Original Article
Eurasian Journal of Toxicology

Carbon Monoxide Poisoning: Comparison of Paediatrics and Adult Patients

Özhan ORHAN[1], Ahmet YEŞİL[2]

[1]Mardin Artuklu University, Faculty of Medicine, Department of Pediatrics, Mardin, Türkiye
[2]Mardin Artuklu University, Faculty of Medicine, Department of Emergency Medicine, Mardin, Türkiye

Abstract

Background: Carbon monoxide (CO) gas is a tasteless, odorless and colorless gas and causes many poisonings every year. In this study, paediatric and adult CO poisoning cases admitted to our emergency department were reviewed retrospectively.

Materials and Methods: Paediatric and adult patients who applied to the Emergency Department of Mardin Training and Research Hospital between 01 January 2021 and 31 December 2022 due to CO poisoning due to stove usage were included in the study. Patients were compared according to age, gender, month and time of admission to the emergency department, complaints at admission, laboratory test results and discharge status.

Results: 90 patients admitted to the emergency department due to CO poisoning caused by stoves between 2021-2022 were included in the study. While the rate of female patients in the paediatric age group was 53.3%, the rate of female patients in the adult group was 48.9% (p=0.673). When compared according to the complaints of admission to the hospital, the most common complaint in the paediatric age group was nausea-vomiting with 42.2%, while the most common complaint in the adult group was shortness of breath with 26.7%. In both groups, it was determined that the most frequent application was in January with 48.9%. While 15.6% of children were hospitalized, this rate was 4.4% for adults. (p=0.065). While the carboxyhemoglobin (COHb) value at the time of first admission was 18.36±6.60 in the paediatric group, it was 22.03±10.24 in the adult group (p:0.047). In the control blood gas values taken at discharge, COHb level was 2.76±1.83 in children and 5.10±3.02 in adults (p<0.001).

Results: CO poisoning should always be considered in the differential diagnosis of patients who present to the emergency department with nonspecific symptoms during the winter months. It should not be forgotten that children are affected more and recovery is fast.

Keywords: Carbon monoxide, Emergency department, Poisoning.

Introduction

Carbon monoxide (CO) is an odourless, tasteless, colourless, non-irritating gas that is produced by the combustion of hydrocarbons and can cause death. While the concentration of CO in the atmospheric air is mostly below 0.001%, it can be higher in large cities and indoor areas. CO released as a result of poor combustion of fuels can cause poisoning and deaths at a rate of 1-31%[1]. In the United States, an average of 15,000 people a year apply to emergency department due to CO poisoning. In developing countries, including Turkey, most of the poisonings are caused by heating systems. Clinical signs and symptoms of poisoning are non-specific. That is why CO toxicity is often overlooked. Patients usually present with non-specific symptoms such as headache, malaise, and nausea. Loss of consciousness, coma and death can be seen in severe poisonings[2–4]. Suspicion and anamnesis are extremely important in the diagnosis. Diagnosis is even more difficult in the paediatric age group due to the common cold and infantile colic-like symptoms. Diagnosis is made by finding a high carboxyhaemoglobin (COHb) value in blood gas. There are methods such as elimination of exposure and oxygen support, and in severe cases hyperbaric oxygen therapy. In general, most CO poisonings are not fatal. Cases with mild symptoms and no neurological symptoms can be discharged after 4-6 hours of treatment with the recommendation of a control examination[5,6].

While the most common cause of this poisoning in developed countries is suicide, in developing countries the most common cause is heater stoves with improper or inadequate ventilation. This study aims to evaluate and compare the characteristics, clinical and laboratory findings of paediatric and adult patients who applied to the emergency department with heater stove-induced CO poisoning between 2021-2022.

