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## TEN YEARS EXPERIENCE IN HYPERBARIC OXYGENATION THERAPY OF ACUTE CARBON MONOXIDE INTOXICATION

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### Introduction

The diminished oxygen content in the body tissues-hypoxia, takes important place in the genesis of a number of diseases, one of the very importance - acute carbon monoxide (CO) intoxication. Carbon monoxide blockades oxygen transporting function of hemoglobin (Hb), forming the compound carboxihemoglobin. Severe hypoxemia develops and later hypoxia, which leads to fatal outcome. Oxygen supply to damaged people is first choice for treatment in the complex therapy, but the abilities of normobaric oxygen therapy are restricted. The input of hyperbaric oxygen therapy with oxygen under high partial pressure, achieved by breathing oxygen under pressure over 1 ATA, gives the opportunity for significant raise of oxygen flow to the injured by hypoxia cells and tissues by increasing its physical solubility. It is a matter of fact the indisputable priority of HBO therapy because dissociation

of carboxihemoglobin goes many times faster than when breathing air or normobaric oxygen. HBO therapy enables to eliminate hypoxia; normalizing disturbed tissue metabolism in short terms and achieving fast recover. The oxygen needs strictly dosage for optimal treatment effect and to avoid oxygen intoxication.

The hyperbaric oxygen doses are defined by regimes of HBO, including optimal oxygen pressure and duration of oxygen therapy.

There are no till now elaboration of oxygen regimes for treatment of different stages CO intoxication and that was our idea.

### Materials and methods

During a year experimental study was conducted on 124 Wistar male white rats with weight 250-300 g, intoxicated with CO in different stages and treated under different regimes of HBO according to their stage of intoxication. We put on them several regimes of HBO: one or two created by us and one or two foreign diving regimes from the oxygen decompression tables of British Royal Navy or US Navy. After the end of the treatment, the laboratory animals were examined post-mortem and histological material taken from the brain was prepared for histological research to detect the stage of pericellular edema. The histological sections were



Fig. 1. Experimental hyperbaric chamber

studied under microscope “Olympus BX-50”, followed by computer analysis with specially created for the study program “Micro Analyze-1,1” of “Chris Soft” - Bulgaria. The method for computer analysis of morphological changes in the brain, which occur under HBO treatment of experimentally intoxicated rats, gives opportunity the effectiveness of applied in practice HBO regimes to be assessed.

### Results

The results received by this method covered the results presented by the two other methods- laboratory analysis and clinical observation. On the base of morphological changes under CO intoxication we recommend for HBO therapy next regimes:

We used for treatment of low stage CO intoxication VMB 1b regime, for moderate - VMB 2 regime and for severe stage VMB 3 regime. These regimes are significantly shorter than those of US Navy and for this reason are more tolerable. This makes them safety because they are intended for sick

people and not for divers.

In the next ten years we exercise the preferred regimes for treatment of patients admitted in the hospital with acute CO intoxication (Fig. 3.).

The cases according to the stage of intoxication are presented in Table 1.

### Discussion

Analyzing the dynamics of CO intoxication rate the following regularities were observed.

1. The downward tendency of CO intoxication rate was closed in 2000.
2. After 2000 a prominent upward tendency of CO intoxication accidents was noted.
3. A parallel increase of cases with moderate and severe stage of intoxication was pointed.

The diminishing of the incidence at the beginning we regarded to the restricted industry in Varna and in the North-eastern region of Bulgaria. The home accidents be-

came more frequent because of the prominent increase in the prices of electricity used for heating. A lot of the households began to use for heating coals and woods instead of electricity. This raised the risk of fires and the risk of inhalation intoxications as a whole and particularly CO intoxications.

In our practice we successfully used the VMB treatment regimes elaborated in the hospital. The patients admitted in

