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Key findings

Exposure to jet fuel, not just noise, contributes to hearing problems

March 20, 2014

It's a fact aircrews know well. Service members who work in and around aircraft are more likely to suffer hearing deficits. But new VA research on the effects of jet propulsion fuel-8, commonly known as JP-8, suggests the problem may be more complex than previously thought.

Airman 1st Class Nicholas McKinney prepares to be extracted from the inside of a C-17 Globemaster III fuel tank during training at Joint Base Charleston, S.C. Fuel system repair airmen remove, repair and install the fuel cells and tanks. *(Photo by Airman 1st Class Tom Brading)*

Dr. O'neil Guthrie, a research scientist and clinical audiologist with the VA Loma Linda Healthcare System in California, says it's not just the noise that is harmful. It can also be the fuel itself.

"JP-8 is one part of a larger class of hydrocarbon chemicals," says Guthrie. "What we're seeing is that even at subtoxic levels, the exposure is affecting the brain and resulting in auditory processing dysfunctions."

While research has tied fuel vapors to hearing problems in the past, Guthrie's study is among the first to definitively link JP-8 with auditory processing dysfunctions —changes that occur inside the brain rather than the ear. The work was published recently in the Journal of Toxicology and Environmental Health.

Brain has trouble deciphering message

Generally, when people talk about hearing loss, says Guthrie, they tend to think in terms of actually not being able to hear a sound. With central auditory processing dysfunction, on the other hand, the sound comes through fine.

"They can hear sounds but the brain has a hard time deciphering the message," says Guthrie.

Think about dyslexia, but for the ears.

"It's a more insidious problem to have. We can manage hearing loss rather effectively with hearing aids," says Guthrie, "but processing the sound—allowing the brain to discriminate—that's something different. We don't yet have a good way to manage that."

For the study, Guthrie, who is also an assistant professor at Loma Linda University Medical Center, used 80 rats. Twenty were exposed to 85 decibels of noise for six hours per day, a level considered safe by the Occupational Safety and Health Administration. Twenty more were exposed to low levels of JP-8 while an identical group received both the noise and the jet fuel. The final twenty served as a control.

After four weeks, none of the rats showed significant levels of hearing loss; however, those exposed to the jet fuel did develop auditory brainstem dysfunctions, particularly those that received combined doses of jet fuel and noise.

Anyone who works around fuel may be at risk

"What we've got is people going to their commander saying something is wrong," says Guthrie. "We give them a hearing test. They pass. We send them on their way and that's not addressing the problem. People with hearing difficulties tend to shy away from communication. That can lead to isolation, depression, and a poor quality of life. We're missing a lot of people just based on the way we test for hearing deficits."

Furthermore, because JP-8 is essentially the same as other hydrocarbon fuels, differing mainly in the chemical percentages, the same risk that aircrews, pilots, and mechanics face may also affect anyone who is consistently around other types of fuels. This can include, for example, truck drivers, gas station attendants, and potentially even passengers who are frequent flyers on commercial jets.

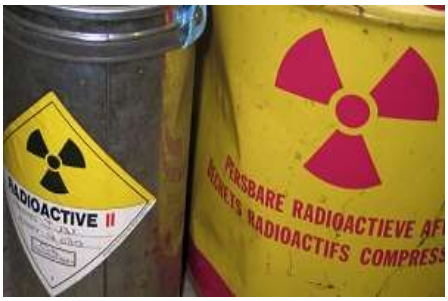
"We need to develop ways to monitor combined exposures (i.e., fuel and noise exposure) and develop safety guidelines," says Guthrie. "Making sure people are limiting their exposure by respiration, wearing protective clothing, and ensuring the fuel doesn't come into direct contact with the skin."

Adds Guthrie: "The next thing we need to look at is treatment. If we know the chemical is affecting the brain, and understand what's going on at the cellular and molecular level, then hopefully we can design treatments to help."

War Related Illness and Injury Study Center

Fuel Exposure Health Effects

Some Veterans may have concerns about potential harmful health effects from fuel exposures. Diesel fuel and JP-8 are the primary fuels used to operate vehicles in deployment settings.



MORE INFORMATION

- Fuels (Petroleum, Oils, Lubricants) and Public Health (http://www.publichealth.va.gov/exposures/fu

Service members may be exposed to fuels through skin, oral, or inhalation routes. Possible health effects often depend on the way you were exposed (i.e., skin, oral, or breathing), the length of time of exposure, and personal characteristics (i.e., age, gender, genetic traits, diet, and other habits).

Possible health effects may include those listed here (http://www.publichealth.va.gov/exposures/fuels/index.asp). Scientific research on long-term effects is not conclusive. Some research has shown there is the potential for health problems (for example - lung and heart effects) if an individual is exposed to high amounts of fuel exposure for a long period of time. The risk of developing long-term health effects often depends on many factors including how long an individual was exposed, how much fuel they were exposed to, and whether or not they had symptoms at the time of exposure.

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Public Health

Fuels (Petroleum, Oils, Lubricants)

Some service members may have been exposed to fuels, such as diesel and JP-8, used to operate vehicles during military sevice.

