

New Onset Migraine Associated With a Civilian Burn Pit

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ABSTRACT Background: Deployed service members exposed to burn pit smoke can experience a multitude of symptoms. Respiratory symptoms after burn pit smoke exposure are well recognized, but neurologic symptoms are less well recognized. There are reports of migraines triggered by odors but no specific reports of new onset migraines triggered by exposure to burn pit smoke. Clinicians encountering patients with new onset migraines in the deployed setting face the dilemma of evacuating the patients to perform neuroimaging or keeping them in theatre. Methods: Retrospective case series study and review of the literature. Findings: Three patients with new onset headache after exposure to open burn pit smoke are described. The headaches met established criteria to be classified as migraine with aura in two patients and migraine without aura in one patient. The migraines were triggered by exposure to the burn pit smoke and relieved by avoidance of the smoke. The patients did not have history of migraine and had normal neurological examinations. Computed tomography performed in one patient and optic nerve insonation performed in all three patients were normal. The patients responded well to triptans and antiemetic medicines. Discussion: Nociceptive odors can trigger classic migraines in adults without prior history of migraine. The temporal association between exposure to the odor and the development of the headache, the absence of abnormalities on neurologic examination, and the response to triptans help establish the diagnosis. Activation of the trigeminal system leading to release of pain-related neuropeptides may mediate the migrainous symptoms. Evacuation for advanced neuroimaging or specialized consultation can be avoided if the above-mentioned criteria are met.

INTRODUCTION

The practice of open-air burning of waste is common in deployed settings, and in poor countries it is the most affordable waste disposal method available to local governments. Deployed service members exposed to burn pit smoke can suffer a myriad of symptoms that may be related to inhalation of combustion products.^{1,2} Toxins such as dioxin, benzene, particulate matter, hexachlorobenzene, volatile organic compounds, carbon monoxide, ash, heavy metals, formaldehyde, hydrogen cyanide, nitrogen dioxide, and sulfur dioxide among others are known to be released in burn pit fires.^{1,2} Such elements are well-recognized respiratory irritants that can cause acute cough, dyspnea, pneumonitis, and bronchitis, but their association with other symptoms is less clear.^{1,2}

During a recent deployment to Djibouti, the author encountered three patients who developed *de novo* migraines triggered exclusively by exposure to burn pit smoke. The clinical characteristics of this syndrome and the possible pathophysiology and management are discussed herein.

CLINICAL CASES

Three active duty service member patients presented to the battalion aid station at Camp Lemonnier, Djibouti, with new onset headaches. The patients were previously healthy and were not former or current smokers. The patients attributed

the headaches to exposure to smoke with a very unpleasant odor emanating from a civilian burn pit located approximately one mile from the perimeter of the camp. All patients were evaluated by a board-certified neurologist. The specific characteristics of the patients are summarized in Table I. The headaches met criteria to be diagnosed as migraine with aura in two patients, and migraine without aura in one patient. Premonitory symptoms were present within seconds to minutes of exposure to the burn pit smoke in all patients. Symptoms did not occur when the service members remained indoors. All three patients admitted to having osmophobia once the migraine had settled. Two of the three patients indicated not suffering headaches when away from camp on remote missions, and recurrence of the headaches upon returning to camp. The patients admitted to having more frequent headaches when wind direction drifted the smoke into the camp. The female patient did not report association between her headaches and her menstrual period. All three patients had suffered more than five headache attacks and therefore met diagnostic criteria for migraine.