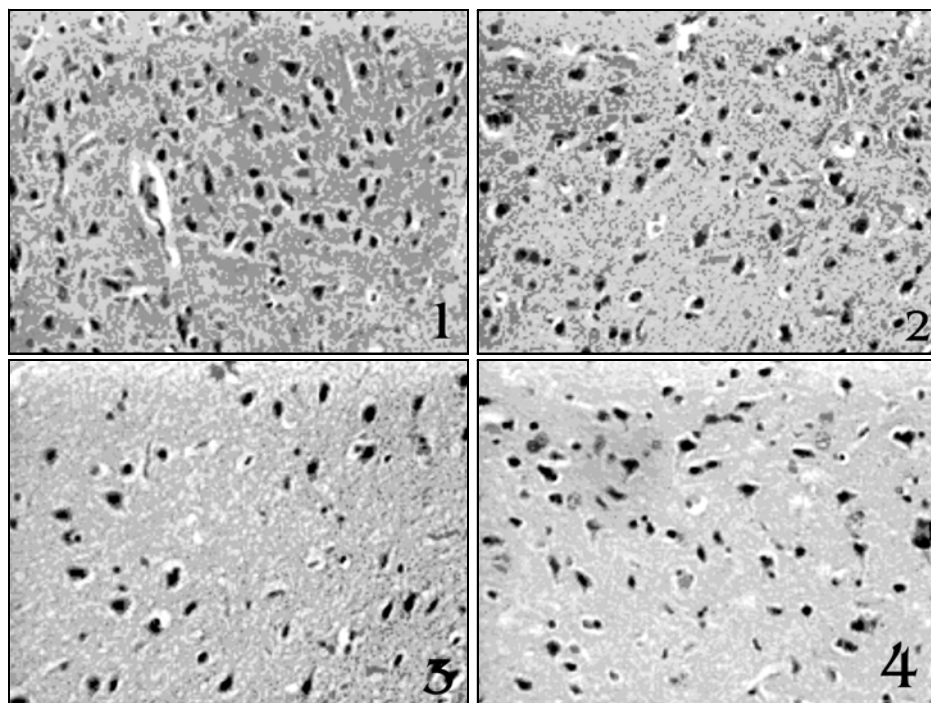


Fig.2. Brain of rat – CO intoxication-moderate degree

1. First group – atmospheric air
2. Second group –normobaric oxygenation
- 3.Third group-HBO-VMB2
- 4.Fourth group-HBO-USA Navy 5

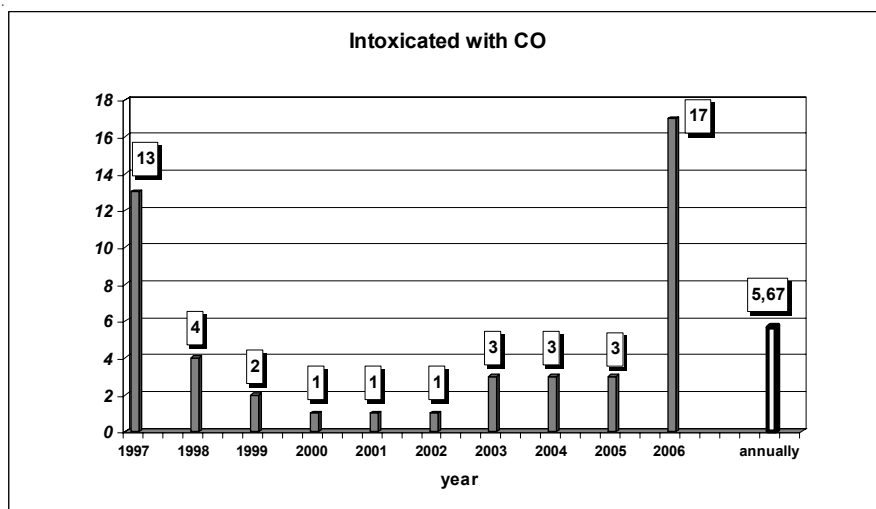


Fig. 3. Quantity of patients admitted in the hospital with acute CO intoxication

the Emergency department were immediately classified according to their intoxication degree. That was made by analyzing carboxihemoglobin level in arterial blood sample and parallel doctor examine.

In the admitted 27 patients with low level intoxication 27 were treated by the regime VMB1b. They felt themselves very

Table 1

## The cases according to the stage of intoxication

Year	Number	Degree	Distribution	Regime	Sessions			Result
					I	II	III	
1997	13	low	7	VMB 1b	7			healing
		moderate	4	VMB 2	4	2		healing
		severe	2	VMB 3	2	2	2	healing
1998	4	low	3	VMB 1b	3			healing
		moderate	1	VMB 2	1			healing
		severe						
1999	2	low	1	VMB 1b	1			healing
		moderate	1	VMB 2	1	1		healing
		severe						
2000	1	low						
		moderate	1	VMB 2	1			healing
		severe						
2001	1	low						
		moderate	1	VMB 2	1			healing
		severe						
2002	1	low	1	VMB 1b	1			healing
		moderate						
		severe						
2003	3	low	2	VMB 1b	2			healing
		moderate						
		severe	1	VMB 3	1			healing
2004	3	low						
		moderate	2	VMB 2	2	1		healing
		severe	1	VMB 3	1			healing
2005	3	low	2	VMB 1b	2			healing
		moderate	1	VMB 2	1			healing
		severe						
2006	17	low	11	VMB 1b	11			healing
		moderate	4	VMB 2	4	2		healing
		severe	2	VMB 3	2	2	2	healing
Annually	5,67				5,67	1	0,25	
Total	48				48	10	4	

