Brief Communication

Characteristics of Headache Associated With Acute Carbon Monoxide Poisoning

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Objective.—To evaluate systematically the characteristics of headache due to acute exposure to carbon monoxide.

Background.—Headache is the most commonly reported symptom in acute carbon monoxide poisoning. While it is often described as throbbing and diffuse, a systematic characterization of carbon monoxide-associated headache has never been published.

Methods.—Patients referred for hyperbaric oxygen treatment of acute carbon monoxide poisoning were asked whether headache was part of their symptom complex. When present, specific details about the nature of the headache were collected from 100 consecutive patients through use of a standardized questionnaire.

Results.—Information on carbon monoxide-associated headache was collected from 34 female and 66 male patients with a mean carboxyhemoglobin level of 21.3% ± 9.3%. The most common location for pain was frontal (66%), although more than one location was involved in 58% of patients. Nature of the pain at any time during its course was dull in 72% of patients and sharp in 36%. Headache was throbbing in 41%, continuous in 74%, and intermittent in 16% of those evaluated. Peak intensity of pain did not correlate with the carboxyhemoglobin level. Headache improved prior to hyperbaric oxygen treatment in 72%, resolving entirely in 21%. Of those with residual headache, pain improved with hyperbaric oxygen in 97%, resolving entirely in 44%.

Conclusions.—The headache accompanying acute carbon monoxide poisoning is extremely variable in nature. "Classic" throbbing, diffuse headaches were rarely described by patients. There are no patterns which can be considered characteristic to aid in the diagnosis of carbon monoxide-induced headache. Similarly, no trait was identified which might allow elimination of carbon monoxide poisoning from the differential diagnosis of headache.

Key words: headache, carbon monoxide, poisoning

Abbreviations: CO carbon monoxide, HBO_2 hyperbaric oxygen, COHb carboxyhemoglobin

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Carbon monoxide (CO) poisoning is extremely common in the United States. It has been estimated that acute CO poisoning generates over 40 000 emergency department visits annually.[1] The most common symptom of CO exposure is headache.[2-5] Despite this, no systematic description of CO-induced headache has been published to date.

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Clinical diagnosis of CO poisoning is notoriously difficult, a consequence of the fact that the common symptoms, including headache, are nonspecific.[4,5] This study was undertaken to evaluate systematically the headache associated with CO poisoning and to determine whether specific characteristics exist that might assist in diagnosis.

METHODS

Alert and communicative patients referred to Virginia Mason Medical Center in Seattle, Washington for hyperbaric oxygen (HBO_2) treatment of acute CO poisoning from November 1995 to June 1999 were asked whether headache was a component of their symptom complex. Specific details concerning the nature of their headaches were collected prospectively

from 100 consecutive patients through use of a standardized questionnaire.

Data were collected and recorded by nursing staff prior to HBO_2 treatment. When asked questions concerning the qualitative nature of their headaches, patients were allowed to select any of the characteristics matching the head pain at any time during its course. As a result, the frequency of responses to some categories of questions summed to more than 100%. Qualitative grading of the intensity of head pain was performed using a scale of 0 (no pain) to 10 (maximum pain).

Simple descriptive statistics were used to report results. Linear regression was used to analyze the relationship between peak intensity of head pain and blood carboxyhemoglobin (COHb) level.

RESULTS

Data regarding CO-associated headache were collected from 66 male and 34 female patients. Ages ranged from 5 to 81 years (mean, 38 ± 14 years). The mean COHb level for the entire population was $21.3\% \pm 9.3\%$. The most common sources of CO were motor vehicles, forklifts, and furnaces (Table 1). Poisonings were accidental in 81% of the cases and intentional in the remainder. All intentional CO poisonings were due to exposure to the exhaust from a motor vehicle.

The most frequently identified location of headache was frontal (66%), followed by left temporal (52%), right temporal (51%), and occipital (47%). Pain was described in more than one of the four locations by 58% of patients and in all four locations by 22%. Both frontal and bitemporal locations were noted by 33%, while only 13% described bitemporal without frontal pain.

The character of the pain at any time during its course was described as dull by 72% of the patients and sharp by 36%. Headache was constant at some point in 74% and throbbing at some point in 41%. Changes in head position exacerbated the pain in 28% of patients. Head tenderness (pain exacerbated by pressing on the head) was described by 22%.

On a scale of 0 to 10, pain intensity at its peak ranged from 1 to 10 (mean, 6.0 ± 2.6). Peak pain intensity was most commonly rated at level 6 (of 10). The intensity of pain at its peak did not correlate with the blood COHb level ($r = -0.1558$; $P = .1337$) (Figure).

