MOVING BEYOND NOISE INDUCED HEARING LOSS

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Why is noise important?

• Hearing loss is the fastest growing and one of the most prevalent chronic conditions in Canada
• Two main causes
  • Age
  • Noise
Statistics

- One million adults have a hearing loss
  - 50% greater than those reporting a vision loss
  - Actual number may be closer to 3 million (under reporting)
- WCB BC
  - 14% of workers under 21 years of age had some hearing loss
- Estimates suggest hearing loss costs Canada $18 billion per year
What is noise?

- Unwanted sound
- Noise in industry greater than 80 dBA
  - 85 dBA is limit in most provincial workplaces
  - 87 dBA is limit in federal workplaces
Volume dB | Noise Examples
--- | ---
60dB | Normal Conversation/Dishwasher
80dB | Alarm Clock
90dB | Hair Dryer/Blender
100dB | iPod, Full Volume
110dB | Concerts/Sporting Events
120dB | Jet Planes
130dB | Ambulances
140dB | Gun Shots/Fireworks
Hearing Conservation Program

- Engineering controls
- Administrative controls
- Hearing protection
- Education
- Consideration of other factors
Regulations in Nova Scotia

- ACGIH TLVs and BEIs are adopted in Nova Scotia and most provinces
- 85dBA is 8 hour limit
  - Other factors should be considered
  - 2018 TLVs require consideration of solvents, metals, gases and pregnancy
Considerations for Hearing Conservation

- Ototoxic chemicals
- Ototoxic medicines
- Fetal hearing loss
- Cardiovascular effects
- Injury rates
### Ototoxic chemicals

<table>
<thead>
<tr>
<th>Solvents</th>
<th>Metals</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chlorobenzene</td>
<td>Arsenic</td>
<td>Acrylonitrile</td>
</tr>
<tr>
<td>Ethylbenzene</td>
<td>Lead</td>
<td>Carbon monoxide</td>
</tr>
<tr>
<td>N-hexane</td>
<td>Manganese</td>
<td>Hydrogen cyanide</td>
</tr>
<tr>
<td>Styrene</td>
<td>Mercury</td>
<td>Organophosphates</td>
</tr>
<tr>
<td>Toluene</td>
<td>Tin</td>
<td>Paraquat</td>
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<tr>
<td>Trichloroethylene</td>
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</table>
Arsenic

- Environmental studies have been done with respect to hearing loss and arsenic in air in communities.
- Showed arsenic exposed children from air pollution sources (confirmed with urinalysis) had increased hearing loss as compared to non exposed children.
Carbon Monoxide

- Severe CO poisoning can cause hearing impairments
  - can partially improve with time
- 78% prevalence of hearing loss occurred with CO intoxication
- Noise >90 dBA plus carbon monoxide led to significantly more hearing loss than groups exposed to those noise levels alone (OR of 1.4)
- Studies showed NIHL effects at around the TLV of 25 ppm, so overexposure not necessary to see impact
Smoking & Noise

- Sung et al, 2013
  - Increase in hearing loss if worker is a current smoker and is exposed to noise at work
  - 10-20 cigarettes per day showed increased hearing loss with an OR of 1.56
  - >30 cigarettes per day showed an increased hearing loss with an OR of 1.64
  - The hearing loss was significantly worse at low frequencies
Lead

- Children exposed to lead showed hearing loss, based on slowed auditory nerve conduction
- Workers exposed to lead showed increased rates and severity of hearing loss
  - OR ranging from 3.1 to 6.3 as compared to workers without lead exposure, given similar noise exposures
Mercury

- Significant alterations in auditory brainstem response with occupationally exposed workers
- Hearing loss occurred in 80% of mercury poisoned group in Minimata, Japan. Since the original loss, 7% improved while 28% deteriorated in their hearing, over a period post exposure
  - The hearing loss extended beyond the typical biological halflife of approximately 3 to 6 months
- Occupational exposures below the current TLV seem to be associated with an increased risk of hearing loss
Styrene

- Workers with high exposures of styrene showed a significant difference in hearing ability at high frequencies.
- Styrene exposure below the TLV plus noise between 85 and 90 dBA showed a significant impact on hearing loss.
- OR of 10.9 for noise plus styrene exposure.
- Low exposures, less than the TLV, produced evidence of hearing loss, with or without noise.
Toluene

- Toluene abuse (glue sniffing) had significant effects on hearing
  - 50% of abusers had hearing loss

- Toluene and noise
  - RR of 11
  - RR of 6

- Effects seem to be most relevant above the 50ppm air exposure level of toluene (above TLV of 20 ppm)
Trichloroethylene

- Excessive exposure leads to high frequency hearing loss
- Children’s hearing was affected by environmental levels in water
- As part of a solvent mixture, was seen to have increased levels of hearing loss
Xylene

- P-xylene has been found to be ototoxic
- Medical lab workers exposed to xylene reported significantly worse pure tone thresholds
- Did not have to be at levels above TLV
- Did not have to have noise present
Summary of Ototoxic chemicals

• Guidelines
  • Provide advice to audiometric technicians regarding exposure to ototoxic chemicals so that they can be prepared to respond to changes in hearing thresholds
  • Manage workplace exposures to ototoxic chemicals, especially in noisy workplaces.
  • Consider instituting controls to lower exposures to less than half of TLV to prevent hearing loss when both noise and ototoxic chemical exposures are present.
Ototoxic medicines

- Some medications have been identified as ototoxic:
  - anti-cancer (cisplatin, carboplatin or bleomycin)
  - anti-inflammatory (NSAIDS)
  - anti-thrombotic (aspirin)
  - anti-malarial (Quinine, chloroquine)
  - anti-rheumatic drugs
  - loop diuretics [furosemide (Lasix) and bumetanide, Ethacrynic acid]
  - antibiotics. (aminoglycosides, can be permanent)
Guidelines for ototoxic medicines

