CASE REPORT

Non-Invasive CPAP Ventilation in Acute Carbon Monoxide Poisoning

Hasan Idil, MD; Orkun Unek, MD

Attending Physician of Emergency Medicine, University of Health Sciences, Tepecik Training and Research Hospital, Izmir, Turkey

Correspondence:
Hasan Idil, MD
University of Health Sciences
Tepecik Training and Research Hospital
Department of Emergency Medicine
Gaziler Caddesi, Yenisehir, 35120, Izmir, Turkey
E-mail: hsnidil@gmail.com

Conflicts of interest/funding: The authors declare that they have no conflict of interest. This study has received no financial support.

Keywords: CO poisoning; CPAP; oxygen therapy

Abbreviations:
CO: carbon monoxide
COHb: carboxyhemoglobin
CPAP: continuous positive airway pressure

Received: December 11, 2018
Revised: February 28, 2019
Accepted: March 16, 2019

doi:10.1017/S1049023X19004485

Abstract

Oxygen is the main treatment of carbon monoxide (CO) poisoning. In two simultaneous cases, the efficacy of conventional and continuous positive airway pressure (CPAP)-administered oxygen therapy was compared. A 63-year-old man and his 58-year-old wife were brought to the emergency department with complaints of dizziness, headache, and nausea. The man had a history of congestive heart failure and additionally had shortness of breath. Initial carboxyhemoglobin (COHb) values were 26% in the male patient and 24% in his wife. For the female patient, oxygen therapy was performed with a reservoir balloon mask; a CPAP device was used for the male patient. The COHb levels decreased below five percent after approximately two hours in the male patient and at the end of five hours in his wife. In follow-up, symptomatic relief was achieved in both patients and no additional complications were observed. According to our experience, CPAP ventilation can be a new and effective method for oxygen therapy in CO poisoning.

Idil H, Unek O. Non-invasive CPAP ventilation in acute carbon monoxide poisoning. *Prehosp Disaster Med*. 2019;34(4):454–455.

Introduction

Carbon monoxide (CO) poisoning is one of the leading environmental emergencies with high mortality and morbidity.[1] It usually occurs as a result of incomplete combustion of organic substances during a fire. Since CO is a colorless and odorless gas, its toxicity is usually noticeable late. The affinity of CO to hemoglobin is around 200-times higher than that of oxygen. In the case of toxicity, a large amount of carboxyhemoglobin (COHb) compound is formed, and there is not enough hemoglobin in the circulation to carry oxygen to the tissues. This is the basic pathophysiological process that causes toxicity.[2]

The main purpose of treatment in CO poisoning is to provide CO elimination and to correct hypoxemia as soon as possible. Therefore, high-concentration oxygen is the cornerstone of the therapy.[3] Conventional oxygen therapy is administered with a nasal cannula or a face mask. Although reservoir balloon mask is useful in a normobaric environment, hyperbaric oxygen therapy is the most effective method in CO toxicity. However, special equipment is required for hyperbaric oxygen therapy, and this treatment cannot be performed in many centers.[4] Therefore, there is a need for alternative treatment modalities in this area. Non-invasive continuous positive airway pressure (CPAP) ventilation is a method that is frequently used in the treatment of major respiratory emergencies, such as acute pulmonary edema, and is effective in tissue oxygenation.[5] Therefore, it is thought that CPAP may also be useful in the treatment of CO poisoning.

Case Report

A 63-year-old man and his 58-year-old wife were brought to the emergency department for being exposed to fireplace smoke in their home on a windy day. Both had complaints of dizziness, headache, and nausea. The man had a history of congestive heart failure, and additionally had shortness of breath; his vital signs were within normal limits, other than hypertension (172/88mmHg). His wife was relatively better and had no significant vital instability. The patients, who were considered to have CO poisoning, were monitored in the emergency department and examined in this respect. In the initial blood gas analysis, COHb values were 26% in the male patient and 24% in the female patient.

A conventional oxygen therapy with a flow rate of 15L/min was started with a reservoir balloon mask for the female patient. Initially, hyperbaric oxygen therapy was considered for her husband, who had shortness of breath. However, the patient would have to be transported to another center to receive this treatment, and his current clinical condition was

