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Hyperbaric therapy of patients poisoned with carbon monoxide in the Hospital Emergency Department at University Hospital No. 1 named after Dr Antoni Jurasz in Bydgoszcz - preliminary report

Ewa Zieliński[1], Ahmad El-Essa[1], Kinga Grobelska[1],

Piotr Dzięgielewski[2], Oksana Telak[3], Walery Zukow[4]

[1]Department of Emergency Medicine and Catastrophe Medicine of Collegium Medicum in Bydgoszcz, University of Mikołaj Kopernik in Toruń, Poland

[2]SPZOZ 10 Military Clinical Hospital with Policlinics in Bydgoszcz , Poland

[3]The Main School of Fire Service, Poland

[4]Department of Spatial Management and Tourism, Faculty of Earth Sciences, Nicolaus Copernicus University in Torun, Torun, Poland

Key words: hiperbarotherapy, carbon monoxide, poisoning

Abstract

The study is a preliminary report on the treatment of carbon monoxide poisoning at the Hospital Emergency Department at University Hospital No. 1 named after Dr. Antoni Jurasz in Bydgoszcz, with

the use of oxybarotherapy in a monoplace chamber. Carbon monoxide (CO) poisoning is a frequent cause of accidental and intentional injuries in the world. Many researchers suggest that the use of hyperbaric oxygen (HBO) in CO poisoning, prevents the development of neurological sequelae. This led to the widespread use of HBO in the treatment of patients with carbon monoxide poisoning. The National Health Fund (NHF) reimburses patients treatment in a multi-person hyperbaric chamber. In the Hospital Emergency Department (HED) in Bydgoszcz there is a one-person hyperbaric chamber, which is mainly used to treat patients poisoned with CO. Treatment is also refunded by the NHF. The cost of treating the patient in the monoplace chamber is included in the contract - (lump sum) from NHF for HED.

Introduction

In the literature on the subject there are many scientific studies on the description and course of research on the effectiveness of hyperbaric oxygen (HBO) use compared to normobaric oxygen (NBO) in the prevention of neurological sequelae in patients with acute carbon monoxide poisoning. The following electronic databases have been searched; MEDLINE (Ovid SP) 1950 to June 2016, EMBASE (Ovid SP) 1980 to June 2017, ISIWeb of Science: Advanced Science Citation Index (SCI-EXPANDED) 1970 to June 2017. All randomized, controlled trials of monoxide poisoning treatment in HBO compared with NBO, include non-pregnant and adults. It is not known, however, whether the therapy took place in single or multi-person chambers. Carbon monoxide is a colorless, odorless gas formed as a result of incomplete combustion of heating products, such as: hard coal, wood, peat, charcoal or oils [1]. CO is commonly called a silent killer.

Oxynormotherapy and oxybarotherapy

The most common consequence of carbon monoxide poisoning is hypoxia. Oxygen treatment is an effective method of treatment because most of the symptoms of CO poisoning disappear after high oxygen flows. Hyperbaric oxygen therapy is a method for delivering an increased amount of oxygen to damaged tissues and organs. In the early 1960s, **Sharp's** and **Smith's** work **resulted in the publication of the results** of effective use of oxygen hyperbaric therapy in the treatment of carbon monoxide poisoning. Currently, both mono and multi person chambers are used for hyperbaric treatment. The patient during the session in the hyperbaric chamber breathes 100% oxygen in an atmosphere of increased pressure (bigger than 1 ATA). At sea level, the plasma oxygen concentration is around 3 ml / l. To maintain normal cellular metabolism, resting tissues need about 60 ml of oxygen per litre of blood[2]. The half-life of CO under hyperbaric conditions is reduced from 300 min in normobaric to 30 min in hyperbaric conditions[3,4,5]

1 Hopkins RO, Woon FLM (2006) Neuroimaging, cognitive, and neurobehavioural outcomes following carbon monoxide poisoning. Behavioural and Cognitive Neuroscience Reviews 5: 144-55.

