Acute Carbon Monoxide Poisoning: Experience of Eight Years

Halise Akça[1], Nilden Tuygun[1], Emine Polat[2], Can Demir Karacan[1]

[1]Clinic of Pediatric Emergency, Dr. Sami Ulus Maternity, Children's Health and Diseases Training and Research Hospital, Ankara, Turkey
[2]Clinic of Pediatrics, Dr. Sami Ulus Maternity, Children's Health and Diseases Training and Research Hospital, Ankara, Turkey

Abstract

Aim: This study aims to evaluate the general characteristics of patients with acute carbon monoxide poisoning in childhood.

Materials and Methods: Medical reports of 240 patients with carbon monoxide poisoning who were admitted to the Pediatric Emergency Department between January 2005 and 2013 (mean age, 82.5±56 months; 115 boys, 125 girls) were retrospectively analyzed. Demographic features of patients, sources of exposure, clinical signs, blood carboxyhemoglobin levels, laboratory findings, and treatment methods were evaluated.

Results: Approximately half of the poisonings were observed in winter (December and January). Among the sources of exposure to carbon monoxide gas, the stove was found to be the most common source. Majority of patients suffered from fainting and headaches, whereas 16% of patients had no active complaints. The average of the initial blood carboxyhemoglobin level was 14.9±10%, and 14.2% of patients had a level of >25%. All patients underwent normobaric oxygen therapy, and 21.7% of them underwent hyperbaric oxygen treatment.

Conclusion: Unexpected deaths because of carbon monoxide poisoning gradually increase, particularly in winter. Carbon monoxide poisoning should be considered in the patients presenting with suspicious findings, particularly in winter. Blood carboxyhemoglobin levels are useful for diagnosis.
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Keywords: Carbon monoxide poisoning, child, emergency department

Introduction

Carbon monoxide (CO), a colorless, odorless, tasteless, and non-irritating gas, is released as a result of incomplete combustion of carbon-containing materials (1). CO poisoning, its frequency particularly increasing in winter, is an important public health problem in our country and worldwide. CO poisoning is generally among the first three causes of childhood poisoning. It has been reported as the most common fatal poisoning cause in our country (2). In CO poisoning, there is a high risk of toxic effect to hypoxia-sensitive tissues, such as the brain and heart. Early symptoms of CO poisoning are non-specific, such as headache, nausea, and weakness. Therefore, CO poisoning is often confused with common cold. CO poisoning is not generally detected at an early stage. Prolonged exposure to CO may lead to brain damage and death (3, 4). In this study, we evaluated patients who were admitted to the Pediatric Emergency Department with CO poisoning and presented our 8 years of experience.

Materials and Methods

Two hundred and forty patients admitted to the Dr. Sami Ulus Maternity, Children's Health and Diseases Training and Research Hospital, Department of Pediatric Emergency Medicine with CO poisoning between January 2005 and 2013 were retrospectively analyzed. Patients who were diagnosed with CO poisoning with only a medical history of high carboxyhemoglobin (COHb) levels (over 5%) were included in this study. Patients excluded from this study were those who were diagnosed other diseases at follow-up. Demographic features of patients, sources of exposure, clinical signs, blood COHb levels, laboratory findings, and treatment methods were evaluated.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences 15.0 statistical package program (SPSS Inc., Chicago, IL, USA). Descriptive statistics were given as mean and standard deviation or frequency.

Correspondence to: Halise Akça e-mail: haliseakca@gmail.com

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Results

Two hundred and forty patients were diagnosed with CO poisoning, of which 52% were female, 48% were male, and the mean age was 82.5±56 months. Approximately half of the poisonings (47%) were observed in December and January. The most common sources of exposure to CO were stove (70.8%), water heaters (10.8%), natural gas (14.2%), and fire (4.2%). CO poisoning had acutely and accidentally occurred in all cases. Symptoms of patients were syncope (29.1%), headache (20.8%), nausea–vomiting (19.6%), changes in consciousness (8.8%), and weakness (5.4%). Some patients (16.3%) had no symptoms. Asymptomatic patients were diagnosed by testing for high blood COHb levels and detecting symptomatic family members sharing the same environment. Approximately 50% of the patients had neurological symptoms. Details of the symptoms are presented in Table 1. The average initial blood COHb level was 14.9±10%, and 14.2% of patients had levels of >25% (Table 2). In all patients, blood gases, complete blood count, and blood biochemistry values were within normal limits (Table 3). All patients had undergone normobaric oxygen therapy. Fifty-two patients (21.7%), who had high blood COHb levels (>25%) and cardiovascular or neurological symptoms, such as altered mental status, seizures, or fainting, received hyperbaric oxygen therapy. A 5-year-old patient died within 24 h after a fire. The cause of death for the patient was not exactly determined because autopsy was not performed. Patients who received hyperbaric oxygen therapy completely recovered.

Discussion

Carbon monoxide poisoning occurs because of CO inhalation. CO is a non-irritant; thus, it is difficult to be noticed by people. Values above 100 ppm are considered to be hazardous to human health (5). Blood COHb levels depend on the CO gas concentration in the environment, exposure time, alveolar ventilation, blood volume, and metabolic activity (6). Hemoglobin binds with CO 200–250 times more readily than with oxygen. CO can displace oxygen and lead to the shifting of the oxygen dissociation curve to the left. Hypoxia, ischemia, and tissue death occur because of decreasing blood oxygen content and oxygen delivery to the tissue (7). Moreover, CO has negative effects on myoglobin and mitochondrial cytochrome oxidase (8).