Material And Method

This study is a retrospectively planned study. Ninety patients who applied to the Mardin Training and Research Hospital Emergency Department between 2021-2022 due to CO poisoning were included in the study. Non-stove CO poisonings were not included in the study. Demographic characteristics such as age and gender, admission times,

Corresponding Author: Özhan ORHAN **e-mail:** ozhan.orhan@hotmail.com.tr
Received: 13.06.2023 • **Revision**: 06.07.2023 • **Accepted:** 06.07.2023
Cite this article as: Orhan Ö, Yeşil A. Carbon Monoxide Poisoning: Comparison of Paediatrics and Adult Patients. Eurasian J Tox. 2023;5(2): 28-31

symptoms, and findings at the time of admission, and discharge status of the included cases were evaluated. In addition, examinations such as complete blood count parameters, blood gas parameters, troponin, and lactate at the time of admission were examined. The patients were divided into two groups as paediatric and adult patients. Blood gas values at the time of admission and blood gas values at discharge were evaluated according to age. The COHb value in the venous blood taken into a dry heparinised blood gas injector was studied in the blood gas device (GEM 5000 Premier).

Approval for the study was obtained from the Non-Interventional Research Ethics Committee of Mardin Artuklu University (19.04.2023-94154). The study was conducted in accordance with the Declaration of Helsinki.

Statistical analyses are made using IBM-SPSS version 24. Results were expressed as percentages for categorical variables. Continuous variables were conveniently presented as mean±standard deviation. The $\chi 2$ test was used to determine the relationship between categorical variables. Student-t test was used if continuous variables were parametrically distributed. Statistically significant difference level was determined as $p \leq 0.05$.

Results

Ninety patients admitted to the emergency department due to heater stove-induced CO poisoning between 2021-2022 were included in the study. The patients were divided into two equal groups as under 18 years old (paediatric) and over 18 years old (adult). The mean age of the paediatric patients participating in the study was 7.82±5.19, and the mean age of the adult patients was 36.44±13.16 ($p<0.001$). While the number of female patients in the paediatric age group was 24 (53.3%), the number of female patients in the adult group was 22 (48.9%) ($p=0.673$). When compared according to the complaints of admission to the hospital, the most common complaint in the paediatric age group was nausea-vomiting in 19 (42.2%) patients, while the most common complaint in the adult group was dyspnea in 12 (26.7%) patients. Other presenting complaints were headache in 10 (11.1%), dizziness in 8 (8.9%), flu-like symptoms in 6 (6.7%) and altered consciousness in 6 cases (6.7%). Fifteen (16.7%) patients were found to be asymptomatic at presentation. The most frequent hospital admissions in paediatric and adult patients were between 00.01-08:00, and their frequencies were 48.9% and 53.3%, respectively. 31 (34.4%) patients applied between 08.01-16.00, and 13 (14.4%) patients between 16.01-00.00 ($p=0.907$). When the distribution of the cases according to the months was analysed, it was found that the most common CO poisoning was observed in January with 44 (48.9%) patients in both groups. 22 patients were admitted in February, 12 patients in December, 4 patients in March, and 8 patients in April. While 7 of the paediatric patients (15.6%) were hospitalized, only 2 (4.4%) of the adult patients were hospitalized ($p=0.065$). 1 (2.2%) in the paediatric age group and 5 (11.1%) in the adult age group were referred for Hyperbaric Oxygen therapy. 83.3% (n=75) of the patients were discharged (Table 1).

Table 1: Characteristics of patients presenting with carbon monoxide poisoning.

Variables		*Children n:45*	*Adults n:45*	*Patients n:90*	*p value*
Age, mean±SD		7.82± 5.19	36.44± 13.16		<0.001
Gender, n(%)	*Female*	24(53.3)	22(48.9)	46(51.1)	0.673
Arrival complaints, n(%)	*Asymptomatic*	9(20)	6(13.3)	15(16.7)	0.109
	Nausea-vomiting	19(42.2)	11(36.7)	30(33.3)	
	Headache	3(6.7)	7(15.6)	10(11.1)	
	Dizziness	4(8.9)	4(8.9)	8(8.9)	
	Dyspnea	3(6.7)	12(26.7)	15(16.7)	
	Flu-like symptoms	4(8.9)	2(4.4)	6(6.7)	
	Altered consciousness	3(6.7)	3(6.7)	6(6.7)	
Application time, n(%)	*00.01-08.00*	22(48.9)	24(53.3)	46(51.1)	0.907
	08.01-16.00	16(35.6)	15(33.3)	31(34.4)	
	16.01-00.00	7(15.6)	6(13.3)	13(14.4)	
Application month, n(%)	*January*	22(48.9)	22(48.9)	44(48.9)	0.469
	February	9(20)	13(28.9)	22(24.4)	
	March	3(6.7)	1(2.2)	4(4.4)	
	April	3(6.7)	5(11.1)	8(8.9)	
	December	8(17.8)	4(8.9)	12(13.3)	
Discharge, n(%)	*Hospitalization*	7(15.6)	2(4.4)	9(10)	0.065
	Referred for Hyperbaric Oxygen	1(2.2)	5(11.1)	6(6.7)	
	Discharge	37(82.2)	38(84.4)	75(83.3)	