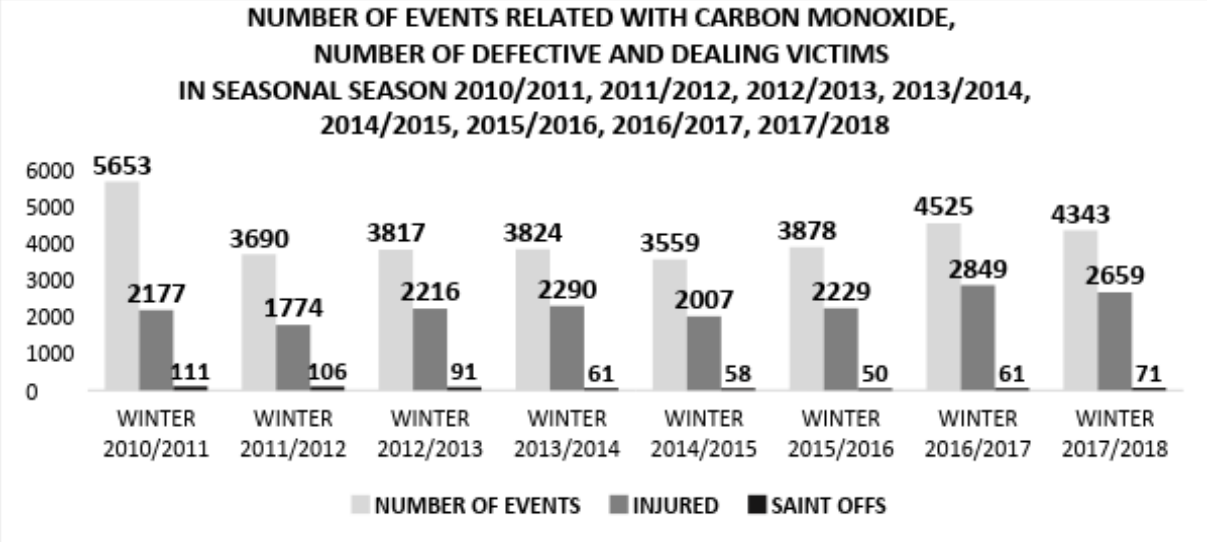
2 Leach R.M., Rees P.J., Wilmshurst P, Hyperbaric oxygen therapy, BMJ. Oct 24, 1998; 317(7166): 1140–1143.

3 Clardy PF, Manaker S., Perry H., ZET AL (2010) Carbon monoxide poisoning. UpToDate (online journal: http://http://www.uptodate.com). access 03.12.2018.

4 Nurczyńska E.,Grobelska K, Galarowicz O, Zieliński E,Telak J. [w]:red. Zieliński E, Telak J. Ratownictwo i Medycyna: Tlenoterapia w stanach ostrych - : założenia teoretyczne i podstawowe zasady stosowania, 2015; s.109-117.

Statistics of carbon monoxide poisoning in the years of 2010-2018

The number of events related to carbon monoxide, the number of injured and fatalities in the heating season of 2010/2011; 2011/1012; 2012/2013; 2013/2014; 2014/2015; 2015/2016; 2016/2017; 2017/2018 are presented below.



Source: https://www.straz.gov.pl/aktualnosci/lista_aktualnosci/idn:35885 access 06.12.2018.

From the analysis of events related to carbon monoxide poisoning, it can be concluded that, unfortunately, the number of events, although it was the highest in winter 2010/2011, is also high compared to 2017/2018, and the 2017/2018 season ranked third. The fact of 2659 victims is worrying, unfortunately this is the second result in the analyzed years. The number of fatalities with carbon monoxide poisoning, which was the highest in the 2010/2011 season, is also alarming. In 2017/2018 it is also high and amounts to 71 fatalities.

Statistics of carbon monoxide poisoning in the Kuyavian-Pomeranian Voivodeship

5 Grobelska K., Królikowska A., Zieliński E., Nurczyńska E, Telak J. Zatrucie tlenkiem węgla - zadania ratownika na miejscu zdarzenia. Bezp. Tech. Pożarn. 2014 : Vol. 34, nr 2, 123-132.

In 2017 (according to the State Fire Service (SFS) statistics), there were 36 people in the Kuyavian-Pomeranian poisoned by CO. In 2018, by the end of August, there were 18 people poisoned by CO. In 2017, twenty-three days of January were marked in the Kuyavian-Pomeranian Voivodeship by thirty-eight cases of carbon monoxide poisoning, as a result of which three people lost their lives (including a 9-year-old child). During the heating period - from 1 September to 23 January, 132 cases of CO poisoning were noted. In accident statistics of poisoning with carbon monoxide, the first place in the Voivodship is occupied by the Grudziądz poviat (29 cases). In Bydgoszcz there were 14 of them. In the poviat of Bydgoszcz - 8, in Nakieł - 9 and in Inowrocław – 6. [6]

Carbon monoxide gets into the body mainly from the respiratory tract, to a lesser extent – through mucous membranes and skin. It is excreted by the respiratory system in an unchanged form, in 1% it is only oxidized to carbon dioxide. In the blood, it combines with haemoglobin (Hb) to form carboxyhaemoglobin (COHb). It lowers the oxygen content (O2) in the blood. The affinity of CO to Hb is 200-250 times bigger than the affinity of Hb to O2, thereby blocking haemoglobin and causing "strangulation of cells" (it reduces O2 bonds by cytochromes A3, P450 and C). CO binds with Hb until equal blood and air concentrations are achieved. Symptoms of CO poisoning are often non-specific. They can be divided into general, advanced and late. [7,8,9,10.]

