

Aviation Fuel Exposure Resulting in Otitis Externa with Vertigo

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- BACKGROUND:** Otitis externa secondary to irritant or chemical exposure is well documented; however, specifically secondary to jet fuel exposure and its associated toxicology is not. Over 2 million military and civilian personnel per year are occupationally exposed to aviation fuels.
- CASE REPORT:** An aircraft maintainer presented with noninfectious acute otitis externa secondary to external ear canal exposure to JP-5 jet fuel. Proper exposure guidelines were followed, but it was not realized that the external ear canal was involved. The first symptoms to emerge were vertigo, dizziness, and disequilibrium; however, on physical exam it appeared that there was no middle ear involvement.
- DISCUSSION:** Otitis externa normally does not present with vestibular symptoms as the pathology affects the external ear canal dermal tissue. Upon review of JP-5's toxicology profile, dermal absorption is a route of entry and can cause general neurological symptoms, including loss of coordination. This case highlights potential deficiencies in the standardized safety data sheets that are used after exposure. Without mention of possible auricular exposure one may focus on the logical protection of the eyes, mouth, and visible skin. This is concerning due to potential delayed exposure symptoms, dermal absorption, high level of dermal destruction, and the close proximity to the sensory system. The goal of this case report is to improve the knowledge of providers caring for personnel who may be exposed and to suggest possible revisions to the Safety Data Sheets for jet fuel.
- KEYWORDS:** jet fuel exposure, JP-5, dermal absorption, atypical vestibular symptoms.

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Jet Propellant 5, often abbreviated to JP-5, is a type of military fuel that is in the same class as Jet Propellant 8 (JP-8) and the civilian aviation equivalent, Jet Propellant A (Jet A-1). Over 2 million military and civilian personnel per year are occupationally exposed to JP-5, JP-8, or Jet A-1.⁵ These fuels are kerosene-based and contain complex mixtures of aliphatic and aromatic hydrocarbons with varying toxicants and additives such as: toluene, benzene, and xylene, which aid in operational requirements, including elevating the flash point and preventing icing. JP-5 and JP-8 are most commonly used in military aircraft, but may also be used for fueling land vehicles or as a fuel source for heaters and lights.^{5,8}

Organizations use Safety Data Sheets for chemicals in the workplace as guidance for first aid in incidents of exposure and for maintenance and disposal of chemical products. The current Safety Data Sheet which outlines the health hazards of JP-5 states “may be irritating to the eyes, nose, throat, skin and lungs. Breathing of the high vapor concentration may cause dizziness, light headedness, headache, nausea, and loss of coordination.”

Under first aid measures, it has sections for: inhalation, skin contact, eye contact, and ingestion. Under skin contact, it recommends “wash off areas with soap and water, remove contaminated clothing,” and it gives explicit warning and instructions on what to do if JP-5, “gets under the skin.”¹ There is no mention of exposure to ears or caveat that if face exposure occurs, one should think of possible exposure to the ear canal.

Acute otitis externa is a common condition involving inflammation of the ear canal. The causes of otitis externa can be split into two main groups: those caused by infections, which account

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for 98% of cases in North America, and noninfectious cases, which include dermatological conditions like irritant dermatitis.^{6,9} Individuals who are exposed to chemical irritation of the external auditory canal may experience symptoms of otalgia, otorrhea, desquamated epithelium, erythema, pruritus, edema, vesiculation, and lichenification.⁶ Many of these symptoms were demonstrated in this case; however, vestibular symptoms after exposure are not typical. After literature review, vestibular symptoms like dizziness, vertigo, or a sensation of disequilibrium are not regularly reported for infectious or noninfectious causes of otitis externa in which the middle ear is not affected.^{4,6,9}

Jet fuel exposures typically occur by dermal absorption, pulmonary inhalation, or oral ingestion. Topical exposure causes erythema, edema, and desquamation.^{3,5,8} Jet fuel has been demonstrated to cause general neurological symptoms, including loss of coordination, headache, fatigue, intoxication, dizziness, difficulty concentrating, moodiness, and sleep disturbances.⁸ Peripheral auditory or vestibular system deficits were not found with acute or repeated exposures to jet fuel; however, studies have linked inhalation of toluene to cochlear injury.^{2,5} The 2017 published toxicological profile states that the amount of chemicals in JP-5, JP-8, or Jet A-1 that can pass into the bloodstream is unknown. However, after jet fuel enters the body, the chemicals in the fuel are distributed throughout the body.⁸ In regard to skin absorption, it has been shown that pre-existing damage to the skin and longer times of skin exposure increase the amount of chemicals that will enter the body.⁸ The majority of the data on health effects of jet fuels comes from animal studies with some limited data in humans who reported exposure. Most of the prior cases in humans that resulted in neural symptoms involved inhalation as the avenue of entry, and much of the evidence that links dermal absorption to neurological symptoms is from animal studies. The pathophysiology of the toxic effects of jet fuels are not well defined and, as such, no known therapies are available to disrupt the mechanisms of action.⁸