- Ensure audiometric testers question employees about their use of ototoxic medicines prior to audiogram
- Ensure guidance is given regarding use of the drugs with concurrent exposure to noise
  - Part of hearing conservation program
  - Part of training for noise induced hearing loss
- May need to remind workers about importance of hearing protection when ototoxic medicines are in use
Fetal hearing loss

- Should limit noise to pregnant worker to 115 dBA TWA after 5 months gestation
- Should limit noise to pregnant worker to 155 dBA impact peak after 5 months gestation
- Use of hearing protection can protect mother but not fetus.
- 5 months gestation marks the middle ear development
  - fetal hearing can be affected by external noise anytime after this point
## TWA establishment for fetal ear protection

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Noise level not to be exceeded dB</th>
<th>Sound attenuation of abdomen dB</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 Hz</td>
<td>93</td>
<td>25</td>
</tr>
<tr>
<td>100 Hz</td>
<td>89</td>
<td>35</td>
</tr>
<tr>
<td>2000 Hz</td>
<td>80</td>
<td>40</td>
</tr>
<tr>
<td>3000 Hz</td>
<td>77</td>
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Hearing Loss is not only effect

- Cardiovascular effects
- Mental health/stress
- Focus
- Injury
Cardiovascular effects

- Elevated blood pressure
- Hypertension
- Ischemic heart disease
Hypertension

- Defined as blood pressure equal to or greater than 140/90
- Mechanism suggested as generalized stress reaction to noise related discomfort and therefore psychological stress leading to CVS effects
<table>
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<tbody>
<tr>
<td>Melamed et al</td>
<td>Higher noise led to higher blood pressure OR 2.66</td>
</tr>
<tr>
<td>Talbott et al</td>
<td>Higher noise led to 2.5 mmHg rise in blood pressure</td>
</tr>
<tr>
<td>Chang et al</td>
<td>20 dBA increase in noise led to 34% higher blood pressure</td>
</tr>
<tr>
<td>Sbihi et al</td>
<td>50% higher risk for high blood pressure if exposed to noise, BC saw mills</td>
</tr>
</tbody>
</table>
Ischemic Heart Disease

• Ischemic heart disease is a heart problem that reduces the supply of blood to the heart due to narrowed heart arteries. It is also called coronary artery disease, and it can lead to angina and heart attacks.

• Same model that predicts a rise in blood pressure also predicts increased:
  • Cholesterol
  • Triglycerides
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<tr>
<td>Melamed et al</td>
<td>Young male workers exposed to high noise levels had significantly higher levels of cholesterol and triglycerides</td>
</tr>
<tr>
<td>Virkkunen et al</td>
<td>RR for ischemic heart disease in workers exposed to &gt;85 dBA was 1.4 after 9 years, and 1.5 after 18 years</td>
</tr>
<tr>
<td>Davies et al</td>
<td>Increasing RR for MI with increasing duration of exposure and increasing exposure</td>
</tr>
</tbody>
</table>
| Gan et al         | OR of 2.9 for angina pectoris within noise exposed group  
|                   | OR of 2.0 for ischemic heart disease within noise exposed group  
|                   | A clear dose response relationship was seen, with males and smokers most significantly affected                                         |
| Willich et al     | A significant increase in risk of MI with an OR of 1.3 for male workers (but not for females)                                           |
Risk of Injury

- Increased risk of injury with noise exposure
- May be due to
  - Noise induced stress
  - Distraction
  - Reduced situational awareness
  - Degraded performance
  - Masking of critical auditory signals or speech
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<td>Melamed et al</td>
<td>Occupational accidents were found to increase as noise level increased. Highest injury risk with an OR of 2.7</td>
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<tr>
<td>Picard et al</td>
<td>A total of 12% of accidents were considered to be caused jointly by hearing loss and noisy environment. 6.2% of accidents were attributable to noise alone</td>
</tr>
<tr>
<td>Cantley et al</td>
<td>Noise exposures over 82 dBA created higher risk of serious injury. Hearing loss increased risk for all injuries. OR of 1.4 for noise exposures between 85 and 88 dBA. OR of 2.3 for noise exposures over 88 dBA</td>
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Summary

• Need to incorporate ototoxicity into hearing conservation program
• Need to evaluate oxotoxic chemicals in the workplace to aim to keep exposures below 50% of the TWA if noise is present
• Need to counsel workers during audiometric testing regarding ototoxic medicines, especially if they are working in noisy environment
• Need to counsel pregnant workers, with a relocation program if noise levels exceed 115 dBA or peaks exceed 155 dBA
• Need to evaluate cardiovascular health as part of hearing conservation program medical
• Incident investigations should consider noise as a potential cause or confounder to incidents
• Documentation, Audible Sound, 2016-11-08.pdf
• Government of Western Australia: Ototoxic chemicals and Noise Induced Hearing Loss, available online at https://www.commerce.wa.gov.au/worksafe/ototoxic-chemicals-chemicals-result-hearing-loss
• Australia-New Zealand AS/NZS 1269:2005 Occupational Noise Management/Informative Appendix on Ototoxic Agents
• Pediatrics, October 1997, VOLUME 100 / ISSUE 4, Noise: A Hazard for the Fetus and Newborn, Committee on Environmental Health, available online at http://pediatrics.aappublications.org/content/100/4/724.full
• Exposure to workplace noise and the risk of cardiovascular disease events and mortality among older adults, Gopinath, Bamini ; Thiagalingam, Aravinda ; Teber, Erdahl ; Mitchell, Paul. Preventive Medicine, 2011, Vol.53(6), pp.390-394