Diagnosis and qualification for HBO

Diagnosis for HBOT of poisoned CO patients includes: ECG, Echo of the heart, chest X-ray, CT scan of the head and laboratory diagnostics: troponin measurement, kinase of keratin, creatinine and liver parameters. Qualification for HBOT treatment of CO-poisoned patients is based on the analysis of the following parameters: COHB level higher or equal to 20%, myocardial ischemic disease and COHB level 15%, pregnant women with COHB level higher than 10%, loss of consciousness in the interview during intoxication , persistent neurological symptoms despite treatment with 100% oxygen. The goal of HBOT treatment is to save lives, prevent or reduce damage to organs, reduce the late consequences of poisoning. The best results in the treatment of HBO of poisoned CO patients are achieved when the therapy is implemented quickly, i.e. 4-6 hours, and max. 24 hours. from poisoning.

Benefits of CO poisoning in HBO

6 http://www.sppsp.bydgoszcz.pl/component/content/article/38-newsy/291-czujka-na-stray-twojego-bezpieczestwa.html access 03.12.2018

7 DM, Kirkpatrick JN: Treatment of acute carbonmonoxide poisonig with hyperbaric oxygen. A review of 115 cases.Ann Emerg Med 1985; 14(12):1168-1171.

8 Rucker J, Fisher JA: Carbon monoxide poisoning. [In:] Albert RK, Slutsky AS, Ranieri VM et al.: Clinical Critical Care Medicine. Elsevier Inc., Philadelphia 2006; 63: 679-683.

9 Sohn YH: Carbon monoxide poisoning. Encyclopedia of Movement Disorders 2010; 187-189.

10 Gorman D, Drewry A, Huang YL, Sames Ch: The clinical toxicology of carbon monoxide. Toxicology 2003; 187: 25-33.

The most important is to reduce the COHB level in the patient's body in the shortest possible time. Adminitsration of oxygen is to prevent cerebral cell edema (effects on cerebral vessels and the blood-brain barrier).

The administration of pure oxygen ventilation through the mask in normobaric conditions causes that the breakdown of COHB lasts about 90 minutes. This process can be definitely accelerated by placing the patient in a hyperbaric chamber and giving him 100% oxygen in coupling of 2.5-3 ATA.

According to the literature, this process at 3 ATA pressure takes about 23 minutes, and the amount of dissolved oxygen in the plasma itself increases to the level of 0.68 ml dissolved in plasma for every litre of blood (in normobaric conditions in air breathing at sea level the amount of oxygen physically dissolved in the plasma is 0.21 ml per litre of blood while haemoglobin is bound to 1.98 ml of oxygen per litre). When oxygen carrier is blocked in erythrocytes, it is important to increase the oxygen capacity of the plasma that is able to protect hypoxic tissues.[11] It should also be remembered that about 15% of carbon dioxide diffuses into the tissues associated with myoglobin, which deepens the poisoning of the body.[12]

11 Nieścior M.,Jackowska T.:Zatrucie tlenkiem węgla. Postępy Nauk Medycznych 7/2013, s. 519-522.

12 Burda. P, Kołaciński Z, Łukasik-Głębocka M, i inn: Postępowanie w ostrych zatruciach tlenkiem węgla - stanowisko Sekcji Toksykologii Klinicznej Polskiego Towarzystwa Lekarskie. Przegląd Lekarski 2012 / 69 / 8, 463-465.

Pic. 1. Medical office with a monoplace hyperbaric chamber in the Hospital Emergency Department at the University Hospital named after Antoni Jurasz in Bydgoszcz - own archive.

Pic. 2. A monoplace hyperbaric chamber in the Hospital Emergency Department at the University Hospital named after Antoni Jurasz in Bydgoszcz - own archive.

Figure 1 below illustrates the course of the session in the hyperbaric chamber for patients treated for CO poisoning.

