

## Case Report

# Carbon monoxide intoxication due to waterpipe smoking as cause of a seizure in an adolescent: a case report.

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### Abstract

Waterpipe smoking has become increasingly popular in Western Europe, particularly among young people. Since the smoke passes through water, it is commonly perceived as less harmful than cigarette smoking. We report a case of a 13-year-old boy who presented himself with a tonic epileptic insult after waterpipe smoking. Especially in young adults presenting with an atypical presentation, clinicians should think of the possibility of a carbon monoxide intoxication. A fortiori, more attention is needed to carbon monoxide intoxication because it can have a lifetime of effects in young adults.

### Case

A 13-year-old boy presented himself around midnight at the emergency department with the suspicion of a first seizure. The boy was accompanied by his parents and they reported an episode of dizziness during a few seconds and altered sensations in his feet. Subsequently, he fell and had a tonic episode during approximately 3 minutes with urine incontinence. The parents tried to open his mouth and pull his tongue out. Clonic movements were not observed. The parents phoned the Emergency Medical Services (EMS). Initial history was unremarkable except for taking two sips of a waterpipe on a terrace with a friend. Other drug use was denied.

Physical assessment by the EMS demonstrated maximal Glasgow Coma Score [15] with no signs of post-ictal phase and normal blood pressure. Additional investigations excluded hypoglycaemia, electrocardiographic findings showed a sinus tachycardia.

During the initial presentation at the emergency department, his single complaint was headache. Physical examination demonstrated an oxygen saturation of 100%, a temperature of 37.3°C and a slight tachycardia of 120 beats/minute. Neurological assessment was normal with symmetric pupillary light reflexes and normal function of other cranial nerves. The deep tendon reflexes were difficult to elicit but pathological reflexes were absent. Extrapyramidal signs were not observed.

Blood gas analysis revealed a carboxyhaemoglobin (COHb) level of 25.3% (normal 0.5-1.5%) which confirmed severe carbon monoxide (CO) intoxication. Additional blood analysis showed a normal complete blood count, glycaemia, kidney function and liver function. There were also no signs of infection. Lactate was elevated, 3.5mmol/liter. Oxygen therapy at atmospheric pressure was started immediately and the patient was transferred to a specialized centre for hyperbaric oxygen therapy (HBOT). After one session of HBOT in a pressure chamber, he was discharged. Upon follow-up 2 days after, he had fully recovered.

When the patient was confronted with the results, he admitted - when his parents were not present - that he had smoked waterpipe for two hours using four charcoals instead of the usual one on the waterpipe.

### Discussion and review of literature

Waterpipe smoking has become increasingly popular in Western Europe, particularly among young people (1-6). Adolescents often present at the emergency department with clinical signs of intoxication but waterpipe

smoking may be overlooked as a cause. Waterpipe smoking can pose serious health problems with potentially very dangerous sequelae, such as CO intoxication (7). Emergency health care providers should be aware of this.

However little data is available on prevalence and incidence of complications. Here, we review the reported cases of CO intoxication due to waterpipe in children/adolescents.

Waterpipe smoking, also known as hookah, shisha, goza, hubble-bubble, argeela and narghile, is a traditional method of tobacco use (1-6). It began in India and spread geographically to Iran and the Mediterranean region (Arabs and Turks). The last years it has become increasingly popular in (Western-)Europe and (North-)America, especially in adolescents (2,6,8). A possible explanation is migration, youth subculture and the belief that it is less addictive and less harmful than cigarette smoking (4,6). The latter is probably due to the fact that the smoke passes through water. This induces the misperception of a filtering effect (5). Alternatively, the introduction of aromatized non-tobacco products with sweet and fruity flavours can also create the impression that waterpipe smoking is less harmful than cigarette tobacco (1,4). While nicotine-free herb blends, which can be used as an alternative, contain less nicotine, the charcoal combustion is still needed, and the quantities of other toxic substances are equal or more (6). Indeed, an abundance of toxic substances such as tar, polycyclic aromatic hydrocarbons, volatile aldehydes and heavy metals have been reported in narghile smokers and the aerosol of narghile smoke (2,6). Additionally, compared to smoking a single cigarette, waterpipe smoke contains 30 times the carcinogenic polycyclic aromatic hydrocarbons, 40 times the tar and twice the amount of nicotine (9).

