



**EXPERIMENTAL STUDY OF THE EFFECTIVENESS OF THE SUPRAMOLECULAR
COMPOUND OF METHYLENE BLUE AND HYDROXYPROPYL BETA-
CYCLODEXTRIN IN CARBON MONOXIDE POISONING**

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Annotation: This article presents the results of laboratory testing of the antidote properties of the supramolecular compound methylene blue and hydroxypropyl beta-cyclodextrin for carbon monoxide poisoning.

Keywords: Methylene blue (MB), carbon monoxide (CO), cyanide and nitrate poisoning, laboratory rat, hemoglobin, carboxyhemoglobin, effective antidote.

Introduction.

According to statistics, carbon monoxide poisoning is the second leading cause of death in the world after alcohol poisoning. According to the Ministry of Emergency Situations, in Uzbekistan in 2021, 125 people died from carbon monoxide poisoning, 115 were injured, and in 2022 this figure reached 146 deaths and more than 50 injuries. Since the beginning of 2024, a total of 74 gas-related incidents have occurred in Uzbekistan (86 in 2023), resulting in 82 deaths and 80 injuries of varying degrees. In some cases, entire family members have died from carbon monoxide poisoning due to a faulty chimney. As can be seen from the above, carbon monoxide poisoning is common among the population, but unfortunately, these cases often end tragically.

Main part

Let's briefly talk about what carbon monoxide poisoning is and how the gas is formed. Carbon monoxide is a strong poison, because it forms strong complexes with biologically active molecules containing metal atoms (blood proteins, hemoglobin), which disrupts the oxygen supply of tissues. It especially affects the cells of the central nervous system. The binding of carbon monoxide to the Fe atoms in the hemoglobin protein disrupts the formation of oxyhemoglobin, which carries oxygen from the lungs to the tissues. Even if there is 0.1% CO gas in the air, this gas displaces half of the oxygen from oxyhemoglobin. In such cases, even the presence of a large amount of pure oxygen in the air cannot prevent death from asphyxiation. The daily permissible dose of carbon monoxide in atmospheric air is set at 3 mg / m³. In many places in the workplace and public transport, it is 20 mg / m³. This gas is released into the air as part of volcanic and swamp gases, and by the secretions of plankton and other microorganisms. Thus, 220 million tons of CO are released into the atmosphere from the surface layers of the ocean every year. In addition, large amounts of carbon monoxide are released into the air from coal mines and forest fires. 300.4 thousand tons of CO are also released during the smelting of every million tons of steel. In total, the annual release of man-made CO into the air is 600 million tons.

Based on the above, it is very important to develop alternative medical treatments for patients with carbon monoxide poisoning. Traditional treatment methods (hyperbaric oxygen therapy) are expensive and have limitations in providing rapid relief. Methylene blue (MK) converts COHb to normal Hb, but its toxicity and low solubility limit its clinical application. In this study, the antidote properties of the supramolecular compound MK+HP-β-CD were experimentally investigated.

Research methods used based on the comments.

Experimental group: 12 healthy male rats (Sprague-Dawley yoki Wistar)

Lung saturation and pulse in animals that received the poisoned injection and those that did not.

Time after poisoning.

				5 min	1 hour	3 hour	24 hour
	No	Name	weight	SpO2 % / PR/bPm			
Experimental group (injected)	1	Head	215	40/40	48/127	69/110	93/127
	2	Neck	225	39/25	51/89	67/98	89/143
	3	spine	200	35/64	61/134	73/107	96/138
	4	waist	220	36/56	57/118	76/113	87/146
	5	Left hand	195	35/48	54/113	64/107	90/131
	6	Right hand	225	38/58	59/121	79/126	91/118
Control group (no injection)	7	Left hand	210	36/46	41/146	57/158	Death recorded
	8	Right foot	185	35/50	Death recorded	-	-
	9	Left	215	39/58	43/134	55/146	67/114

Experimental group (n=6): Lung saturation was measured and recorded using a specialized veterinary Berry AM6200 Capnograph pulse oximeter for animals administered CO poisoning + MB+HP-β-CD solution.

Control group (n=6): Animals exposed to CO poisoning + saline were monitored for pulmonary saturation using a Berry AM6200 Capnograph pulse oximeter. The duration of the experiment was 1 day. Before the start of the experiment, the laboratory rats were named and their weight was measured and recorded using an analytical scale. A special animal-safe alcohol-based yellow dye was used to clearly distinguish the laboratory rats. The dye was used to label the rats' tail, head, spine, left leg, left arm, right leg, right arm, left and right flanks, and neck. The Berry AM6200 Capnograph was used and saturation and pulse were determined for 5 minutes, 1, 3, 6, 12, and 24 hours. 5 minutes after the animals were exposed to carbon monoxide, the pulse and saturation of the animals in the control group did not differ from the experimental group. One hour after poisoning the animals with carbon monoxide, the saturation in the experimental animals was 10% higher and the pulse rate was 8% higher than in the control group. After 3 hours, the saturation was 20% higher and the pulse rate was 12%. 24 hours after poisoning the animals and the introduction of 0.5% methylene blue, the saturation was on average 90%, the pulse rate was 100 beats per minute. Compared with the results of the animals in the control group, the saturation in the experimental group was restored faster, the pulse rate was within normal limits. The result shows that the injection of 0.5% methylene blue saturates the blood with oxygen and relieves the body from carbon monoxide poisoning.

		buttock					
10	Right buttock	195	42/68	47/145	58/183	69/135	
11	Head/back	230	35/54	39/137	Death recorded	-	
12	Head/spine	210	39/56	45/87	61/114	73/156	

Conclusions and results. The supramolecular compound MK+HP- β -CD is an effective antidote for CO poisoning, restoring SpO₂ to 90% within 24 hours.

HP- β -CD increases the solubility of MK and reduces its toxicity. The results can serve as a basis for clinical trials. By studying the changes occurring in the body and analyzing them in depth, it will be possible to develop alternative treatment methods for carbon monoxide poisoning.

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