Non-work causes of hearing loss in noise exposed workers

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Reasons for Considering Non-work Related Factors

1. To reduce the extent of hearing loss and all related costs.
2. To minimize any interactions of work related ototoxins and noise with non-work factors that could augment noise induced hearing loss.
4. For documentation in potential worker compensation cases.
5. For determining the amount of worker compensation.
Non-work factors

- Medications
- Health-related Diseases
- Recreational Drugs
- Hobbies involving noise exposure
- Aging
- Other examples: Noise exposure during commute

http://www.clipartpal.com/clipart/sport/hunting_166995.html
Identifying Non-work related Factors

- Sample Case-Study
- Serial Audiogram Review
- Case-History
• Mr. OE believed that he has hearing deficits due to work-related exposure to ototoxins
• Interested in finding if his worker compensation claim can be supported.
• More specifically interested in
  – Serial audiogram review
  – a central auditory evaluation
Case-History Form

• A complete case-history was obtained by using a case-history form
  – (Chapter 4, Appendix, Rawool, 2012 Hearing Conservation In Occupational, Recreational, Educational, and Home Settings)

• Additional probe questions were asked based on the information noted in the case-history.
<table>
<thead>
<tr>
<th>Ototoxin in the workplace</th>
<th>Period of exposure</th>
<th>How exposure occurred</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Trichloroethylene</strong></td>
<td>Aug 1974 to Feb 1980</td>
<td>Very high exposure levels during certain periods. Exposure through skin contact and through breathing of fumes.</td>
</tr>
<tr>
<td><strong>Styrene</strong></td>
<td>Aug 1974 to Feb 1980</td>
<td>The patient operated incinerator for solvents including Styrene.</td>
</tr>
<tr>
<td><strong>Carbon tetrachloride</strong></td>
<td>Aug 1974 to Feb 1980</td>
<td>The patient operated incinerator for solvents including carbon tetrachloride.</td>
</tr>
<tr>
<td><strong>Thorium</strong></td>
<td>Aug 1974 to Feb 1980</td>
<td>The patient operated incinerator for radioactive materials including Thorium.</td>
</tr>
<tr>
<td><strong>Carbon Monoxide</strong></td>
<td>Aug 1974 to Feb 1980; Some exposure during 1994-1999</td>
<td>Primarily from vehicles (trucks running inside buildings) where the patient was working or other pieces of equipment being operated inside the building.</td>
</tr>
<tr>
<td><strong>Diesel Fuel</strong></td>
<td>Aug 1974 to Feb 1980</td>
<td>From fork lifts inside buildings and diesel engines.</td>
</tr>
</tbody>
</table>
Table 1. Work related exposure to various ototoxins while working as a chemical operator as reported by the patient.

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<tr>
<td>Lead</td>
<td>Aug 1974 to Feb 1980</td>
<td>Being around a lot of batteries in some of the process buildings and from cleaning batteries in battery room.</td>
</tr>
<tr>
<td>Arsenic</td>
<td>Aug 1974 to Feb 1980</td>
<td>From trap changes and scrapping operations.</td>
</tr>
<tr>
<td></td>
<td>July 1994 to Dec 2000</td>
<td></td>
</tr>
<tr>
<td>Mercury</td>
<td>Aug 1974 to Feb 1980</td>
<td>The patient operated incinerator for metals including mercury. Previous masks did not filter Hg.</td>
</tr>
<tr>
<td>Pesticides and herbicides</td>
<td>Aug 1974 to Feb 1980</td>
<td>During weed and grass control using roundup. Trifluralin may have been used outside the buildings but huge ventilation fans often pulled fumes with bad odor in building. Break rooms and other rooms in the building were sprayed for bugs using Malathion often in the presence of workers.</td>
</tr>
</tbody>
</table>
Family History

• No family history of hearing loss.
  – No genetic disposition
• His father has a hearing loss due to work related noise exposure.
• His mother has diabetes.
Medical History

• **Chronic Beryllium Disease (CBD)** due to exposure to beryllium at the workplace.
• Enlarged arteries on the left side of the heart, high blood pressure.
• Abnormal cholesterol levels.
• Arthritis.
• Diabetes.
• Acid reflux.
• Skin cancer which was treated surgically.
• Depression & anxiety.
Medications

- Flovent (220 mg) and **Proair HFA AER TEV** for CBD since 2003
- Cymbalta (20 mg) for depression and anxiety
- **Lorazepam** (5 mg)
- **Nexium** for Acid Reflex
- Crestor (10 mg) for abnormal cholesterol, and
- Flunisolide (Nasareal) for breathing difficulties.
- **No alcohol or any other recreational drugs.**
Hearing

• Difficulty in hearing speech since 1981 or 1982.