Possible health effects depend on how they were exposed (skin, oral, or breathing), length of time exposed, and personal factors, such as age, gender, genetic traits, and diet.

Symptoms of exposure to fuels

Health effects may include irritation to unprotected skin, eye and upper respiratory irritation, fatigue, breathing difficulty, headaches, dizziness, and sleep disturbances. Drinking fuels is dangerous and may result in convulsions, coma and even death.

Scientific research on the long-term effects of exposure to fuels is inconclusive; however, if an individual is exposed to fuel at very high levels over a long period of time, lung and heart problems may develop.

Health concerns?

If you are concerned about health problems associated with fuel exposure during your military service, talk to your health care provider or contact your local VA Environmental Health Coordinator (/exposures/coordinators.asp) to help you get more information from a health care provider.

VA offers a variety of health care benefits (/exposures/benefits/health-care.asp) to eligible Veterans. Not enrolled in the VA health care system? Find out if you qualify for VA health care (https://www.va.gov/health-care/how-to-apply/).

Compensation benefits for health problems

Veterans may file a claim for disability compensation for health problems they believe are related to fuel exposure during military service. VA decides these claims on a case-by-case basis. File a claim online (https://www.ebenefits.va.gov).

Learn more about VA benefits. (/exposures/benefits/index.asp)

Journal of Toxicology and Environmental Health, Part A ›
Current Issues
Volume 85, 2022 - Issue 16

Research Article

Abnormal neural adaptation consequent to combined exposure to jet fuel and noise

O'NEIL W. Guthrie

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ABSTRACT

of change in the statistical parameters of an input signal. Such neural adaptation shapes the performance features of contiguous neural circuits that ultimately drive sensory discrimination. The current study focused on whether combined exposure to jet fuel and noise might alter the capacity of the auditory nerve to adapt to stimulus presentation speed. Young hooded Long-Evans 4–5 weeks old male rats were grouped and used in the current experiment. One group was exposed via inhalation to 1000 mg/m^3 of jet propulsion fuel for 6 hr per day, 5 days per week for 4 weeks. Another group was exposed to a 5.5–11.3 kHz band-pass noise at 85 dB SPL for 6 hr per day, 5 days per week for 4 weeks. An additional group was simultaneously exposed to both jet fuel and noise. An age-matched group served as control and was not exposed to either jet fuel or noise. After experimental exposures, animals were given 4 weeks to recover and then assessed for neural adaptation. Both slow and fast rectangular voltage pulses were employed to elicit neuroelectric activity from the animals. Data demonstrated significant neural adaptation (1.46 μV shift) among controls, where neural activity decreased as the stimulus presentation speed rose from 10 to 100 per sec. This effect might also be observed in animals in the jet fuel treated and rats in the noise-exposed group. However, animals who were simultaneously exposed to both jet fuel and noise failed to exhibit neural adaptation. This abnormality appeared to be masked because independent slow and fast stimuli produced similar neural activity between controls and rats exposed to both jet fuel and noise. Therefore, neural adaptation assays may further be developed to unmask silent neurotoxicity consequent to physiochemical exposures.

KEYWORDS: Neuropathy Synaptopathy Ototoxicity Noise Hidden Hearing loss Mixtures Hearing Auditory

Previous article **View** issue table of contents **Next** article

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No potential conflict of interest was reported by the author(s).

Data

The author confirms that data supporting the findings of this study are available within the article.

Additional information

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Research Article

Degenerate brainstem circuitry after combined physiochemical exposure to jet fuel and noise

O'neil W. Guthrie, Brian A. Wong, Shawn M. McInturf & David R. Mattie

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ABSTRACT

Degenerate neural circuits exhibit “different” circuit properties yet produce similar circuit outcomes (many-to-one) which ensures circuit robustness and complexity. However, neuropathies may hijack degeneracy to yield robust and complex pathological circuits. The aim of the current study was to test the hypothesis that physiochemical exposure to combined jet fuel and noise might induce degeneracy in the brainstem. The auditory brainstem of pigmented rats was used as a model system. The animals were randomized into the following experimental groups: Fuel+Noise, fuel-only, noise-only, and control. Ascending volume conductance from various auditory brainstem regions were evaluated simultaneously with peripheral nervous system (PNS) input to brainstem circuitry. Data demonstrated normal PNS inputs for all groups. However, the Fuel+Noise exposure group produced different caudal brainstem circuit properties while rostral brainstem circuitry initiated outputs that were similar to that of control. This degenerative effect was specific to Fuel+Noise exposure, since neither noise-alone or fuel-alone produced the same result. Degeneracy in the auditory brainstem is consistent with perceptual abnormalities, such as poor speech discrimination (hear but not understand), tinnitus (ringing in the ear), hyperacusis (hypersensitivity to even low-level sound), and loudness intolerance. Therefore, a potential consequence of Fuel+Noise exposure among military and civilian populations may be evidenced as increased rates of super-threshold auditory perceptual abnormalities. This is particularly important because to date, the ototoxic profile of Fuel+Noise exposure has remained unresolved.

