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Demographic and Clinical Characteristics of Carbon Monoxide Poisoning: Data Between 2014 and 2018 in Erzurum

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Abstract

Objective: This report describes the epidemiology and analyses the clinic status, treatment, morbidity of carbonmonoxide intoxication cases in a university hospital. Furthermore, the results of blood tests of cases mentioned in this study were evaluated in detail.

Materials and Methods: In this retrospective study, patients diagnosed with toxic effects of carbonmonoxide were evaluated between years 2014-2018. The data extracted from the patients' files included seasonal variation, age, gender, underlying comorbidities, smoking and alcohol abuse history, vital parameters, clinical manifestations and source of poisoning, laboratory and imaging records, treatment and outcome.

Results: A total of 653 patients were included in the study. Admissions during the winter was found to be higher that other seasons with a significant difference ($p < 0.001$). The most frequent symptoms were headache (%62.3), nausea (%42.3), sudden loss of consciousness (%15.9) and dizziness (%12.1). Lactate levels were positively correlated with carboxyhemoglobin values ($r= 0.257$, $p < 0.001$) and troponin I levels ($r=0.267$, $p<0.001$). A blood lactate concentration >2 mmol/L was associated with %40 sensitivity and %75 specificity for predicting hyperbaric oxygen therapy requirement. Hyperbaric oxygen therapy group had a longer hospitalization period, which was statistically significant (mean difference -0.98; 95% CI = -1.38, -0.57) ($p <0.001$).

Conclusion: Emergency medicine clinics are fighting almost alone in carbonmonoxide poisoning cases. Now it is required to develop new perspectives in these cases. Lactate can be used safely in the management of patients as an option.

Keywords: carbonmonoxide, intoxication, lactate, poisoning

Özet

Amaç: Bu çalışma bir üniversite hastanesine, karbonmonoksit zehirlenmesi tanısı ile başvuran vakalarının klinik durumunu, tedavisini ve morbiditesini analiz etmeyi ve epidemiyolojik verilerini tanımlamayı amaçlamaktadır. Ek olarak, bu çalışmada belirtilen vakaların kan testlerinin sonuçları ayrıntılı olarak değerlendirilmiştir.

Gereç ve Yöntem: Bu retrospektif çalışmada, 2014-2018 yılları arasında karbonmonoksitin toksik etkileri tanısı alan hastalar değerlendirildi. Hastaların dosyalarından elde edilen veriler arasında yaş, cinsiyet, altta yatan komorbiditeler, sigara kullanımı, alkol kötüye kullanımı öyküsü, vital bulgular, klinik belirtiler, laboratuvar ve görüntüleme sonuçları, tedavi, sonuç, zehirlenme kaynağı ve mevsimsel değişken yer alıyordu.

Bulgular: Çalışmaya toplam 653 hasta dahil edildi. Kış mevsiminde yapılan başvuruların diğer mevsimlere anlamlı olarak daha yüksek olduğu tespit edildi ($p <0.001$). En sık görülen semptomlar baş ağrısı (% 62.3), bulantı (% 42.3), ani bilinç kaybı (% 15.9) ve baş dönmesi (% 12.1) idi. Laktat seviyeleri ile karboksihemoglobin değerleri ($r = 0.257$, $p <0.001$) ve troponin I düzeyleri ($r = 0.267$, $p <0.001$) arasında pozitif korelasyon gösterildi. > 2 mmol / L'lik bir kan laktat konsantrasyonu, hiperbarik oksijen tedavisi ihtiyacını öngörmek için% 40 hassasiyet ve% 75 özgüllük ile ilişkilendirildi. Hiperbarik oksijen tedavisi grubu daha uzun bir hastanede kalış süresine sahipti, bu durum istatistiksel olarak anlamlıydı (ortalama fark -0.98;% 95 CI = -1.38, -0.57) ($p <0.001$).

Sonuç: Acil tıp klinikleri karbonmonoksit zehirlenmesi vakalarında neredeyse tek başına savaşmaktadır. Bu nedenle yeni bakış açılarına ihtiyaç vardır. Laktat, hastaların yönetiminde bir seçenek olarak güvenle kullanılabilir.

Anahtar kelimeler: karbonmonoksit, intoksikasyon, laktat, zehirlenme

Introduction

Carbon monoxide (CO) toxicity is common in Turkey, especially in eastern cities. Carbon monoxide is an odorless gas which is formed from insufficient burning of organic substances. It is usually emitted through domestic or industrial media that require fuel-burning such as water and gas heaters, cooking equipment, motor vehicles, gas-powered furnaces, portable generators and processes like charcoal burning[1]. In our country, especially in winter months, CO intoxication

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cases increase with the use of chimney stoves, barbecues and water heaters in small areas with insufficient ventilation[2]. Considering the developed countries, suicide attempts take the first place in the list of causes of CO intoxication.