When the first admission blood values of paediatric and adult patients were compared, no significant difference was found in terms of white blood cell, haemoglobin, platelet, pH, pCO^2, lactate and troponin positivity (Table 2). While the COHb value at the time of first admission was 18.36±6.60 in the paediatric group, it was 22.03±10.24 in the adult group ($p=0.047$). In the control blood gas values taken at discharge, COHb level was 2.76±1.83 in paediatric patients and 5.10 ± 3.02 in adult patients ($p<0.001$).

No mortality was observed in the cases followed up in our hospital.

Table 2: Patients' admission and discharge blood values.

Variables	*Children n:45*	*Adults n:45*	*Patients n:90*	*p value*
First admission blood values				
White Blood Cell	11.67± 5.53	10.68± 3.38	11.18± 4.58	0.309
Hemoglobin	13.23± 5.10	13.62± 1.88	13.43± 3.83	0.633
Platelet	297.53± 72.48	284.06± 53.26	290.80± 63.60	0.318
PH	7.36±0.04	7.36±0.05	7.36±0.05	0.916
PCO²	41.05± 6.64	43.52± 5.84	42.29± 6.34	0.064
Laktate	2.66± 1.42	2.28±1.64	2.47±1.54	0.253
COHb	18.36± 6.60	22.03± 10.24	20.20± 8.77	0.047
Troponin positivity n(%)	9(20)	8(17.8)	17(18.9)	0.788
Discharge values				
PH	7.38±0.06	7.37±0.02	7.38±0.05	0.197
PCO²	40.87± 4.48	41.80± 4.97	41.33± 4.72	0.354
Laktate	1.24±0.52	1.04±0.49	1.14±0.51	0.058
COHb	2.76±1.83	5.10±3.02	3.93±2.74	<0.001

Discussion

CO poisoning is among the important health problems seen in developing countries such as our country. CO poisoning occupies an important place among the poisoning cases admitted to emergency department and affects people of all ages[7]. Studies have shown that CO poisoning is more common in females, and it is thought that this may be related to the low erythrocyte count of women[8,9]. In a study in Ankara between 2007 and 2010, 261 CO poisoning cases were evaluated in a tertiary paediatric hospital and it was found that 51.1% of these cases were girls[10]. In another study group, 38 (44.7%) of 85 patients were male, 47 (55.3%) were women[11]. In our study, the number of female patients in the paediatric age group was 53.3%, while the number of female patients in the adult group was 48.9% (p=0.673).

CO poisoning is among the poisonings that cause the most death and is difficult to diagnose because it can mimic many different clinical pictures. All forms of admission are possible, from flu-like symptoms to coma. It can also manifest itself with diarrhoea and colic in paediatric patients[12]. In studies on this subject, it has been stated that the most common causes of admission to the emergency department are headache, nausea, dizziness and altered consciousness[13,14]. In our study, when compared according to the complaints of admission to the hospital, the most common complaint in the paediatric age group was nausea-vomiting with 42.2%, while the most common complaint in the adult group was dyspnea with 26.7%. Other complaints were headache 11.1%, dizziness 8.9%, flu-like symptoms 6.7%, and altered consciousness. On the other hand, 16.7% of the patients had no complaints at the time of admission.

CO poisoning is more common in winter. The most important reason for the increase in this period is the use of stoves for heating. Cases of poisoning continue due to reasons such as unsuitability of the fuels used for heating, insufficient ventilation, lack of timely maintenance of the heater stove, and the lack of sufficient public knowledge on this matter. In our country, CO poisoning increases especially in winter months[7,10,15]. In the study of Akköse et al., the source of poisoning was stated to be heater stoves at a rate of 80% 16. In our study, all of the patients were selected from the patients who applied due to heater stove poisoning. When the distribution of cases according to months was examined, it was found that the most common CO poisoning was observed in January with 48.9% in both the paediatric and adult groups, similar to other studies.

