EARLY IDENTIFICATION OF NOISE-INDUCED HEARING LOSS

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Aim of a Hearing Conservation Program (HCP)

- To prevent the acquisition of noise-induced hearing loss (NIHL)
- To prevent worsening of NIHL
- Improve quality of life of subjects exposed to noise
- Reduce costs related to NIHL
NIHL results from the destruction of cochlear hair cells in the basal turn of the cochlea

Destruction of hair cells in the basal turn of the cochlea produces a high frequency hearing loss that increases gradually over time.

There is a characteristic “notch” at either 3, 4 or 6 kHz.
The ACOEM in January 2012 stated that in NIHL:

“Its first sign is a “notching” of the audiogram at the high frequencies of 3000, 4000, or 6000 Hz with recovery at 8000 Hz.”

Regarding the distinctive audiometric pattern, the ACOEM also states:

“In early NIHL, the average hearing thresholds at the lower frequencies of 500, 1000, and 2000 Hz are better than the average thresholds at 3000, 4000, and 6000 Hz, and the hearing level at 8000 Hz is usually better than the deepest part of the notch.”

Definitions of a “Notch”

* Not quantified by ACOEM
* Should we determine 5, 10 and 15 dB differences for a positive “notch”

Frequential “Notch”

* Based on 1st audiogram of subjects
* Analysis of frequential “notch” of 5, 10 and 15dB

<table>
<thead>
<tr>
<th>AGE GROUP</th>
<th>≥ 5 dB</th>
<th>≥ 10 dB</th>
<th>≥ 15 dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 – 24 years old</td>
<td>96%</td>
<td>86%</td>
<td>76%</td>
</tr>
<tr>
<td>25 – 34 years old</td>
<td>97%</td>
<td>89%</td>
<td>80%</td>
</tr>
<tr>
<td>35 – 44 years old</td>
<td>98%</td>
<td>91%</td>
<td>83%</td>
</tr>
<tr>
<td>45 – 54 years old</td>
<td>98%</td>
<td>92%</td>
<td>85%</td>
</tr>
<tr>
<td>≥ 55 years old</td>
<td>99%</td>
<td>93%</td>
<td>81%</td>
</tr>
</tbody>
</table>

* This approach is not practical because of its high incidence in subjects with normal audiograms
High Frequency Hearing Loss (HFHL)

* 1st Analysis Performed
* HFHL is based on the following approach:

$$\left(\frac{3 + 4 + 6}{3}\right) - \left(\frac{.5 + 1 + 2}{3}\right) \geq 10\ dB$$

All audiograms meeting this criteria are classified in the high frequency hearing loss category

Ref.: American College of Occupational and Environmental Medicine (ACOEM), Occupational Noise-Induced Hearing Loss, JOEM, Volume 54, Number 1, January 2012.
High Frequency Hearing Loss (HFHL)

* 3 categories:
  1. 0-15 dB (proactive)
  2. >15-25 dB (identification of worsening)
  3. >25 dB (level of compensation)

* Average based on frequencies used for compensation in particular jurisdiction
All subjects not included in the HFHL or Normal groups

Includes:
- Flat audiograms (>15 dB)
- “Cookie Bite”
- “Ski Slope” Patterns
- Reversed Slope
- Asymmetric: Exclusion worse ear

Most of these subjects present a pathology causing the miscellaneous hearing losses
In the proactive approach, we classify audiograms as follows:

1. High frequency hearing loss (HFHL)
2. Normal hearing (N)
   - Average < 15 dB at .5, 1, 2, 3, 4 and 6 kHz, with the exception of subjects presenting a HFHL
3. Miscellaneous patterns (Misc.)
   - All subjects whose pattern does not fall into that of group 1 or 2
Early manifestation can occur in the 1st year of exposure

