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Ototoxicants

What are ototoxicants?

Ototoxicants include certain pesticides, solvents, metals and pharmaceuticals. Research has revealed that exposure to certain chemicals in the workplace may have negative effects (temporary and permanent) on hearing and/or balance, regardless of noise exposure. The ability to hear low volume sounds may be reduced and sound may also lose clarity, because ototoxicants can affect the central auditory system. The combination of exposure to both ototoxicants and noise may have synergistic effects, which may result in hearing loss even though all the exposures are below the permissible exposure limits (PELs). Based on the part of the ear they damage, ototoxicants are classified as neurotoxicants, cochleotoxicants, or vestibulotoxicants. Neurotoxicants are ototoxic when they damage the nerve fibers that interfere with hearing and balance. Cochleotoxicants mainly affect the cochlear hair cells, which are the hearing sensory receptors. Vestibulotoxicants affect the hair cells on the spatial orientation and balance organs. There is still limited research on ototoxicants and their interactions with noise.

The following table includes some identified ototoxicants grouped by substance class:

Substance Class	Chemicals
Pharmaceuticals *Ototoxicity at therapeutic doses is limited	Aminoglycosidic antibiotics (e.g. streptomycin, gentamycin) and some other antibiotics (e.g. tetracyclines), Loop diuretics* (e.g. furosemide, ethacrynic acid) Certain analgesics* and antipyretics* (salicylates: e.g. aspirin; Quinine; chloroquine), Certain antineoplastic agents (e.g. cisplatin, carboplatin, bleomycin).
Solvents	Carbon disulfide, n-hexane, toluene, p-xylene, ethylbenzene, n-propylbenzene, styrene,methylstyrene, trichloroethylene.
Asphyxiants	Carbon monoxide, hydrogen cyanide and its salts, tobacco smoke
Nitriles	3-Butenenitrile, cis-2-pentenenitrile, acrylonitrile, cis-crotononitrile, 3,3'-iminodipropionitrile.
Metals and Compounds	Mercury compounds, germanium dioxide, organic tin compounds, lead.

(Source: DHHS (NIOSH) Publication Number 2018-124 https://www.cdc.gov/niosh/docs/2018-124/)

How do I prevent exposure to ototoxicants?

1. Review Safety Data Sheet (SDS) Section 11: Toxicological Information to identify ototoxicants. Ototoxicants may be listed as specific target organ toxicity, such as neurotoxicants, cochleotoxicants, or vestibulotoxicants. ACGIH® has adopted "OTO" notation to highlight a chemical's ability to cause hearing impairment either alone or in combination with noise starting from 2019 Threshold Limit Values (TLVs®) and Biological Exposure Indices (BEIs®) booklet, which may also help to identify ototoxicants.

2. Eliminating ototoxicants from the workplace. If not possible, substitute with a less toxic chemical whenever possible.
3. If elimination or substitution are not possible, use engineering controls such as isolation and enclosures. Volatile ototoxicants should be used in chemical fume hoods or with other appropriate devices to ensure local capture of airborne material.
4. Use administrative controls, such as eliminating unnecessary tasks involving ototoxicants or noise exposure, limiting exposure time, not operating noisy equipment when other workers are around.
5. Always wear personal protective equipment (lab coats, safety glasses/goggles, appropriate gloves, and other recommended PPE) when working with ototoxicants and hearing protection when working with noisy equipment or in noisy environment. If you need help with noise exposure or selecting appropriate hearing protectors, please contact Xingmei (Sherry) Liu.

References and Additional Resources:

1. OSHA/NIOSH Preventing Hearing Loss Caused by Chemical (Ototoxicity) and Noise Exposure. https://www.osha.gov/dts/shib/shib030818.html
2. Sheikh, M. A., Williams, W., & Connolly, R. (2016). Exposure to ototoxic agents and noise in workplace–a literature review. In Acoustics 2016-The Second Australasian Acoustical Societies Conference; 2016 Joint Conference of The Australian Acoustical Society and The Acoustical Society of New Zealand.
3. Sheppard, A., Hayes, S. H., Chen, G. D., Ralli, M., & Salvi, R. (2014). Review of salicylate-induced hearing loss, neurotoxicity, tinnitus and neuropathophysiology. Acta Otorhinolaryngologica Italica, 34(2), 79.
4. AIHA, the Synergist. Ototoxicants and Hearing Impairment. https://synergist.aiha.org/201912-ototoxicants-and-hearing-impairment

For more information please visit https://ehs.umass.edu/hearing-conservation-program or e-mail Xingmei (Sherry) Liu.