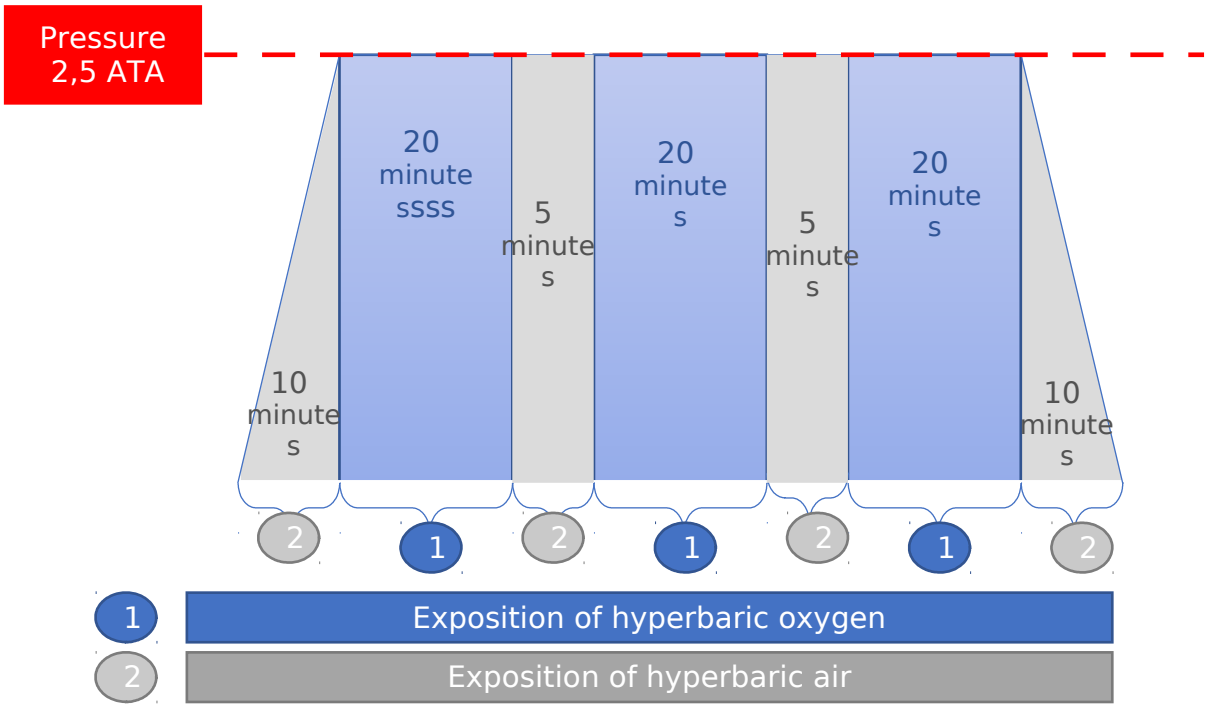


Fig. 1. The course of the session in the hyperbaric chamber

The patient after the positive qualification by the physician servicing the hyperbaric chamber is subjected to the session. It lasts 90 minutes. The patient undergoes air compression for 10 minutes until the pressure chamber reaches 2.5 ATA. Then he takes three 20 min. oxygen exposures with 5 minutes breaks, during which he breathes with air, and then the patient undergoes 10-minute air decompression.

Characteristics of treatment of CO poisoning at Hospital Emergency Department at University Hospital No. 1 named after Dr Antoni Jurasz in Bydgoszcz in 2017.

In 2017 at Hospital Emergency Department at University Hospital No. 1 named after Dr Antoni Jurasz in Bydgoszcz, there were 19 people treated for carbon monoxide poisoning, 11 of whom were women and 8 were men. The poisoned were at the age of between 17 and 64. 15 people were inhabitants of Bydgoszcz, and 4 people lived in the vicinity of Bydgoszcz. The poisoning mainly occurred in January and in February. 18 cases are T58 and one is epilepsy, pre-qualified as T58. 18 people were brought by

the Medical Rescue Team (MRT), and one person reported to the Hospital Emergency Department alone. The condition of people at the time of admission to Hospital Emergency Department was as follows: 10 people did not lose consciousness during exposure to CO, 2 people fainted, 1 person suffered fainting, 2 people did not lose consciousness and 4 victims were unconscious. 9 people complained of pain and dizziness, 6 of vomiting and nausea; chest pain was found in 2 people. In addition, 2 patients experienced convulsions, following 2 had shortness of breath. The COHb concentration ranged between 12.3% and 40.6%, (except for the suspicion of T58, in which COHb was 2.1% and the patient suffered from epilepsy). Four people were transferred to HBT treatment, and one person was also qualified, but the woman refused the treatment in the chamber. 1 person was taken to the Hyperbaric Centre in Redłowo. 12 people, for various reasons, i.e. the occurrence of POCHP and C80 additional disease, were not qualified for monoplace treatment.

Summary

Considering epidemiological data, the largest number of poisonings is observed in autumn and winter. It is connected with possible staying indoors with inefficient ventilation in construction areas in which coal furnaces are used or there is a gas system for space heating or water heating. CO poisoning also concerns victims of fires and to a lesser extent industrial failures. In the process of treatment and diagnosis of CO poisoning, it should be remembered that some symptoms of CO poisoning are not specific and may remain unrecognized. It is important to determine the COHb value. Early diagnosis of poisoning enables immediate treatment of both NBO and HBO. Patients with CO poisoning may have disturbances of consciousness with unclear aetiology. The key to treatment seems to be quick access to therapy in the hyperbaric chamber and the implementation of complementary treatment as soon as possible after exposure to CO.

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