KEYWORDS: Ototoxicity otology audiology central auditory processing military

Journal of Toxicology and Environmental Health, Part A ›
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Original Articles

Inhalation of Hydrocarbon Jet Fuel Suppress Central Auditory Nervous System Function

O'neil W. Guthrie, Brian A. Wong, Shawn M. McInturf, James E. Reboulet, Pedro A. Ortiz & David R. Mattie

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Abstract

consumption of these fuels necessarily puts the public at risk for repeated inhalation exposure. Recent studies showed that exposure to hydrocarbon jet fuel produces lethality in presynaptic sensory cells, leading to hearing loss, especially in the presence of noise. However, the effects of hydrocarbon jet fuel on the central auditory nervous system (CANS) have not received much attention. It is important to investigate the effects of hydrocarbons on the CANS in order to complete current knowledge regarding the ototoxic profile of such exposures. The objective of the current study was to determine whether inhalation exposure to hydrocarbon jet fuel might affect the functions of the CANS. Male Fischer 344 rats were randomly divided into four groups (control, noise, fuel, and fuel + noise). The structural and functional integrity of presynaptic sensory cells was determined in each group. Neurotransmission in both peripheral and central auditory pathways was simultaneously evaluated in order to identify and differentiate between peripheral and central dysfunctions. There were no detectable effects on pre- and postsynaptic peripheral functions. However, the responsiveness of the brain was significantly depressed and neural transmission time was markedly delayed. The development of CANS dysfunctions in the general public and the military due to cumulative exposure to hydrocarbon fuels may represent a significant but currently unrecognized public health issue.

Previous article **View** issue table of contents **Next** article

Journal of Toxicology and Environmental Health, Part A ›
Current Issues
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Original Articles

Exposure to Low Levels of Jet-Propulsion Fuel Impairs Brainstem Encoding of Stimulus Intensity

O'neil W. Guthrie, Helen Xu, Brian A. Wong, Shawn M. McInturf, Jim E. Reboulet, Pedro A. Ortiz & ...show all

Pages 261-280 | Received 11 Sep 2013, Accepted 03 Nov 2013, Published online: 03 Mar 2014

Abstract

Atlantic Treaty Organization countries adopted JP-8 as a standard fuel source and the U.S. military alone consumes more than 2.5 billion gallons annually. Preliminary epidemiologic data suggested that JP-8 may interact with noise to induce hearing loss, and animal studies revealed damage to presynaptic sensory cells in the cochlea. In the current study, Long-Evans rats were divided into four experimental groups: control, noise only, JP-8 only, and JP-8 + noise. A subototoxic level of JP-8 was used alone or in combination with a nondamaging level of noise. Functional and structural assays of the presynaptic sensory cells combined with neurophysiologic studies of the cochlear nerve revealed that peripheral auditory function was not affected by individual exposures and there was no effect when the exposures were combined. However, the central auditory nervous system exhibited impaired brainstem encoding of stimulus intensity. These findings may represent important and major shifts in the theoretical framework that governs current understanding of jet fuel and/or jet fuel + noise-induced ototoxicity. From an epidemiologic perspective, results indicate that jet fuel exposure may exert consequences on auditory function that may be more widespread and insidious than what was previously shown. It is possible that a large population of military personnel who are suffering from the effects of jet fuel exposure may be misidentified because they would exhibit normal hearing thresholds but harbor a “hidden” brainstem dysfunction.

MARCH 23 2022

Is jet fuel exposure associated with central auditory nervous system difficulties: An exploratory study in military personnel[a)]

Special Collection: Noise-Induced Hearing Disorders: Clinical and Investigational Tools

Laura Dreisbach ; Sara Murphy; Reginald Arevalo; Caroline Schlocker; Tanner Miller; O'neil Winston Guthrie

+ Author & Article Information

J Acoust Soc Am 151, 2027–2038 (2022)

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Central auditory nervous system dysfunction (CANSD) can manifest as hearing difficulty in the absence of audiometric abnormalities. Effects of noise or jet fuel exposure on the CANS are documented in animal models and humans. This study screened military personnel using the modified Amsterdam Inventory for Auditory Disability (mAIAD) to assess whether concurrent jet fuel and noise (JFN) exposures potentiate central auditory difficulties compared to noise only exposures. A total of 48 age- and sex-matched participants were recruited: 24 military bulk fuel specialists (JFN) and 24 military personnel without jet fuel exposure. All participants completed the mAIAD, the Noise Exposure Questionnaire, and basic audiological testing. Results revealed non-significant differences in pure-tone thresholds between groups, but the JFN group had higher noise exposures. Additionally, the JFN group revealed consistently lower mAIAD scores compared to the noise only group. Interestingly, a JFN stratified subgroup reporting more listening difficulty exhibited statistically significant lower mAIAD scores in the speech intelligibility in noise subdomain. These preliminary data suggest that jet fuel exposure may potentiate noise-induced CANSD, such as speech-in-noise difficulties. Such difficulties

may be more prominent among specific military personnel with combined exposures. Hearing conservation programs could add CANSD screening by use of the mAIAD.

Topics

Speech communication, Auditory perception, Hearing impairment, Audiometry, Auditory system, Speech intelligibility, Medical diagnosis, Nervous system, Animal model, General linear model