Neurologic examination was completely normal in all three patients. Ultrasound examination of the optic nerve, performed using point-of-care ultrasonography, showed normal optic nerve diameter in all three patients. Computed tomography was performed in one of the three patients and was normal. Magnetic resonance imaging was not available. Patients were treated with oral sumatriptan (as abortive therapy) and with ondansetron as needed with adequate clinical response. One patient was followed after leaving theatre via e-mail and indicated resolution of her symptoms upon returning to the United States. The other two patients remained in theatre and responded to triptans as needed. Prophylactic

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doi: 10.7205/MILMED-D-16-00200

TABLE I. Clinical Characteristics of Patients

Age (years)	Gender	Personal History of Migraines	Family History of Migraines	Unilateral Pain	Visual Aura	Nausea	Vomiting	Photophobia	Sonophobia	Osmophobia	Dysphoria	Response to Triptans
27	Male	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
44	Female	No	No	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
29	Male	No	No	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes

therapy was not instituted in any of the patients as they were satisfied with the response to abortive therapy.

DISCUSSION

Migraine is a complex neurological disorder with a myriad of potential triggers. Odors as possible migraine triggers were first described by Gowers in 1988.³ It is estimated that up to 40% of all migraineurs suffer from migraines triggered by odors.^{4,5} A plethora of odors can act as migraine triggers to include both irritant smells as well as seemingly pleasant smells. Among the best recognized odors that can trigger migraines are vehicle exhaust, pesticides, combustible gas, tobacco smoke, asphalt, perfumes, fresh paint, industrial glue, and detergents.⁴⁻⁶ Certain food smells can also provoke migraines; alliaceous migraines are triggered by smelling onions or garlic.⁵ Although there are multiple reports of odors triggering migraines in patients with known migraine headaches, there are no reports in the English literature of de novo migraines in patients exposed to burn pit smoke.

The patients described here had no prior history of migraine and developed headaches upon exposure to burn pit smoke at relatively late age. It is believed that migraine onset in this setting follows a two stage process.⁴ In the initial stage (induction), chemical sensitivity develops after being exposed to the offending odor. The subsequent stage occurs when low-level exposure to environmental triggers provokes migraines in a manner akin to an immunological reaction. Although odors are perceived via the olfactory nerve, odors activate the trigeminovascular system.⁴⁻⁶ Chemical irritants, transmitted via sensory trigeminal branches, lead to release of substance P and calcitonin-gene-related peptide—two important pain modulators. Neurogenic inflammation leads to activation of the parasympathetic neurons that converge in the superior salivatory nucleus and sphenopalatine nucleus, and that in turn stimulates meningeal neurons.⁴⁻⁶ Trigeminal aromas can activate the anterior and central insula, claustrum, cingulus, and facial area of the primary sensory cortex—areas all involved in pain modulation. It is possible that the patients herein described were exposed to a new irritant present in the burn pit smoke that they had not encountered before and that triggered the trigeminal activation and neurogenic inflammation.

Clinicians in the deployed setting may be hesitant to keep patients with new onset headaches in theatre and may be tempted to evacuate them to perform advanced neuroimaging.

However, certain migraine features can help distinguish migraine headaches from other primary headaches and from secondary headaches. Headaches triggered by odors are almost always migraines; other primary headaches and secondary headaches are not provoked by odors. Clinical studies exposing headache patients (migraineurs and nonmigraineurs) to migraine-triggering odors failed to elicit headaches among nonmigraineurs.⁶ Nausea often precedes the headache (as opposed to occurring synchronously with the headache) in odor-triggered migraines and this clinical feature may assist the clinician in making the diagnosis. There are no reports in the English literature of migraine provocation by exposure to urban fires or wildfires, but migraine is often triggered by exposure to cigarette smoke.⁷ Aversive odors particularly when emanating from organic compounds are well-recognized migraine triggers.⁷ Presumably the aversive nature of the smell stimulates the trigeminal nerve and initiates the migraine cascade.

New onset migraines can develop in military personnel exposed to burn pit smoke. The clinical history is paramount in arriving at this diagnosis; if signs and symptoms that suggest increased intracranial pressure are not present and there are no focal signs or symptoms, advanced imaging is not warranted. The temporal relation to smoke exposure, headache characteristics, and the response to triptans help confirm the diagnosis. Evacuation to perform neuroimaging is not necessary if the clinical criteria described here are present.

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