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Postmortem Formation of Carbon Monoxide in Blood and Body Cavity Fluids of Rats Drowned and Kept Immersed in Fresh Water*)

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ABSTRACT

Rats were drowned in fresh water collected from a river, and kept immersed in the water for four weeks in separate bottles. When five rats were placed outside in the shade, where the temperature varied from 1 to 9°C, carboxyhemoglobin (HbCO) saturations in the blood and thoracic cavity fluid were not more than 1% and 10% respectively. When fifteen rats were immersed at 8-9°C, HbCO saturations in the body cavity fluids were more than 20% in six. HbCO saturations in the blood, however, were not more than 10% in all cases.

The results indicate that low carbon monoxide (CO) levels are produced in the blood and high CO levels are formed in the body cavity fluid, and that body cavity fluid should not be used for CO determination.

INTRODUCTION

A remarkable production of carbon monoxide (CO) following death was suggested in a cadaver that had drowned and had been immersed in the water of a storage dam at approximately 8°C[3], and a typical postmortem formation of CO was observed in a drowned body found in a river[5]. Though a considerable amount of CO was formed in two out of three rats drowned and immersed in fresh water collected from a river at 4-5°C, only a little amount of CO was produced in one, and the highest carboxyhemoglobin (HbCO) saturation was 19.5% in the blood and 78.2% in the thoracic cavity fluid[6].

Since the most appropriate temperature for the postmortem formation of CO seemed to be around 8°C, rats were drowned and kept immersed at around 8°C. High CO levels were produced in the body cavity fluids of some cases, and low CO levels were produced in the blood of all cases. The results indicate that immersion in fresh water at around 8°C following drowning was not a good condition for the postmortem production of CO, and that body cavity fluid should not be used for CO determination.

MATERIALS AND METHODS

Adult male Wister-strain rats, kept for more than one week without fasting at our laboratory, were used for the experiment. Water for drowning and immersion was untreated fresh water collected from a river. An airtight 2-liter bottle with a cap was used for storage.

CO concentration was analyzed by gas chromatography[4,5]. Total hemoglobin (Hb) concentration was determined by a modified international cyanmethemoglobin method[4,5]. HbCO saturation was calculated by the ratio of the CO content and the CO-binding capacity[4,5].

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ANIMAL EXPERIMENT

Rats were drowned in the water, and kept immersed in the water in separate bottles for four weeks. Water in the bottle was changed once a week for new water collected from the river.

Five rats in the separate bottles were placed outside in the shade, where the temperature varied from 1°C to 9°C (Fig. 1). Another five

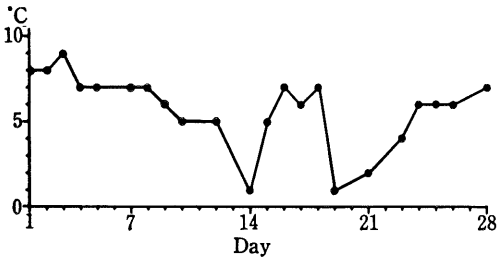

Fig. 1. Temperatures during storage outside in the shade, where rats in separate bottles were placed.

rats were placed in a dark cold room, where the temperature was controlled at 8°C. Another ten animals were placed in a water bath controlled at 8-9°C in the daylight room.

After four weeks' immersion, all animals were dissected. Blood in the heart cavities and large vessels, thoracic cavity fluid and abdominal cavity fluid was collected. CO and Hb concentrations were analyzed, and HbCO saturation was calculated.

RESULTS

When five rats in separate bottles were placed outside, total Hb concentrations ranged from 14.6 to 27.8 g/100 g in the blood, and from 4.52 to 6.17 g/100 g in the thoracic cavity fluid. The highest concentration of CO was 0.24 ml/100 g at standard temperature and pressure (STP) in the blood, and 0.56 ml/100 g at STP in the thoracic cavity fluid. The saturations of HbCO were not more than 1.0% in the blood, and less than 7.3% in the thoracic cavity fluid (Fig. 2).