Pain improved in conjunction with normobaric oxygen administration prior to HBO_2 treatment in 72%, resolving entirely in 21%. Of those with residual headache at the time of HBO_2 therapy, pain improved in 97%, and resolved entirely in 44%.

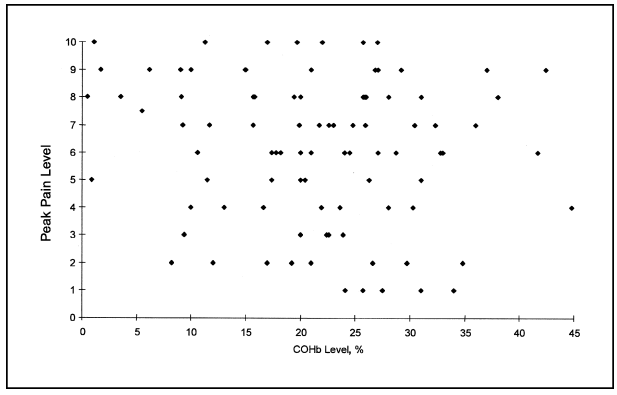
Other symptoms present in patients with CO-induced headache are detailed in Table 2. The most commonly associated symptoms were dizziness, lightheadedness, weakness, and nausea.

COMMENTS

Headache is the most common symptom among individuals with symptomatic CO exposure, possibly because it is one of the earliest manifestations of the

Table 1.—Sources of Carbon Monoxide Exposure

Source	No. of Males	No. of Females	Total
Motor vehicles	23	8	31
Forklifts	22	1	23
Furnaces	3	8	11
Space heaters	5	1	6
Boats	1	5	6
Indoor use of charcoal	1	4	5
Miscellaneous gas engines	2	0	2
Fire	1	1	2
Gasoline-powered electrical generator	1	0	1
Other	7	6	13
Total	66	34	100



Relationship of blood carboxyhemoglobin level to peak head pain intensity.

Table 2.—Other Symptoms Reported in 100 Patients With Carbon Monoxide-Induced Headache

Symptom	No. of Patients
Dizziness	81
Lightheadedness	77
Weakness	72
Nausea	66
Lethargy	63
Confusion	48
Photophobia	33
Blurred vision	32
Vomiting	23
Phonophobia	22
Diplopia	5

syndrome. In a series of 160 persons ill from simultaneous exposure to CO from a malfunctioning furnace, headache was present in 90%.[6] Headache was also the most common symptom among 79 patients treated with HBO_2 due to severe CO poisoning from exposure to indoor burning of charcoal briquets[7] and among 100 consecutive adult cases of CO poisoning from mixed sources treated at one hospital in Australia.[8] Similar findings have been described in pediatric populations; headache was the most common symptom in a group of children with blood COHb levels greater than 10% in one series[9] and present in 93% of children with symptomatic CO exposure in another.[10]

Carbon monoxide-induced headache was included in the classification of headache published in 1988 by the International Headache Society (headache category 8.1.3),[11] but diagnostic criteria were not established.[11] It frequently has been written that CO-induced headache manifests as forehead tightness with blood COHb levels between 10% to 20%, becoming a throbbing pain in the temples as the COHb level rises to the range of 20% to 30%.[12-14] Although origin of this description can be traced to a 1923 report on CO poisoning from the US Bureau of Mines,[15] no data were provided in that publication to support the proclaimed correlation between the blood COHb level and the nature of the associated headache.

Headache due to CO exposure is most often described as "throbbing."[14,16,17] Interestingly, only 41% of the patients in the current series noted throbbing pain at any time during the course of the headache. As noted above, CO-induced headache traditionally has been described as starting in the forehead and progressing to a bitemporal location. In the present study, frontal was the most common location identified, present in 66% of patients. Both frontal and bitemporal locations were noted by only one third of patients, while only a small minority described bitemporal without frontal pain. In the present series, no typical location or pattern of CO-induced headache was apparent.

It has been estimated that 3% to 5% of patients seen in urban emergency departments with wintertime headache or dizziness have occult CO poisoning.[18,19] As such, the use of headache as a screening tool for CO poisoning in emergency departments has been proposed[18] and tested.[19] The use of headache as an identifying symptom among workers with unexplained headache in specific industrial environments has also been suggested.[20] As headache is certainly common among CO-exposed individuals, these are both reasonable considerations. Unfortunately, the present study demonstrates that CO-induced headache is highly variable in its symptomatology. Because of this, it is not possible to propose a typical description of headache that would allow one to exclude individuals experiencing headache in those settings from further evaluation. If headache is present and CO exposure is a reasonable possibility, blood COHb measurement should be considered.

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