#### CO intoxication

When compared to cigarette smoking, the increased CO exposure in waterpipe smoking is potentially more harmful. Several factors contribute to the increased CO exposure. First, the amount of smoke inhaled. A single waterpipe session results in 90L of smoke versus 0.5L of smoke with cigarette smoking (5). Secondly, the CO concentration can be up to 30-fold higher in waterpipe smoking (3,8). Furthermore, to inhale the same amount of nicotine and to get the nicotine satisfaction, exposure to a higher CO concentration is necessary in shisha (10). A single session can expose the person to an equivalent of consuming 100 or more cigarettes in one session (1,2,5). At room temperature, CO is a colourless, tasteless, odourless and

non-irritating gas (5,6,10-12). Because of the less irritating nature of the moisturized smoke, it can be smoked for several hours at a time and it can be inhaled more deeply (3). The larger volumes of inhalation, the longer duration of one session, and the use of charcoal to burn tobacco contribute to a higher absorption of CO when compared to cigarette smoking (3). It is independent of the use of non-tobacco flavours because the CO intoxication originates mainly from the incomplete combustion of charcoal (hydrocarbons), used to heat the tobacco (1,5,6,8,11,12).

#### *Pathophysiology*

The binding affinity of haemoglobin for CO is 200-300 times higher than that for oxygen (5,10,12). Due to the formation of COHb, there is a left shift of the oxygen dissociation curve and the oxygen delivery to other organs is affected, even though normal arterial oxygen partial pressure (PaO<sub>2</sub>) is present (6,7,10). Consequently, CO impairs not only the oxygen uptake due to its competition for haemoglobin, but also the oxygen delivery capacity (6,7,12). This may lead to severe cardiovascular and metabolic manifestations like myocardial ischemia, ventricular arrhythmias, pulmonary oedema and profound lactate acidosis (10,11).

#### *Acute symptomatology*

Diagnosing a CO intoxication can be challenging due to the variability and non-specific nature of the symptoms and may be related to the physical development stage of the patient (3,5,11). Indeed, Kurt *et al.* investigated the difference in presenting symptoms according to age and found that nausea and vomiting are the most common presenting symptoms, but also headache, syncope (transient loss of consciousness), dizziness, fatigue and confusion are commonly presented (5,6,11). In the adolescent group, the neurologic symptoms, like nausea and vomiting, headache, syncope, dizziness and seizure, occurred most frequently (11).

CO intoxication causes both, immediate and delayed neurological symptoms (6). It can result in seizures, syncope and coma (11).

The severity of symptoms is thought to be more likely related to the duration of exposure than to COHb-levels (6,7,11). However, Kurt *et al.* showed that a COHb level above 25% was correlated with more severe symptoms, a lower Glasgow Coma Score, higher hospitalization rate and longer duration of hospital stay, when compared to levels between 5-25% (11).

#### *Diagnostic pitfalls*

As our case demonstrates, when adolescents present with non-specific symptoms which cannot easily be categorized, one should consider CO intoxication (5,8). The photometric absorption of COHb is the same as oxyhaemoglobin and therefore pulse oximetry cannot discriminate between oxyhaemoglobin and COHb and thus will read normal oxygen-saturation (5-7,12). A blood gas analysis is the fastest way to confirm CO intoxication (5,6,8).

#### *Treatment*

Treatment of CO intoxication due to waterpipe smoking does not differ from treatment for another cause (1). Depending on available facilities, high dose oxygen therapy can be given through a non-rebreathing mask or HBOT (5,6,8,10). The latter two will reduce the CO-elimination half-life from 320 minutes in ambient air to 74 minutes and 20 minutes, respectively (1,7,12). It is thought that HBOT will decrease the delayed neurologic injury (3). An additionally benefit of HBOT is the inhibition of leucocyte-mediated inflammatory changes and oxidative stress in the brain (7). Expert opinion recommends treatment by HBOT for all patients having undergone severe CO intoxication involving loss of consciousness, cardiac ischemia alterations, neurologic deficits, metabolic acidosis, or COHb-levels above 25% (1,5,12).

Patients can experience symptoms in the days/months after the intoxication because CO can cause inflammation through different pathways that contribute to a systemic inflammatory response syndrome and delayed neurologic sequelae (7,8,11,12).

#### *Long term consequences*

On the long term, it can cause neurological and neuropsychological sequelae such as memory loss, impaired concentration, mood disorders, movement

disorders (gait and balance), affective disorders (depression, anxiety), personality changes, and various other symptoms (6,12).

## **Conclusion**

Contrary to common belief, waterpipe smoking can be potentially harmful (3,5). Since adolescents and young adults are not likely to link their symptoms to previous waterpipe smoke exposure, clinicians should be vigilant of CO intoxication when this group presents itself atypically, such as unexplained confusion or non-specific neurological symptoms. Mostly because CO intoxication can have (long-term) adverse effects.

The authors have no conflict of interest to declare.

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