The symptoms of CO intoxication are non-specific. Patients often do not understand that they are exposed to CO. Common symptoms of exposure include headache, dizziness, fatigue, nausea, vomiting, and chest pain[3]. Mild exposure to CO causes headache, myalgia or dizziness, whereas severe exposure will result in confusion, loss of consciousness or death.

Carbon monoxide forms carboxyhemoglobin (COHb), which has an affinity for hemoglobin 250 times greater than its affinity for oxygen; therefore, even low amounts of inhaled CO can cause severe tissue hypoxia[4]. The main reason for the lethal mechanism of intoxication is tissue hypoxia. Survivors of severe CO intoxication may experience cardiac damage and acute neurological pathologies depending on the duration of exposure.

The most important clue to determine the severity of CO intoxication is the clinical condition of the patient. However, if the patient has no evidence of CO exposure in his/her history, this will be inconclusive. Therefore, the final diagnosis requires clinical acumen and a high index of suspicion coupled with epidemiological data, thoughtful clinical examination as well as patient COHb levels, which remains the mainstay for the diagnosis[5]. The main reason why COHb levels alone are insufficient in diagnosis is that the patients' clinical situation at admission is not always consistent with COHb levels. This situation can be explained by the contact with normal atmospheric oxygen after leaving the environment of intoxication and the elimination of COHb during the time of arrival to the hospital[6]. Therefore, the addition of different laboratory parameters (such as pH, lactate and troponin) to the process of evaluating the severity of intoxications is a guide for clinicians in emergency medicine practice.

Treatment of CO intoxication begins with inhalation of a high concentration oxygen and aggressive supportive care. Hyperbaric oxygen therapy (HBOT) accelerates the dissociation of CO from hemoglobin and may prevent delayed neurologic sequelae[7,8].

In our country, the most important clinic in the diagnosis and treatment of cases related to CO intoxication is the emergency medicine clinic. The articles, in which the features of CO intoxication cases and their clinical courses after the admission to the emergency clinic are compiled, constitute easily accessible sources for every doctor. This report describes the epidemiology and analyses the clinic status, treatment, morbidity of CO intoxication cases in a university hospital in Erzurum from 2014 to 2018. Furthermore, the results of blood tests of CO intoxication cases mentioned in this study were evaluated in detail. Based on this data, the usability of blood lactate levels in the emergency services for the diagnosis and treatment of CO intoxication was investigated.

Materials and Methods

The population of this retrospective study included all adults and children who were admitted to the Department of Emergency Medicine of Erzurum Atatürk University with suspected CO intoxication during the years 2014–2018. The study was approved by the Ethics Committee of the same institution. The patients who were diagnosed with 'Toxic effect of carbon monoxide (T58)' were identified through the computerized medical and laboratory records of the hospital. The data extracted from the patients' files included seasonal variation, age, gender, underlying comorbidities, smoking and alcohol abuse history, vital parameters, clinical manifestations and source of intoxication, laboratory and imaging records, treatment and outcome. The application seasons of patients were defined as spring (March, April, and May), summer (June, July, and August), autumn (September, October, and November), and winter (December, January, and February). On admission to the emergency department, blood samples were obtained from patients; blood gas analysis and white blood cell (WBC) and hemoglobin (Hg) counts were done in heparinized tubes, and troponin I, creatinine, creatine kinase (CK) and creatine kinase-MB (CK-MB) levels were measured in anticoagulant tubes. From blood gas analysis, values for pH, bicarbonate, COHb and lactate were evaluated. Mortality was evaluated as mortality during hospitalization. According to COHb level, the patients with 0% -25% COHb were classified as 'mild exposure' (Group 1), 25%-40% were classified as 'moderate exposure' (Group 2), and 40% and above were classified as 'severe exposure' (Group 3).

Statistical analysis

In the statistical evaluation of the data, IBM Statistics 20.0 (SPSS) statistical package program was used. The baseline patient characteristics are presented as frequencies for categorical variables and as medians and interquartile ranges for continuous variables. For continuous variables, Student's t-test or the Mann-Whitney test was used for two group comparisons according to normality, which was tested using the Shapiro-Wilk test. For categorical variables, the Chi-Square test was used. The Spearman correlation analysis was used to evaluate the relationship between laboratory parameters. Receptor operating characteristic (ROC) analysis was used to determine the diagnostic value and cut-off value of lactate levels in predicting HBO treatment status of poisoned patients. In the obtained ROC curve, the Area under the curve (AUC) value is close to 1, indicating that the value of the test is high. Results were evaluated at 95% confidence interval and $p < 0.05$ at significance level.

