The Causes and Consequences of Hearing Loss

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Assessing Hearing

1. Subjective – The Audiogram
   Other Behavioral Tests

2. Objective - Auditory Brainstem Response
   Otoacoustic Emissions
The Audibility Curve
HEARING LOSS AUDIOGRAMS

(The dB difference between normal hearing and the measured threshold)
Types of Hearing Loss

1. Conductive -- Blockage of Sound Conducting Path From Source to Cochlea.
   -- 120 Million Cases/year
   -- 30 - 40 dB Hearing Loss
   -- Treatable and Reversible
The Outer Ear Pathology

Artesia of the Canal, Pinna Malformation, Ear Wax in Canal, Bugs in the Canal!!
The Middle Ear

DISORDERS

Ear-Drum Perforation, Ossicle disarticulation, Otosclerosis, Otitus Media, Colesteatoma, Poor Eustachian Tube function, Perilymphatic Fistula,
Diagnosing Conductive Hearing Loss

The Air-Bone Gap Reveals the Conductive Loss

Bone Conduction Threshold

Air Conduction Threshold
Types of Hearing Loss

2. **Sensorineural** -- Damage to Inner Ear or Central Auditory Pathway

   -- Hair Cell Loss

   -- Auditory Nerve Loss

   -- Vascular Damage

   -- **Incurable, Leads to Permanent Hearing Loss**
Diagnosing Sensorineural Hearing Loss

Note:
There is no Air-Bone Gap – Thus There is No Conductive Component to The Hearing Loss
-- 30 – 35 Million Americans Suffer Measurable Sensorineural Hearing Loss

-- 1.4 Million are Completely Deaf

-- 1 in 1000 Babies are Born with Severe Hearing Loss, 50% of which are Due to Genetic Factors

-- 14 Million Americans Suffer from Tinnitus

-- 1 in 3 Americans over 65 Have Age Related Hearing Loss Called Presbycusis (1 in 2 Over 75)
Sources of Sensorineural Hearing Loss

-- Bacterial, Viral, Vascular Damage

-- Genetic Origins: e.g., Presbycusis

-- Ototoxic Drug Exposure
  Gentamycine, Cisplatin, etc.

-- Overstimulation (Exposure to
  Intense Sound
  Recreational
  Occupational)
AUDIOGRAM

PRESBYCUSIS

Graph showing hearing loss (dB) at different frequencies for various age groups (20 y, 40 y, 60 y, 90 y).
<table>
<thead>
<tr>
<th>Decibels</th>
<th>Noise Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>Jet Take-Off</td>
</tr>
<tr>
<td>140</td>
<td>Gun Shot</td>
</tr>
<tr>
<td>130</td>
<td>Jack-Hammer, Rock Concert</td>
</tr>
<tr>
<td>120</td>
<td>Car Stereo, Band Practice</td>
</tr>
<tr>
<td>110</td>
<td>Dance Clubs, Headphones</td>
</tr>
<tr>
<td>100</td>
<td>Factory</td>
</tr>
<tr>
<td>90</td>
<td>Subway</td>
</tr>
<tr>
<td>80</td>
<td>Busy Street</td>
</tr>
<tr>
<td>70</td>
<td>Restaurant</td>
</tr>
<tr>
<td>60</td>
<td>Conversation</td>
</tr>
</tbody>
</table>
MEMBRANOUS LABYRINTH

SCALA VESTIBULI (PERILYMPH)
REISSNER'S MEMBRANE
SCALA MEDIA (ENDOLYMHP)
STRIA VASCULARIS
HAIR CELLS
INTERNAL
EXTERNAL
TECTORIAL MEMBRANE
RETICULAR LAMINA
HENSEN'S CELLS
CLAUDIUS' CELLS
BASELAR MEMBRANE
DEITERS' CELLS
SPIRAL LIGAMENT
INTRAGANGLIONIC SPIRAL BUNDLE
SPIRAL GANGLION
NERVE FIBERS
RODS AND TUNNEL OF CORTI
SCALA TYMPANI
IHC AND OHC SENSORY HAIR BUNDLES
Basilar Membrane Movement Creates a Shearing Force that Bends the Stereocilia of the Hair Cells
2 microns

Sensory Hair Bundle of Hair Cell

Cell Body of Hair Cell

Water Jet

Isolated Single Hair Cell
Sustained Loud Sound Exposure can Cause Injury by:

1. Mechanical Injury and Destruction to the Hair Bundle and Organ of Corti

2. Metabolic Fatigue leading to Hair Cell Death
Stereocilia filaments

Actin Filaments Cross-Bridged By Fimbrin

Excessive Sound Causes Depolymerization Of the Actin-Fimbrin Paracrystal Array
“GATING SPRING” HYPOTHESIS OF HAIR CELL TRANSDUCTION

Tip Link
Tip-Links can Repair Themselves!!

Control

Exposed
Sustained Exposure can Metabolically Fatigue the Hair cells and This Results in Their Death.

Note: Major Outer Hair Cell Loss and Some Inner Hair Cell Loss.
LOSS OF 8th NERVE FIBERS AFTER HAIR CELL LOSS
ASYMPTOTIC THRESHOLD SHIFT

A window into the dynamics of hearing loss and recovery
Octave Band Noise
EXPOSURE:
OCTAVE BAND: CF = 500 Hz
SYMBOL: OBL IN SPL
△ 105
○ 95
● 85
□ 75

ASYMPTOTE
- 62.7 dB
- 48.8 dB
- 31.1 dB
- 16.9 dB

TTS₄ AT 0.775 kHz

EXPOSURE DURATION IN MINUTES

MIN 15 30 1 2 4 8 12 16
HOURS 1 1.5 2 3 4 5 6 7
DAYS 20 40 60 80 100 200 400 800 1K 2K 4K 8K 10K
Relation between hair cell loss and Permanent Hearing Loss
Consequences of Hearing Loss

Loss of Communication
Psychological and Social Isolation
Quality of Life
Danger in Failure to Detect Distance Stimulation

What Can be Done?

Hearing Aid
Other Assisted Listening Devices
Lip Reading Training
Cochlear Implant