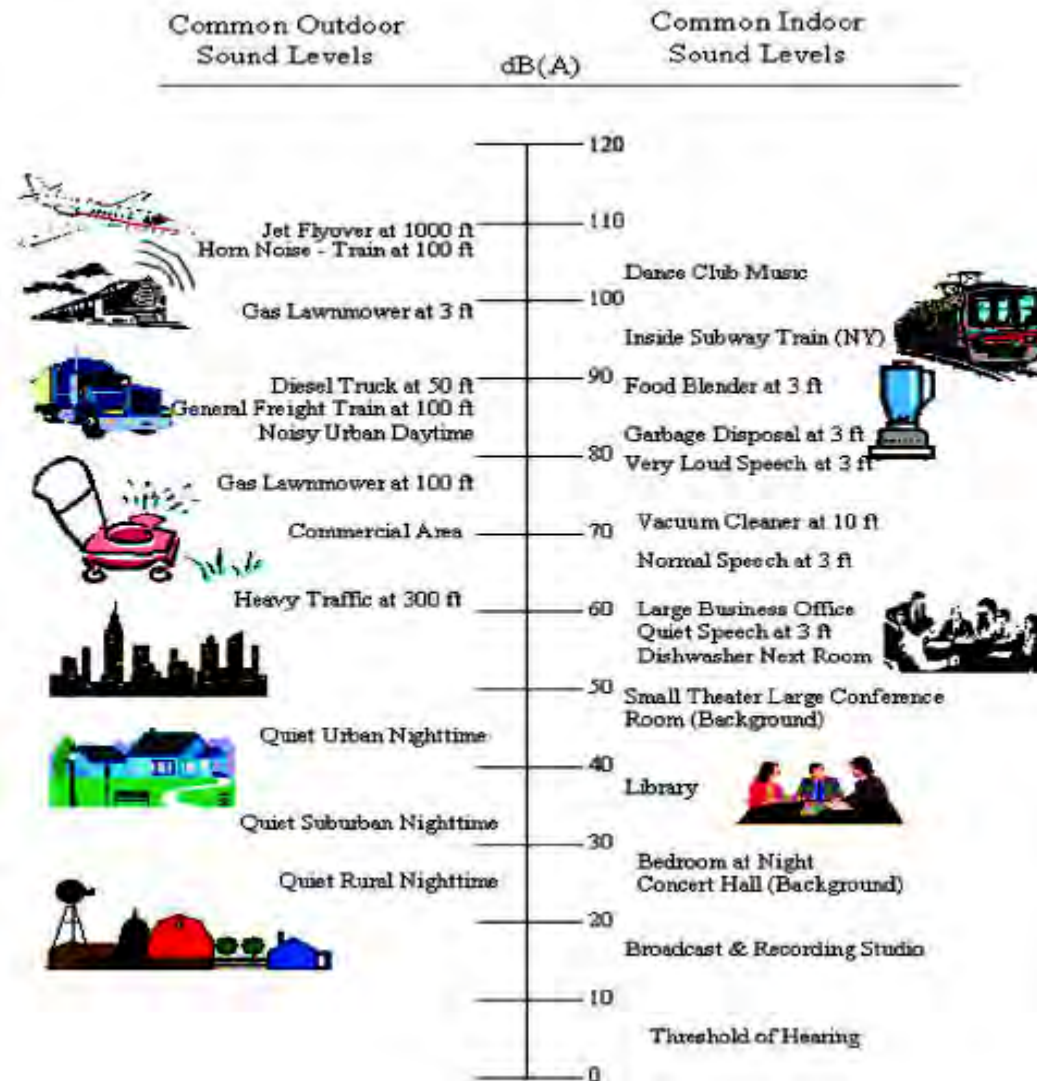


Center for Disease Control



In the United States: the CDC estimated in 2013 that **12.5%** of children and adolescents aged 6–19 years (approximately 5.2 million) and **17%** of adults aged 20–69 years (approximately 26 million) have suffered permanent damage to their hearing from excessive exposure to noise.

Common noises in Decibels (dBA)





- Average sporting event 80 dB- 117 dB
- Nightclubs and bars average sound levels of 104 dB-112 dB
- Output of personal listening device ranges from 75 dB – 136 dB
 - Listening levels increase in background noise