Results

A total of 653 patients were included in the study. %56.2 of the cases is female and %43.8 of the cases is male. In addition to the fact that the average age of the people who were the subject of the cases was 37.2 ±0.7, the adults (18 years and older) constituted %92.6, while the children and adolescents constituted %7.4. The basic data of the cases are summarized in Table 1. The time interval between exposure and admission to the hospital was calculated to be 5.7±0.3 hours in average. It was found out that the patients in the 337 of the cases (%51.6) had applied to the hospital during the winter months and 159 (%24.3) in spring (Fig 1). The number of cases admitted during the winter was found to be higher than the number of those admitted in the other season with a significant difference ($p < 0.001$). The CO sources that caused intoxication are listed in Table 2. The rate of most frequent comorbid conditions in the patients who were included in the study were hypertension with % 6.3, chronic obstructive pulmonary disease with %2.1, coronary artery disease with %1.4 and diabetes with %1.4. A history of smoking and alcohol abuse was present in the %18.4 and %0.9 of the patients respectively. The most frequent symptoms were headache (%62.3), nausea (%42.3), sudden loss of consciousness (%15.9) and dizziness (%12.1). In 16 of the patients, there was altered level of consciousness. In terms of suspected cardiac complications, four of them reported palpitation, while eight reported chest pain.

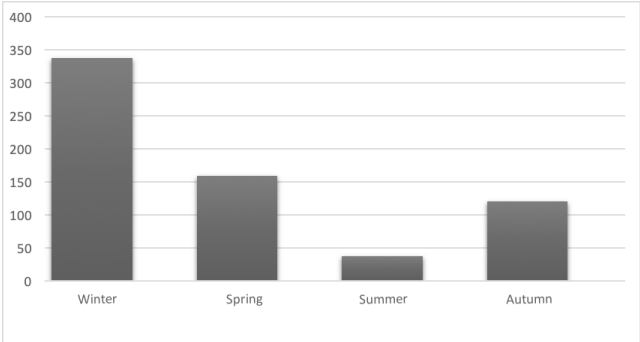

Figure 1. Number of patients approaching emergency department in all years according to seasons.

During the laboratory analyses, the average COHb level was calculated to be 11.5±0.4. Among the patients, 563 of them had Group 1, 81 of them had Group 2 and 8 of them had Group 3 of COHb level. No significant difference was found between measured COHb levels and demographic characteristics of the patients like age and gender ($p>0.05$). This is the same for the other evaluated laboratory parameters (WBC, Hg, troponin I, creatinine, CK; CK-MB and lactate). The difference between the lactate levels of Group 1 and Group 2 was statistically significant (mean difference -1.02; 95% CI = -1.43, -0.61) ($p <0.001$). Moreover, lactate levels were positively correlated with COHb values ($r= 0.257$, $p < 0.001$) and troponin I levels ($r=0.267$, $p<0.001$).

It was found out that oxygenotherapy had been administered in all the cases, while HBOT had been provided in 352 of them (%53.9). The average COHb level in those ad-

Table 1. Baseline characteristics of the study population.

Variables	Mean + SD or median (IQR) of All Patients
Age	37.2 ±0.7
Systolic blood pressure (mm Hg)	125 (115-136)
Diastolic blood pressure (mm Hg)	75 (67-82)
Pulse (beats/min)	86.6 ±0.6
Respiratory rate (breaths/min)	16 (15-18)
Oxygen saturation (%)	96 (94-98)
Temperature (°C)	36.5 (36.2-36.7)
COHb (%)	11.5 ±0.4
Hb (g/dL)	14.2 ±0.8
WBC (count, /mm³)	9.4 (7.7-11.8)
Creatinine (mg/dL)	0.7 (0.6-0.9)
CK (IU/L)	116 (79-171)
CK-MB (IU/L)	21 (16-28)
Troponin I (ng/mL)	0.010 (0.00-0.016)
Lactate (mmol/L)	1.6 (1.2-2.3)

Abbreviations: COHb, carboxyhemoglobin; Hb, hemoglobin; WBC, white blood cell; CK, Creatine kinase

ministered HBOT was 13.9±0.6 and the lactate level was 2.1±0.1. We developed a ROC curve to investigate the value of lactate levels in predicting HBO treatment status of poisoned patients. AUC for lactate was calculated as 0.577 (95% confidence interval, 0.53, 0.62; p <0.001). A blood lactate concentration > 2 mmol/L was associated with %40 sensitivity and %75 specificity for predicting HBOT requirement. In the follow-up of the patients, those administered HBOT had a longer hospitalization period compared to the others, which was statistically significant (mean difference -0.98; 95% CI = -1.38, -0.57) (p <0.001). Distribution of clinics where patients were admitted and referred are demonstrated in Figure 2.