When five animals in separate bottles were placed in the dark cold room, total Hb concentrations ranged from 10.0 to 17.2 g/100 g in the blood, and from 3.68 to 4.75 g/100 g in the thoracic cavity fluid. The highest concentration of CO was 0.94 ml/100 g at STP in the blood, and 3.70 ml/100 g at STP in the thoracic cavity fluid. The saturations of HbCO were not more than 5.3% in the blood, and less than 56.8% in the thoracic cavity fluid

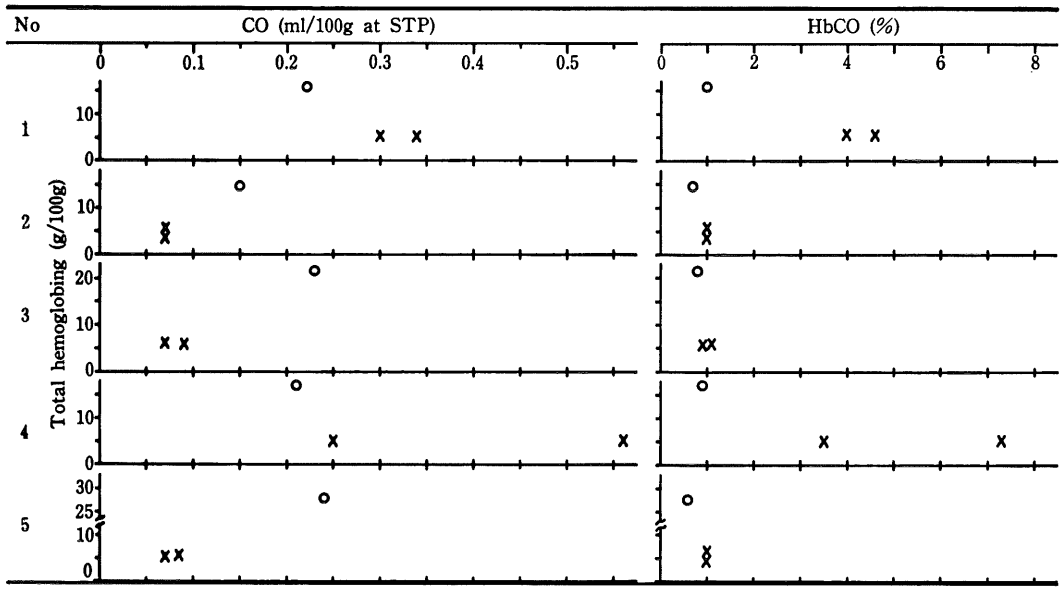

Fig. 2. Summarized results of rats placed outside in the shade (1-9°C). ○: Heart blood. ×: Thoracic cavity fluid.

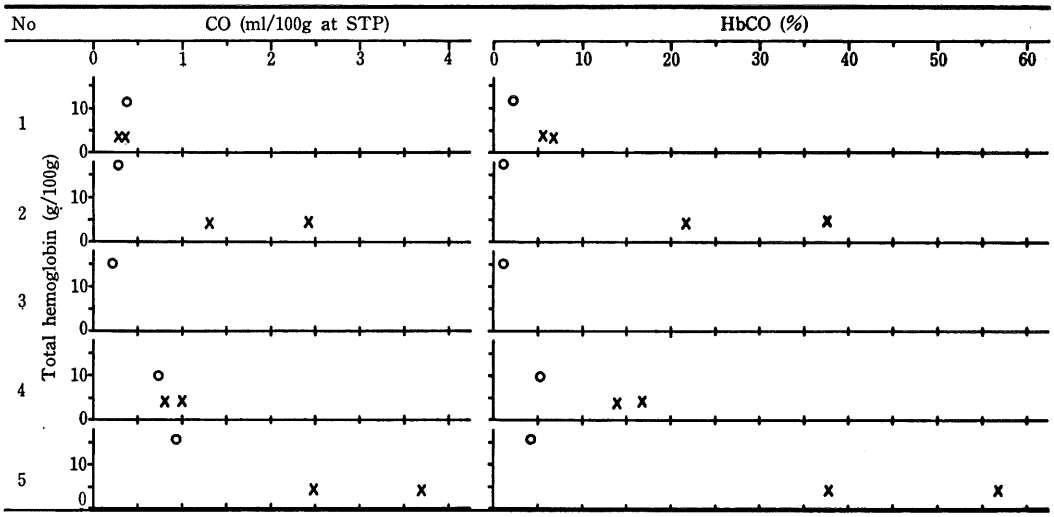

Fig. 3. Summarized results of rats placed in a dark cold room (8°C). ○: Heart blood. ×: Thoracic cavity fluid.