CASE REPORT

A 22-yr-old military aviation technician presented with left ear pain 3 d after military grade fuel (JP-5) accidentally splashed on the left side of his face. At the time of exposure, the patient reported a bad taste in his mouth, but had no immediate symptoms. The patient was working in a small space within an aircraft compartment, which required him to remove his headgear to finish his task. After being splashed with JP-5 the patient flushed out his eyes and mouth and washed his face; however, he stated that he did not flush out his ears. The day after exposure he felt imbalanced and dizzy, and reported repeatedly “drifting to one side of the hallway while walking, then over-correcting and stumbling.” Two days after exposure, the patient awoke with severe left ear pain, thin yellow drainage from the ear, and muffled hearing that continued through the day. On the third day postexposure, the patient presented to medical with ear pain, drainage, muffled hearing, and a sensation of ear pressure; however, the vertigo had resolved.

Exam

Otoscope examination of the left external ear canal showed desquamation and wet-appearing skin with debris consisting of large amounts of gray to whitish desquamating skin. The external canal was erythematous, having intact sensation without pain, but “it tickled.” Prior to rinsing, the tympanic membrane was not visualized due to the debris. After rinsing with water, the tympanic membrane had a small amount of dull whitish-appearing excoriations with erythema. The tympanic membrane had positive movement with Valsava, no fluid levels were present in the middle ear, the drum was not bulging, there was a normal light reflex, and no evidence of perforation. Audiometric testing showed that his hearing was within normal limits and was consistent with his reference audiogram.

Treatment

The patient was diagnosed with acute noninfectious otitis externa of the left ear, secondary to chemical/fuel exposure. Following multiple irrigations, the patient was given ciprofloxacin/dexamethasone 0.3–0.1% (Ciprodex OTIC), 4 drops twice daily, for 1 wk and was given strict return precautions. All symptoms had resolved 3 d post-treatment and he had no lasting detriment or complaints.

DISCUSSION

Accidental exposure to JP-5 is not uncommon. Every year many cases are mitigated effectively and with minimal adverse outcomes after the washing protocols in the Safety Data Sheet are followed. However, the occurrences of ear canal involvement are rarer or less documented, as are the reports of vestibular symptoms after exposure. In this case, the skin in the external ear canal was exposed to JP-5 jet fuel—an environment that is not favorable for evaporation or washing and is in close proximity to neural structures. In otitis externa, vestibular symptoms are uncommon regardless of the pathological damages of the external auditory canal. In this case, the patient presented with strong vestibular symptoms and they appeared to occur before the dermal inflammation and break down became an issue.

Chemicals in JP-5 can enter the bloodstream following dermal absorption; however, the amounts, specific chemicals, depth of penetration, and the mechanism of neurological involvement, either by central effects or on peripheral sensory structures, are not fully understood. In this case, one may speculate that JP-5, through local dermal absorption on the unwashed thin epidermis of the external ear canal, along with the close proximity to the vestibular sensory structures, caused these symptoms. It is also possible that it was due to some type of central neurological involvement via the bloodstream from gross body exposure. However, this may be less likely with the number of gross body exposures in the population compared with the irregularity of vestibular symptoms reported.

Only one other case study was found that described the effects of jet fuel exposure on the external ear canal. In that

case report, the individual was exposed to JP-8 and, in similar fashion to the JP-5 case above, the individual had an intact tympanic membrane and no evidence of middle ear effusion. The reported symptoms and physical exam were also similar; however, there were no reports of disequilibrium.⁷ This difference may stem from the amount of jet fuel residue left in the ear canal or the differences in the specific toxicologies of JP-5 vs. JP-8.

In this case vestibular testing was unfortunately not done because of the military operational situation. This, along with the generally limited understanding of JP-5 and jet fuel toxicology mechanisms of action, means only speculations and assumptions can be made. However, with the risks of delayed exposure symptoms, dermal absorption, high level of dermal destruction if not washed, and warnings of possible surgical emergency if JP-5 “gets under the skin,”¹ there should be a concern for possible ear canal involvement and vestibular system compromise after exposure to jet fuel. In this case the patient and his military unit followed the exposure guidelines and focus was given to the listed safety precautions of rinsing the patient’s eyes, mouth, face, and exposed skin. The patient then returned to work as normal after he changed into fresh clothing. Additional considerations may need to be added to the “safety data sheet” or passed to medical providers who care for exposed individuals. Working with aircraft, jet engines, or flight operations is potentially dangerous. Following exposure, work restrictions might be appropriate because of the possibility of delayed onset of vestibular symptoms, placing the individual or others around them into harmful situations. It should also be understood that sensitive locations like the external ear canal might be overlooked during the heightened stress following exposure. The Safety Data Sheet is a useful tool for aircrew and aircraft maintainers; however, it is recommended that it be revised to also recommend careful

rinsing of the ear and external auditory canal if the face is exposed.

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