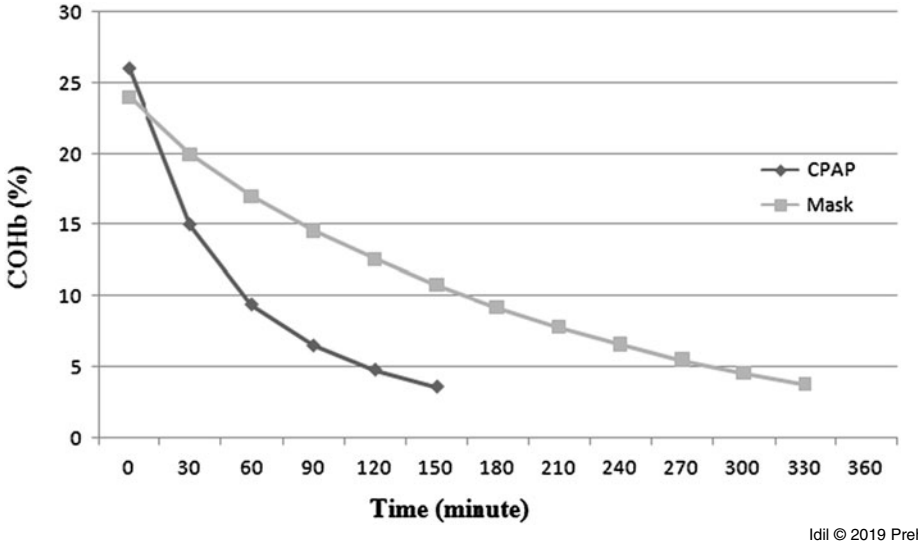

Figure 1. COHb Levels Over Time during Oxygen Therapy with Reservoir Balloon Mask and CPAP. Abbreviations: COHb, carboxyhemoglobin; CPAP, continuous positive airway pressure.

not suitable for this. Therefore, non-invasive CPAP ventilation was initiated with 100% FiO_2 (fraction of inspired oxygen) and 5cmH_2O PEEP (Positive End Expiratory Pressure), which is effective for both congestive heart failure and CO poisoning. Blood gas analyzes were repeated every 30 minutes for the first two hours in both patients, and every 60 minutes for the remaining treatment period of the female patient.

It was determined that COHb values decreased below five percent in approximately two hours with CPAP ventilation, and in approximately five hours with the reservoir balloon mask. The change in COHb values over time with both treatments is shown in Figure 1. In follow-up, symptomatic improvement was observed in the patients and routine blood tests, electrocardiograms, and chest radiographs showed no clinically significant additional abnormal results. Both patients were discharged at the end of the day.

Discussion

Carbon monoxide poisoning is known as the "thousand-faced disease" because it may present with many clinical conditions. In the early period, it may present with relatively mild symptoms such as headache, weakness, nausea, and vomiting, or it may lead to more severe conditions such as chest pain, shortness of breath, syncope, confusion, stroke, seizures, and coma.[3] After weeks or months, neuropsychiatric disorders such as headache, lethargy, confusion, emotional lability, amnesia, anhedonia, depression, and psychosis can be seen in 40% of cases.[4]

All patients with CO toxicity are recommended to receive a high-dose of oxygen therapy as soon as possible. These patients should be treated according to emergency medicine standards. Oxygen therapy can be performed by reservoir balloon mask (15L/min O_2), non-invasive CPAP ventilation (100% FiO_2), or endotracheal intubation according to the clinical status of the patients.[6]

Non-invasive CPAP ventilation provides tissue oxygenation rapidly and can be applied in many centers, unlike hyperbaric oxygen therapy.[6] Non-invasive CPAP ventilation increases FiO_2 to 100%, compared with the reservoir balloon mask, and increases the diffusion area and gas exchange of the lung by preventing the alveolar collapse.[5] Accordingly, it can be said that CPAP ventilation is more accessible than hyperbaric oxygen therapy and may be more effective than reservoir balloon mask in the treatment of CO poisoning.

Limitations

Although there are insufficient data in the literature about the use of non-invasive CPAP ventilation for CO toxicity, the fact that a single case has been examined in this report is an important limitation. In addition, the long-term effects of CO poisoning in patients treated with this method are not known.

Conclusion

Non-invasive CPAP ventilation, which can rapidly provide tissue oxygenation and CO elimination, may be an alternative method for the treatment of CO poisoning in the emergency department. There is a need for extensive clinical trials that measure the effectiveness of this method and compare it with traditional treatment modalities.

Author Contributions

Conception and design: HI and OU; data collection: OU; literature review: HI and OU; writing the paper: HI.

References

1. Roth D, Schreiber W, Herkner H, Havel C. Prevalence of carbon monoxide poisoning in patients presenting to a large emergency department. *Int J Clin Pract*. 2014;68(10):1239–1245.
2. Hoyte C. "Carbon Monoxide." In: Brent J, Burkhart K, Dargan P, et al. *Critical Care Toxicology*. New York, New York USA: Springer; 2017:1911–1928.
3. Weaver LK. Clinical practice. Carbon monoxide poisoning. *N Engl J Med*. 2009;360(12):1217–1225 .
4. Buckley NA, Juurlink DN, Isbister G, Bennett MH, Lavonas EJ. Hyperbaric oxygen for carbon monoxide poisoning. *Cochrane Database Syst Rev*. 2011;4:CD002041.
5. Vital FM, Ladeira MT, Atallah AN. Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary edema. *Cochrane Database Syst Rev*. 2013;5:CD005351.
6. Eichhorn L, Thudium M, Jüttner B. The diagnosis and treatment of carbon monoxide poisoning. *Dtsch Arztebl Int*. 2018;115(51–52):863–870.

https://doi.org/10.1017/S1049023X19004485 Published online by Cambridge University Press