NOISE THERMOMETER

140 Decibels

Immediate danger to hearing
Jet engine at take-off, Gunshot



120 Decibels

Hearing damage < 8 seconds
Rock Concert,
Ambulance siren



100 Decibels

Hearing damage in 15 minutes



94 Decibels

Hearing damage in 1 hour
Electric drill



88 Decibels

Hearing damage in 4 hours
Lawnmower, city traffic



125 Decibels

Pain threshold
Fire Alarm,
Firecracker



115 Decibels

Hearing damage in 30 seconds
Leafblower, stadium
football game



97 Decibels

Hearing damage in 30 minutes
Motorcycle



91 Decibels

Hearing damage in 2 hours
Hairdryer, Garbage disposal



85 Decibels

Hearing Damage in 8 hours

30 Decibels

Faint Sound
Whisper

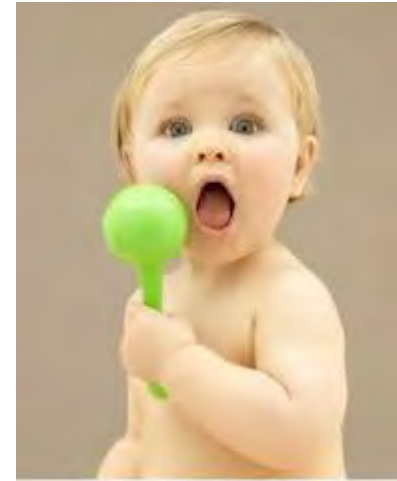



HiddenHearing
we listen, you hear



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Toys



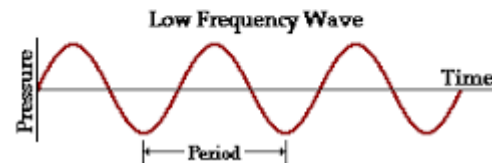
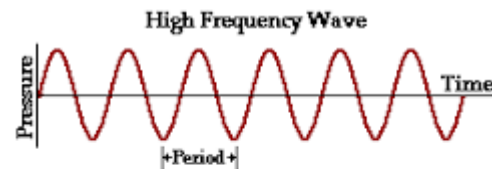
- Rattles and squeaky toys average 110 dB
- Musical toys (drums, horns) average 120 dB
- Toy Phones average 125 dB
- Toy Guns average 150 dB

Average noise increases with proximity to ears



Not all sounds are created equal...

- Continuous Stimuli are more dangerous than pulsatile.
- High frequency noise has been shown to be more damaging than low frequencies.
 - A sliding scale is utilized to determine potential to produce hearing loss



Occupational NIHL

Because of occupational risk of noise induced hearing loss, there are government standards regulating allowable noise exposure.

Regulations for hearing protection at work were instituted in the mid 1960s.