Analyzing carboxihemoglobin level in arterial blood sample and parallel doctor examine

Intoxication degree	COHb level in arterial blood	HBO therapy
low	10-30%	0.18MPa oxygen for 60 min
moderate	30-40%	0.18MPa oxygen for 90 min
severe	> 40 %	0.18MPa oxygen for 170 min

Table 2

In the VMB regimes there are two basic steps at 0.18 Mpa and 0.09 Mpa. The time for compression is longer than in similar navy tables, because VMB tables are created for

well after the first session. All complaints had gone and there was no need of second session. These which had not other injuries were discharged from the hospital after 24 hours under observation. The patients with burning and other damages were directed to other departments of the hospital.

In the period of study 14 patients with moderate degree of intoxication were admitted. They were treated under regime VMB2. Six of them needed second session under the same regime because of remaining complaints after the first session as headache and asthenia. After the second session the complaints had gone.

Six patients with severe intoxication degree were admitted in the period. They were treated under regime VMB3. All of them needed second session and 4 patients received another third session. Although the healing of acute symptoms of intoxication and life saving, patients with severe CO intoxication had remaining complaints of neurological aspect. They had various characteristics and were not a subject of this study. All cases with severe intoxication needed continuous hospitalizing.

**Conclusions:**

For the studied ten years period all patients admitted in the hospital with CO intoxications were successfully treated with HBO. There is no lethal outcome. All patients were discharged from the hospital after different period. Patients with low and moderate intoxication degree had not further complaints. We observed such in 4 patients with severe intoxication degree. There were not noted any complications or adverse events due to the HBO therapy.

treating sick people and not for divers like in US Navy table 5 and US Navy table 6 in which the compression time is 2 minutes.

All this present the positive effect of the applied regimes and their therapeutical safety. The results of clinical observation for the ten years period prove the favorable effect of the complex method for preparing therapeutical standards-combination of clinical, laboratory and morphological data.

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#### Резюме

ДЕСЯТЬ РОКІВ ВЖИВАННЯ  
ГІПЕРБАРИЧНОЇ ОКСИГЕНАЦІЇ В ТЕРАПІЇ  
ГОСТРИХ ОТРУЄНЬ МОНООКСИДОМ  
ВУГЛЕЦЮ

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Використання ГБО (Гіпербарична оксигенація) є високоефективним методом для лікування отруєння особливо

помірного і важкого ступеня. Кисень піддається строгому дозуванню для досягнення максимального лікувального ефекту і запобігання кисневої інтоксикації.

Для створення режиму найбільшої ефективності ГБО для лікування отруєння автори використовували комплексний метод та експериментальні моделі з щурами і мінібарокамерой. Результати експериментів оцінили на базі клінічних, лабораторних і морфологічних методів з використанням спеціальної програми. Програма самостійно обчислювала перичелюлярну і периваскулярну пухлину зрізів мозку експериментальних тварин. Результати заносили в таблиці і проводили математичний аналіз.

#### Резюме

ДЕСЯТЬ ЛЕТ ПРИМЕНЕНИЯ  
ГИПЕРБАРИЧЕСКОЙ ОКСИГЕНАЦИИ В  
ТЕРАПИИ ОСТРЫХ ОТРАВЛЕНИЙ  
МОНООКСИДОМ УГЛЕРОДА

*Бозов Ц.С, Ставрев Д.Г., Янева М.К.*

Использование ГБО (Гипербарическая оксигенация) является высокоэффективным методом для лечения отравления СО особенно в умеренной и тяжелой степени. Кислород подвергается строгому дозированию для достижения максимального лечебного эффекта и предотвращения кислородной интоксикации.

Для создания режима наибольшей эффективности ГБО для лечения отравления СО мы использовали комплексной метод, и экспериментальные модели с крысами и минибарокамерой. Результаты экспериментов оценили на базе клинических, лабораторных и морфологических методов с использованием специальной программы. Программа самостоятельно вычисляла перичелюлярную и периваскулярную опухоль срезов мозга экспериментальных животных. Результаты заносили в таблицы и проводили математический анализ.