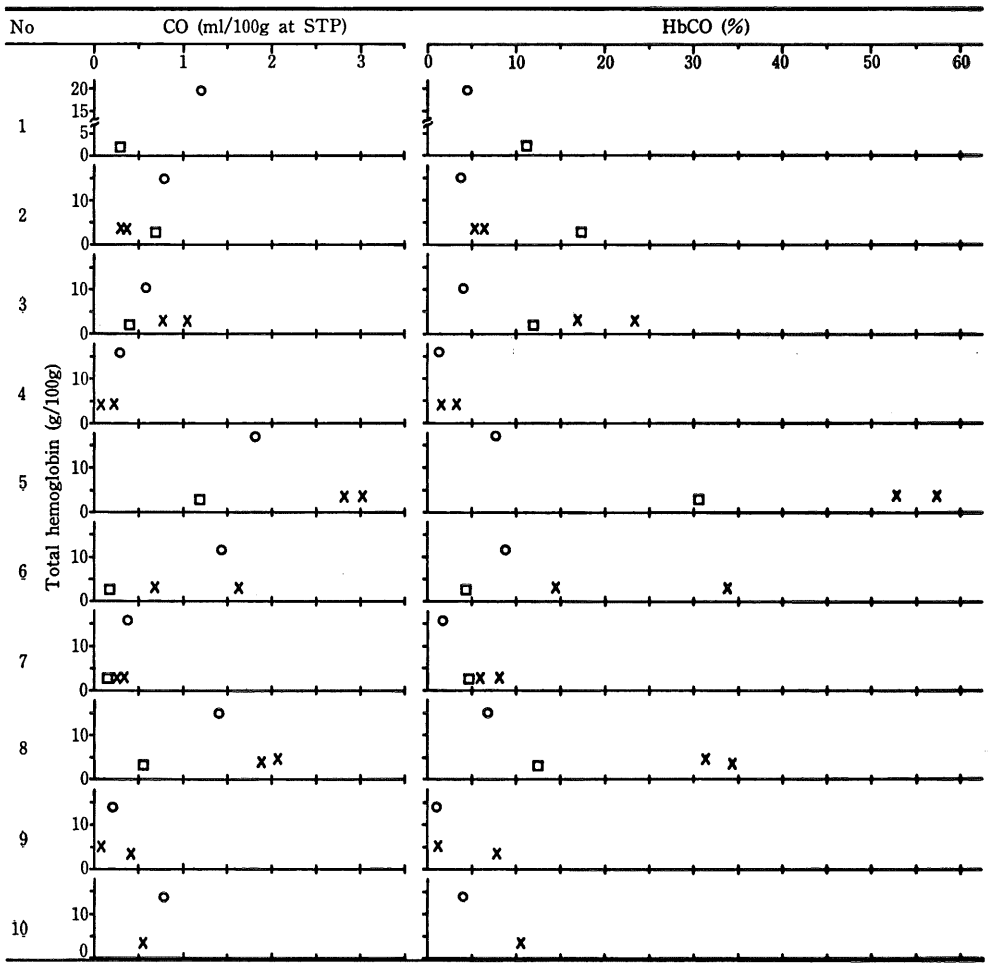

Fig. 4. Summarized results of rats placed in a water bath in the room (8-9°C). ○: Heart blood. ×: Thoracic cavity fluid. □: Abdominal cavity fluid.

(Fig. 3).

When ten rats in separate bottles were placed in the water bath in the room, total Hb concentrations ranged from 10.4 to 19.5 g/100 g in the blood, from 3.15 to 5.38 g/100 g in the thoracic cavity fluid, and from 1.89 to 4.09 g/100 g in the abdominal cavity fluid. The highest concentration of CO was 1.82 ml/100 g at STP in the blood, 3.02 ml/100 g at STP in the thoracic cavity fluid, and 1.21 ml/100 g at STP in the abdominal cavity fluid. The saturations of HbCO were not more than 8.9% in the blood, less than 57.4% in the thoracic cavity fluid, and less than 30.5% in the abdominal cavity fluid (Fig. 4).

DISCUSSION

According to Sjöstrand[7-9], CO is produced by decomposition of Hb and myoglobin. Engel et al.[1] reported that alpha-hemolytic Streptococcus mitis and hemolytic Bacillus cereus formed CO from the heme compounds under aerobic conditions. The previous animal experiment, in which rats were drowned and kept immersed in fresh water, suggests that microorganisms in the water, and low temperatures of around 5°C during storage, played an important role in the postmortem formation of CO[6].

Though the optimum temperature for postmortem production of CO seemed to be approximately 8°C[3,6], the results of this experiment suggest that immersion at about 8°C is not a good condition.

When rats drowned and kept immersed in fresh water in separate bottles were placed in a dark room or in the daylight room, the effect of light on CO production following death was not observed.

Goldsmith et al.[2] reported that HbCO saturations as high as 12% were occasionally found in heavy cigarette smokers immediately after smoking. The highest HbCO saturation in the body cavity fluid was 78.2% in the previous experiment[6] and 57.4% in this experiment. The highest saturation of HbCO in the blood, however, was 19.5% in the previous experiment[6] and 9.5% in this experiment. These results indicate that low CO levels are produced in the blood and high CO levels are formed in the body cavity fluid, and body cavity fluid should not be used for CO determination.

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