<table>
<thead>
<tr>
<th>Age at 1st Audiogram</th>
<th>Total Number</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td>Number</td>
<td>%</td>
</tr>
<tr>
<td>18 - 24 years old</td>
<td>5205</td>
<td>4569</td>
</tr>
<tr>
<td>25 - 34 years old</td>
<td>8359</td>
<td>6141</td>
</tr>
<tr>
<td>35 - 44 years old</td>
<td>5043</td>
<td>2807</td>
</tr>
<tr>
<td>45 - 54 years old</td>
<td>2528</td>
<td>1000</td>
</tr>
<tr>
<td>≥ 55 years old</td>
<td>455</td>
<td>88</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>21590</strong></td>
<td><strong>14605</strong></td>
</tr>
</tbody>
</table>
Evolution of average of .5, 1 and 2 kHz (bottom) with average of 3, 4 and 6 kHz
Evolution of NIHL

High frequency hearing loss increases over the years depending on levels of noise exposure.
Evolution of Audiometric Patterns

Percentage of subjects according to age, based on 1\textsuperscript{st} audiogram
Early Identification

* Identification of early high frequency hearing loss
* Detected with audiogram that can be considered normal
* Identifies subjects before they are aware of hearing loss
All audiograms which have 15 dB or less at .5, 1, 2, 3, 4 and 6 kHz frequencies

However, subjects meeting the criteria of the HFHL formula are considered to be in the HFHL category even if all frequencies are 15 dB or less
* In the United States, OSHA has enacted a procedure to identify NIHL
* In the presence of a positive STS OSHA, the employee must be informed
* The STS OSHA procedure identifies subjects with a confirmed NIHL
HFHL vs. STS OSHA

Incidence of HFHL compared to positive STS OSHA
Incidence of HFHL (category 1) compared to positive STS OSHA
As NIHL occurs mainly in the first 10 to 15 years of exposure to noise, more attention is focused on younger subjects.

Change from a category of normal to a HFHL category identifies problem cases.
Quebec Mining Association (QMA)

- HCP established in 1978
- In 1980, following NHCA presentation by Cohen et al., NITTS procedures were used for problem cases with HFHL

**EXPÉRIENCE QUÉBECOISE**

<table>
<thead>
<tr>
<th>Année</th>
<th>Nombre de réclamations pour surdité</th>
</tr>
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<tbody>
<tr>
<td>1977</td>
<td>1843</td>
</tr>
<tr>
<td>1976</td>
<td>1393</td>
</tr>
<tr>
<td>1975</td>
<td>545</td>
</tr>
<tr>
<td>1974</td>
<td>544</td>
</tr>
<tr>
<td>1973</td>
<td>240</td>
</tr>
<tr>
<td>1972</td>
<td>175</td>
</tr>
<tr>
<td>1971</td>
<td>184</td>
</tr>
<tr>
<td>1970</td>
<td>24</td>
</tr>
</tbody>
</table>
QMA
Beginning Economic Impact

Rising medical costs from 1970 to 1976
QMA Compensation Cases (%)

Percentage of employees potentially subject to compensation based on the standards used in the Province of Quebec (Canada)
Using 1977 as a reference: The cost of compensation is evaluated using the same data base and the standards of the Province of Quebec (Canada)
In 4205 subjects employed after introduction of program, no subjects had compensable NIHL
Proactive Approach: Early Identification of NIHL

Allows for the following:

* Identification of potential problem cases
* Introduction of appropriate methods to prevent worsening of hearing loss
  * Motivational education regarding the effects of noise on hearing
  * Motivational education regarding the effects of hearing loss on quality of life
  * Education in the proper use of hearing protection devices (HPDs)
  * NITTS testing to evaluate effectiveness and appropriate usage of HPDs used
Conclusions

- HFHL occurs at an earlier stage than STS OSHA
- Taking a proactive approach allows:
  - The introduction of appropriate measures earlier than STS OSHA
  - A reduction in the degree of hearing loss and number of compensation claims filed
  - An important reduction in the cost of the compensation claims that are filed