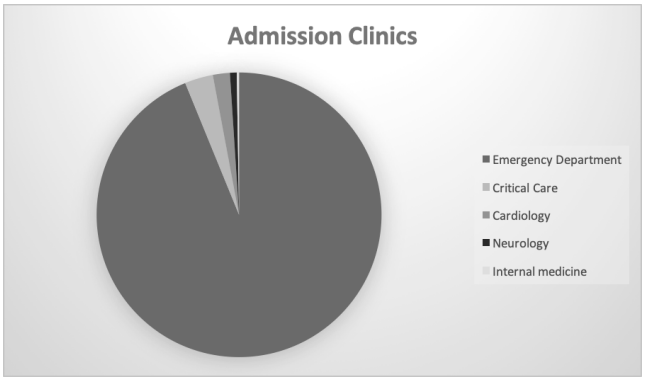

Figure 2. Clinics where patients were admitted and referred.

Discussion

As there are lots of various systems that are used in daily life and emit CO, the population of intoxication is extremely large. The different age groups may be affected negatively from CO. However, the average age calculated in our study indicates that the frequency of the mid-thirties is higher. This is compatible with the literature[9].

Being in an indoor environment not ventilated enough during the fuel consumption for heating is the most common reason for intoxication[10]. Therefore, the number of cases encountered increases during the winter months. We found that during the winter, there was a higher percentage of CO intoxication than during the other seasons. Furthermore, we found that intoxication were most likely to be caused by the use of warming stoves and water heaters in accordance with similar literature[11]. The clinical findings of CO intoxication are highly variable. Headache, as expressed in many studies, is a common early symptom of CO intoxication[12,13]. Among the CO intoxication cases investigated in our study, the most common symptom was headache, followed by nausea and sudden loss of consciousness. The symptoms, signs, and prognosis of acute CO intoxication correlate poorly with the level of COHb measured at the time of arrival at the hospital. Although a history of CO exposure was present among all the cases in our study, the average COHb levels were found to be lower than the studies in the literature[11,14]. This situation can be related to the fact that the time interval and admission to the hospital was long in the cases of this study. The low levels of COHb themselves did not change our clinical approach towards the patient. As COHb levels alone are not conclusive enough in the diagnosis and treatment, there are some studies that examine the lactate levels in the intoxications due to these levels' relation to tissue hypoxia. The debates about the blood lactate measurements' contribution to CO intoxication are still ongoing. In our study, we found that the lactate levels of the patients correlated with COHb and troponin I levels. Besides, among the exposure groups, it was found that the lactate levels were higher in Group 2 than Group 1 with a significant difference.

The role of HBOT in the management of CO toxicity remains controversial. Clinical Policies Subcommittee of the American College of Emergency Physicians emphasizes that hyperbaric oxygen is a therapeutic option for CO poisoned patients, although its use cannot be mandated[17]. In our study, we found that approximately half of CO intoxication cases had received HBOT. This rate is higher than previous studies, and we believe that the differences in the clinical presentation of the patients may be the main cause of this[1]. In addition, we found that lactate levels were higher in HBOT group than in other cases. Increased tissue hypoxia in the patients receiving HBOT has been an indicator of the suitability of treatment choice.

In our study, there are some limitations. Only the cases whose data is complete were included in the study, making the sum of the patients few. Furthermore, the data belongs to one region and clinic. Consequently, regional differences are not included in the study. If a similar, but multicentered, study is conducted, it may represent the data of CO intoxication in our country better.

Conclusion

The main reason of CO intoxication cases in our country is the heating systems used in winter months. Raising the public awareness public about CO intoxication and seriousness and taking necessary precautions will reduce the number of

Table 2. Sources of Carbon Monoxide in Intoxicated Cases

Sources	Patients (%)
Stove	70
Water Heater	7.2
Natural Gas	4.6
Fires	3.8
Tandoor Smoke	3.7
Exhaust Fumes	2.1
Gas Cylinder	1.1
Other	0.2

cases. Emergency medicine clinics are fighting almost alone in CO intoxication cases. Now it is required to develop new perspectives in these cases. Lactate measurements can be used safely in the management of patients as an option to facilitate our diagnosis and treatment.

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