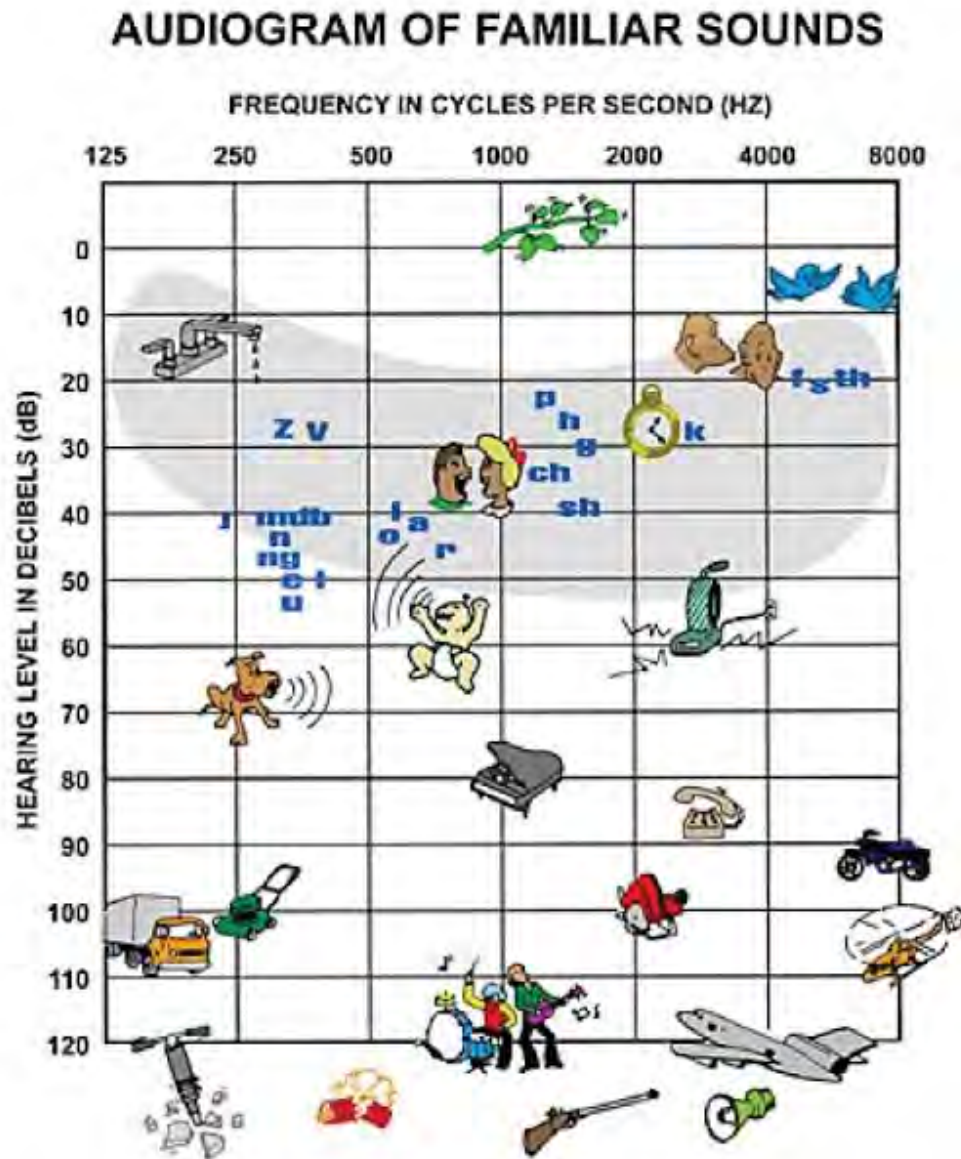


OSHA regulations

- Regulations of no more than 85 dB over 8 hour period
- The OSHA standard uses a 5 dBA exchange rate. This means that when the noise level is increased by 5 dBA, the amount of exposure time is cut in half to receive the same dose.
 - Direct relationship to limits
 - 100 dB for 15 minutes



Effects of High Frequency HL



Common Complaints

- Difficulty understanding in background noise
 - Restaurants, sporting events
- Clarity of speech
 - People are “mumbling”
- Loss of music appreciation
- Psychological effects
 - Tinnitus -- Insomnia
 - Stress -- High Blood Pressure
 - Anxiety -- Increased Heart Rate



Prevention

- Avoid or limit exposure to excessively loud sounds
- Turn down the volume of music system
 - Should be able to have a conversation at the same time
- Move away from the source of loud sounds when possible
- Use hearing protection devices when it is not feasible to avoid exposure to loud sounds or reduce them to a safe level
- Use carefully fitted earbuds
- Use noise-cancelling earphones or headphones to reduce the need to raise volume levels



Education

- Empowering people with the correct information about safe listening by knowing their products and their associated risks.
- Physicians have a significant opportunity to educate their young patients regarding hearing loss prevention and protection.
- Parents, teachers, officials can convey an appropriate message about the risks of loud noise exposure and promote healthy listening habits by being role models and educators.




What you can do....

- During annual exams:
 - Ask your young patients how loud and how frequently they listen to music through headphones/earbuds.
 - Explain the dangers of noise-induced hearing loss.
 - Be specific about the sources of harmful noise. Urge parents and preteens to utilize hearing protection in noisy environments.
 - Provide written information
- Inform parents about hearing screenings and alert parents to potential problems if their child complains about hearing issues or if they've been exposed to loud noises.

<https://www.noisyplanet.nidcd.nih.gov/educators/tips-to-teach-kids>

Programs



- [It's a Noisy Planet: Protect Their Hearing](#), NIDCD, National Institutes of Health
- [Listen to Your Buds](#), American Speech-Language-Hearing Association
- [Turn it to the Left](#),  American Academy of Audiology



A message from Dr. Etienne Krug

WHO Director for the Department for Management of Noncommunicable Diseases, Disability, Violence and Injury Prevention

“As they go about their daily lives doing what they enjoy, more and more young people are placing themselves at risk of hearing loss. They should be aware that once you lose your hearing, it won’t come back. Taking simple preventive actions will allow people to continue to enjoy themselves without putting their hearing at risk.”



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Hearing Loss Risk Factors

Per Joint Commission on Infant Hearing (JCIH 2000): "All infants who pass newborn hearing screening but who have risk indicators for other auditory disorders and/or speech and language delay receive ongoing audiologic and medical surveillance and monitoring for communication development. Infants with indicators associated with late-onset, progressive, or fluctuating hearing loss as well as auditory neural conduction disorders and/or brainstem auditory pathway dysfunction should be monitored."

Birth/ Medical risk factors requiring audiology consult:

- **Prematurity (<37 weeks)**
- **Maternal infection during pregnancy (Toxoplasmosis, Syphilis, HIV, Hepatitis B, Rubella, Cytomegalovirus (CMV), Herpes simplex, Zika, etc)**
- **Cranio-facial anomalies**
- **Exchange transfusion for elevated bilirubin**
- **NICU stay longer than 5 days**
- **Ototoxic medication (Gentamycin, Vancomycin, Chemotherapy, etc)**
- **Mechanical ventilation 5 days or more (under 5 years of age)**
- **Bacterial and viral meningitis**
- **Extra-Corporeal membrane oxygenation (ECMO)**
- **Family history of permanent, sensorineural hearing loss during childhood**
- **Head Injury associated with loss of consciousness or skull fracture**
- **Neurodegenerative disorder**
- **Parent concerns**
- **Speech/ language developmental delay**
- **Syndromes with associated hearing loss (Pendred, Usher, Waardenburg, neurofibromatosis, etc)**
- **Recurrent middle ear infections or one episode lasting extended time**
- **Exposure to potentially damaging noise levels**



Questions?

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