Carbon monoxide poisoning generally acutely and accidentally appears in childhood. It occurs because of various reasons related to the ethnic and sociocultural factors and residential area. In our country, coal stove or natural gas-fired tube boilers and water heaters that are used in bathrooms are reported as the main reasons of accidental CO poisoning (9, 10). In our study, CO poisoning acutely and accidently occurred in all patients, and stoves are the most common source of exposure to CO, which is similar to studies in the literature (11).

Many different and non-specific signs and symptoms develop in CO poisoning. Organs that require high oxygen levels, such as the brain and heart, are susceptible to CO poisoning (12). Headache, dizziness, confusion, and flu-like symptoms are observed in low level exposure, whereas severe exposure has toxic effects on the central nervous system and heart. Neurological sequels can occur even years after acute exposure (5). While many studies declare nausea and vomiting as the most common complaints, the most common complaint was syncope in our study and patients also developed other non-specific symptoms.

The diagnosis of CO poisoning is confirmed with high COHb level. The half-life of COHb is 2-3 h. Thus, higher levels at the time of admission were considered significant, but late presentation of patients with low COHb levels did not exclude the diagnosis. Therefore, in the presence of history and clinical findings regarding CO poisoning, it does not matter whether COHb levels are high or low. All patients should be managed as CO poisoning. The half-life of COHb in the blood is short. Therefore, COHb levels were not controlled in patients. Laboratory tests are not helpful in predicting diagnosis, clinical outcome, and late complications (13, 14). In initial and follow-up, all routine laboratory tests of our patients were within normal limits. Therefore, it did not provide guidance on the follow-up and treatment process.

Table 1. Patients' signs and symptoms

Signs and symptoms	Number	(%)
Fainting	70	29.1
Headache	50	20.8
Nausea–vomiting	47	19.6
Altered mental status	21	8.8
Weakness	13	5.4
Asymptomatic	39	16.3

Table 2. Blood carboxyhemoglobin levels

	All patients (240)	Patients who received only normobaric oxygen therapy (188)	Patients who received hyperbaric oxygen therapy (52)
Carboxyhemoglobin (%)	14.9±10	12.6±9.2	18.8±11.7

Table 3. Laboratory test results

Tests	Mean±SD
Hb (g/dL)	12.7±1.4
WBC ($\times 10^9$/L)	10.8±4.2
Plt ($\times 10^9$/L)	331.4±98.8
Blood glucose (mg/dL)	109.6±26.2
Na (mEq/L)	137.1±2.4
K (mEq/L)	4.1±0.5
AST (U/L)	32.4±17.4
ALT (U/L)	17.9±11.3
BUN (mg/dL)	11.1±3.5
Cre (mg/dL)	0.4±0.2
pH	7.38±0.07
pO_2	89.8±66.1
pCO_2	35.0±8.5

SD: standard deviation; Hb: hemoglobin; WBC: white blood cell; Plt: platelet; Na: sodium; K: potassium; AST: aspartate aminotransferase; ALT: alanine aminotransferase; BUN: blood urea nitrogen; Cre: creatinine; pO_2: partial oxygen pressure; pCO_2: partial carbon dioxide pressure

Airway, breathing, and circulation must be first controlled in all patients who were admitted to the Pediatric Emergency Department with severe clinical findings and suspected poisoning. Normobaric oxygen therapy with non-breathing mask should be immediately initiated to patients. Hyperbaric oxygen therapy is planned according to the symptoms or blood COHb levels of the patients. If the patient is a non-responder, second and third hyperbaric oxygen therapy sessions are necessary. Treatment should be continued until the patients become asymptomatic and COHb levels fall below 5%. Standard oxygen therapy enables CO separation from hemoglobin (15, 16). Some studies suggest hyperbaric oxygen therapy when COHb levels are >40%. However, 25% or more COHb levels are generally preferred in therapy (6). Our patients who had 25% and higher COHb levels underwent hyperbaric oxygen therapy.

Most patients with CO poisoning had mild clinical signs and improved with normobaric oxygen therapy. Only a 5-year-old patient died after exposure to intensive CO after a fire. It is reported that patients are more sensitive to CO exposure in childhood (12). However, considering that deaths are generally at the scene, only mild to moderate cases of CO poisoning can reach the hospital.

Study limitations

In some cases, incomplete files or incorrect diagnosis codes were noticed. Therefore, we could not evaluate all the patients with CO poisoning.

Conclusion

Unexpected deaths due to CO poisoning gradually increase, particularly in winter. In our study, we diagnosed patients with CO poisoning on the basis of clinical findings and/or COHb levels, which is similar to the literature. The other laboratory examinations may not be useful on admission and in the clinical course of the process. CO poisoning should be considered in patients presenting with suspicious findings (fainting, headache, and nausea–vomiting), particularly in winter. Blood COHb levels are useful for diagnosis.

Ethics Committee Approval: This study is retrospective so, ethical approval is not necessary.

Informed Consent: Study data files scanned retrospectively, patient consent could not received.

Peer-review: Externally peer-reviewed.

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