The most frequent admission time to the hospital was between 18.00-24.00 in the study of Keleş et al., between 24.00-06.00 in the study of Besli et al., and between 16.00-24.00 in the study of Uysalol et al.[17–19]. In our study, the most frequent hospital admissions in paediatric and adult patients were between 00.01-08.00 hours, and their frequencies were 48.9% and 53.3%, respectively. 34.4% of the patients applied between 08.01-16.00 and 14.4% between 16.01-00.00 (p=0.907).

Children are more affected by CO poisoning due to their high basal metabolic rate and tissue oxygen demand. Therefore, it is expected that the symptoms of poisoning will appear early. However, since the ventilation number per minute per body mass unit is high, there is a faster recovery and the need for intensive care is lower[20,21]. In a study by Kandiş et al., in which CO poisoning was evaluated in patients over the age of 16, it was observed that 2.7% of the patients were hospitalised in the ward and 2.3% in the intensive care unit[22]. In another study, it was observed that 12.2% of those diagnosed with CO poisoning in the paediatric emergency department were hospitalised in the ward and 0.4% in the intensive care unit[10]. In our study, 15.6% of paediatric patients were hospitalised, while this rate was 4.4% in adult patients (p=0.065). While the COHb value at the time of first admission was 18.36±6.60 in the paediatric group, it was 22.03±10.24 in the adult group (p=0.047). In our study, although the COHb level was lower in children, the rate of being affected and hospitalised was higher. In the control blood gas values taken at discharge, COHb level was 2.76±1.83 in paediatric patients and 5.10±3.02 in adult patients (p<0.001). In our study, control COHb levels taken

at discharge were found to be lower in paediatric group than in the adult group.

Deaths due to carbon monoxide poisoning have been reported. In our country , the number of deaths due to CO poisoning in 2010 was approximately 5 people per ten million[15]. Although the number of deaths in our country is low compared to the number of patients, in our study, there were no deaths due to CO poisoning.

Being a retrospective study and including data from a single center, are the limitations of the study. There are very few studies comparing paediatric and adult patients in terms of CO poisoning. Epidemiological studies with more extensive data on this subject should be conducted.

Conclusion

CO poisoning from heater stoves is an important health problem in developing countries such as Turkey. The incidence of CO poisoning can be reduced by public education on the subject. CO poisoning should always be considered in the differential diagnosis, particularly in patients who apply to the emergency department with non-specific symptoms during the winter months. It should not be forgotten that children are affected more, yet their recovery is fast.