• Tinnitus since the mid-1980s.
  – Rapid clicking with almost no separation between the clicks.
Vestibular

- Dizziness and balance issues since the 1980’s
  - Continues to experience sudden falls.
  - He has been prescribed with a cane to minimize falls.
- During or after work he would often feel dizzy due to exposure to solvents.
- Sometimes the fume buildup in the workplace would be unbearable.
Hearing Aid History

• Due to persistent difficulties in hearing the patient acquired his first hearing aid in 1989 at the age of 40 years.
• Currently he uses digital hearing aids in both ears on a regular basis
• Continues to report difficulty in understanding speech through hearing aids.
Audiological evaluation

• Ipsilateral and contralateral reflexes were elevated bilaterally at 500 Hz and 1000 Hz suggesting
  – Mild dysfunction within the acoustic reflex pathway.
Central auditory evaluation
Mild auditory processing deficit

- **Subjective Measures**
  - Dichotic Digits
    - Normal
  - Gap Detection
    - Normal
  - **Temporal Order Judgement**
    - Pitch pattern perception
    - Performance below normal limits (Borderline abnormal)

- **Objective Measures**
  - Temporal Processing Speed
    - Normal
  - Temporal Decay
    - No significant decay
    - Normal performance
  - Binaural Summation
    - Normal
Audiogram Review
1973 to 1981 Right Ear

1973 to 1981

- Maximum exposure to multiple ototoxins occurred during this period
- An age corrected significant threshold shift in the right ear at 4 kHz.
- A shift of 40 dB at 8 kHz in the left ear
  - Threshold shifts from some ototoxins such as lead and Styrene have been reported at 8 kHz
    - (Hwang, Chiang, Yen-Jean & Wang, 2009; Sliwinska-Kowalska et al; 2003).
- **Work related exposure to multiple ototoxins may have contributed to the hearing impairment.**
1981 Versus 1994 audiograms

• 1981 to 1994: Worked as a real estate agent
• Age corrected significant threshold shift at 4 kHz in the left ear.
• Age corrected OSHA (1983) standard threshold shift in the left ear.
• Significant thresholds shifts have been reported after cessation of exposure to Styrene at relatively high levels in rats (Campo, Lataye, Loquet, & Bonnet, 2001).
• The patient’s hearing may have stabilized somewhere between the 1981 and 1994 period, but other audiograms during this period were unavailable for this review.
1994 to 2006

• Returned back to previous work-site
• Some exposures to Arsenic and Carbon Monoxide.
• After accounting for potentially age related worsening of hearing (OSHA, 1983), no significant threshold shifts are apparent
• Retired in 2006
2006 to 2013 Audiograms

2006 and 2013

- A significant age corrected threshold shift at 2 kHz
- OSHA (1983) standard threshold shift only in the right ear.
- Diabetes and hypertension since 2008 are additional risk factors for hearing loss during this period.

Worsening of existing hearing loss from ototoxins

A mild auditory processing deficit in patient OE (Temporal pattern perception and acoustic reflex thresholds).

Improved auditory processing
Neural Plasticity
1. Extended time for recovery from ototoxin exposure since 1981.
2. Consistent and prolonged use of hearing aids.

Compromised auditory processing
1. Aging
2. Diabetic neuropathy

Figure from Rawool, V. W. (2014). Auditory processing Deficits. New York: Thieme.
Summary

• **Work-related Factors**
  - Ototoxins
  - Noise
  - Heat
  - Vibrations
  - *(1973 to 1981)*

• **Non-work related factors**
  - Diabetes
  - Hyper-tension
  - Aging
  - Medications
    - Lorazepam, Nexium, and PROAIR HFA. Potential side effects
      - Tinnitus
      - Dizziness
  - *(2008 to 2013)*
Work related?

Tinnitus? Dizziness ?

Work Exposure to Beryllium

Chronic Beryllium disease

PROAIR HFA

Medication to treat disease
References