References

1. Raub JA, Mathieu-Nolf M, Hampson NB, Thom SR. Carbon monoxide poisoning — a public health perspective. *Toxicology*. 2000;145(1):1-14. doi:10.1016/S0300-483X(99)00217-6
2. The Importance of Hyperbaric Oxygen Therapy In The Management of Carbon Monoxide Poisoning Is Neglected. doi:10.1007/s12012-019-09560-7
3. Harper A, Croft-Baker J. Carbon monoxide poisoning: undetected by both patients and their doctors. *Br Geriatr Soc*. 2004;33(2):105-109. doi:10.1093/ageing/afh038
4. Kao LW, Nañagas KA. Carbon monoxide poisoning. *Emerg Med Clin North Am*. 2004;22(4):985-1018. doi:10.1016/J.EMC.2004.05.003
5. İncekaya Y, Feyizi H, Bayraktar S, et al. Cabon Monoxide Poisoning And Hyperbaric Oxygen Therapy. *Med J Okmeydani Train Res Hosp*. 2017;33(2):114-118. doi:10.5222/OTD.2017.1106
6. Juurlink DN, Buckley N, Stanbrook MB, Isbister G, Bennett MH, McGuigan M. Hyperbaric oxygen for carbon monoxide poisoning. Juurlink DN, ed. *Cochrane Database Syst Rev*. 2005;(1). doi:10.1002/14651858.CD002041.PUB2
7. İŞLER Y. Karbonmonoksit zehirlenmesi. *Eurasian J Toxicol*. 2022;11(3):54-60. doi:10.51262/ejtox.1101903
8. Cho CH, Chiu NC, Ho CS, Peng CC. Carbon Monoxide Poisoning in Children. *Pediatr Neonatol*. 2008;49(4):121-125. doi:10.1016/S1875-9572(08)60026-1
9. Guzman JA. Carbon monoxide poisoning. *Crit Care Clin*. 2012;28(4):537-548. doi:10.1016/J.CCC.2012.07.007
10. Kurt F, Bektaş Ö, Kalkan G, Öncel MY, Yakut HI, Kocabaş CN. Does age affect presenting symptoms in children with carbon monoxide poisoning? *Pediatr Emerg Care*. 2013;29(8):916-921. doi:10.1097/PEC.0B013E31829EC22B
11. Delice O, Daş M, Çelik K, Kavaklı Ş, Neşelioğlu H, Hatıl I. Evaluation of Plasma Total Thiol Levels in Patients with Carbon Monoxide Poisoning in the Emergency Department. *Eurasian J Tox*. 2023;5(1):1-4. Accessed July 6, 2023. https://dergipark.org.tr/ejtox
12. Kumarihamy P, Kularatne SAM, Pathirage M, Gunaratne WMSN, Waduge R. A case of delayed neurological manifestation following carbon monoxide poisoning in Sri Lanka: epidemiology of exposure and literature review. *BMC Pharmacol Toxicol*. 2019;20(1):1-8. doi:10.1186/S40360-019-0295-9/FIGURES/4
13. Altintop I, Akcin ME, Tatli M, Ilbasmis MS. Factors that influence the decision for hyperbaric oxygen therapy (HBOT) in cases of carbon monoxide poisoning: a retrospective study. *Ann Burns Fire Disasters*. 2018;31(3):168. Accessed May 6, 2023. /pmc/articles/PMC6367868/
14. Klein JG, Alter SM, Paley RJ, et al. Carbon monoxide poisoning at a Florida Hospital following Hurricane Irma. *Am J Emerg Med*. 2019;37(9):1800-1801. doi:10.1016/J.AJEM.2019.03.009
15. Metin S, Yildiz Ş, Çakmak T, Demirbaş Ş. Frequency of carbon monoxide poisoning in Turkey in 2010. *TAF Prev Med Bull*. 2011;10(5):587-592. doi:10.5455/PMB.20110417125648
16. Akköse Ş, Türkmen N, Bulut M, Akgöz S, Işcimen R, Eren B. An analysis of carbon monoxide poisoning cases in Bursa, Turkey. *East Mediterr Heal J*. 2010;16(1):101-106. doi:10.26719/2010.16.1.101
17. Makalesi A, Besli GE, Ergüven M, Karadoğan M, Yılmaz Ö. Çocuklarda Karbon Monoksit Zehirlenmesi Carbon Monoxide Poisoning in Children. doi:10.4170/JAEM.2009.19480
18. Uysalol M, Uysalol EP, Saraçoğlu GV, Kayaoğlu S. Çocuk Acil Servise Karbon Monoksit Entoksikasyonu ile Başvuran Çocuk Hastaların Geriye Dönük Analizi. *Balkan Med J*. 2011;2011(3):237-243. doi:10.5174/TUTFD.2010.03766.1
19. Keleş A, Demircan A, Kurtoğlu G. Carbon monoxide poisoning: How many patients do we miss? *Eur J Emerg Med*. 2008;15(3):154-157. doi:10.1097/MEJ.0B013E3282EFD519
20. Iqbal S, Clower JH, Boehmer TK, Yip FY, Garbe P. Carbon Monoxide-Related Hospitalizations in the U.S.: Evaluation of a Web-Based Query System for Public Health Surveillance. *http://dx.doi.org/101177/003335491012500311*. 2010;125(3):423-432. doi:10.1177/003335491012500311
21. Weaver LK. Carbon Monoxide Poisoning. *https://doi.org/101056/NEJMcp0808891*. 2009;360(12):1217-1225. doi:10.1056/NEJMCP0808891
22. Kandiş H, Katirci Y, Karapolat BS. Karbonmonoksit Zehirlenmesi. *Düzce Üniversitesi Tıp Fakültesi Derg*. 2009;11(3):54-60.