

## 24-h ECG AND BLOOD PRESSURE MONITORING IN WORKERS EXPOSED TO CARBON DISULPHIDE (CS<sub>2</sub>)

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### INTRODUCTION

Carbon disulphide is an industrial toxicant, a solvent commonly used in the viscose and rubber industries and in the chemical industry for carbon tetrachloride and ammonium salts production. Exposure to high CS<sub>2</sub> concentrations (ca 1000 ppm) may induce acute psychosis whereas the levels of ca. 5000 ppm may be fatal (1). However, long-term exposure to CS<sub>2</sub> at low concentrations was not found to produce any specific effect. This exposure leads to numerous symptoms associated with the different effects of CS<sub>2</sub> on particular organs and systems; the most prevalent being vascular diseases e.g. cerebral atherosclerosis, ischaemic heart disease (1,2,3) nephropathy (4), retinal microaneurysms (5). For more than 20 years it has been known that chronic exposure to CS<sub>2</sub> not only leads to a development of ischaemic heart disease but also worsens its prognosis. However, the pathomechanics of CS<sub>2</sub> effect on the cardiovascular system has not been fully explained (6). It may be brought about both by vascular changes due to impaired lipid metabolism and coagulation processes and by catecholamine metabolism disorders. Moreover, a direct toxic effect of CS<sub>2</sub> on the myocardium may also account for that (5,6). It is assumed that the cardiovascular impairments resulting from CS<sub>2</sub> exposure may be associated with some functional disorders of the autonomic nervous system. The data on the frequency of arterial hypertension in CS<sub>2</sub>-exposed workers are ambiguous, although the opinion prevails that in this occupational group the frequency may be higher than in the general population (3,5). Some authors report no blood pressure changes in workers exposed to CS<sub>2</sub> at the concentrations of 30-95 mg/m<sup>3</sup> or increase (approx. by 5 mm Hg) only in diastolic pressure (7). Although prognosing for people occupationally exposed to CS<sub>2</sub> has been much more favourable since new technologies were applied and the hygienic conditions of work improved, this population should still be regarded as a high risk group. In workers occupationally exposed to CS<sub>2</sub>, the mortality rate from myocardial infarction has been found to be 2-5 times as high as in the general population (3,8,9) It is not infrequent that myocardial infarction is the first evident symptom of CS<sub>2</sub> effect on the cardiovascular system and it goes unpredicted by any abnormalities in the resting ECG. Therefore, the problem of proper diagnostics of the cardiovascular function in people exposed to CS<sub>2</sub> gains special significance. With the above in mind we have undertaken a study to determine the electrophysiological methods for the screening of individuals at risk of cardiovascular diseases.

### MATERIAL and METHODS

The examination was performed on a group of workers employed at the Chemical Fibres Plant. The studies concerned 190 workers, aged 23-67, with the period of exposure ranging from 5-30 years. The population under study was divided into three groups according to exposure duration: Group A - exposure longer than 20 years (mean 27.3 ± 9)

- 50 workers aged 44-67 (mean  $55.7 \pm 6$ ), Group B - exposure from 10 to 20 years (mean  $14.7 \pm 3$ ) - 59 workers aged 30-55 (mean  $41.5 \pm 7$ ) and Group C - exposure from 5 to 10 years (mean  $7.8 \pm 2$ ) - 81 workers aged 23-45 (mean  $35.5 \pm 7.5$ ). The subjects were under conditions of a continuous exposure to CS<sub>2</sub>, the level of which was highest in Groups A and B and amounted to 30-60 mg/m<sup>3</sup>. In Group C the lowest level of CS<sub>2</sub> exposure, ranging from **10-25 mg/m<sup>3</sup>**, was noted. The decreased air concentration of CS<sub>2</sub> was attributed to the technological process modifications. All the subjects were employed according to a 4-shift working system with a **6-hr** shift. The shifts started at **6 am.**, at noon (**12 am.**), at **6 pm.** and at **midnight** (12 pm.). During a year the working time for each worker covered about 500 workshifts i.e. 1500 hours.

The assessment of health status was based on an extended questionnaire (72 groups of questions consisting of **2-8** detailed items) completed by all workers. This questionnaire was oriented towards the presence and risk factors of ischaemic heart disease, and the self evaluation of health status and circulatory diseases in the worker's family members. Responding to the questionnaire was followed by the history taking and routine physical examination performed by the occupational health physician. 24-hr ECG recording was carried out using Medilog 3000 set (**oxford**, England) and Crypton 2500 (Micro-Medics, Germany) from two bipolar leads, CM5 and CS1. The study was conducted during normal occupational and leisure-time activities, and also during sleep. The analysed parameters included: abnormalities in Holter ECG (heart rhythm, conduction and repolarization disturbances), mean **24-h**, day-time and night-time heart rate. The recordings were automatically analysed and verified visually. Final results included evaluation of average heart rate, symptoms of ischaemia, arrhythmia and conduction disturbances. The obtained results were related to standards adopted for Holter monitoring (10).

Ambulatory blood pressure monitoring was performed during everyday professional and other activities using Oxford Medilog ABP System. The measurements were performed automatically, every half hour during daily activities and every hour during sleep. Altogether, approximately **40** measurements were made for each subject. Mean systolic (**BPS**) and diastolic (**BPD**) blood pressures for the 24 hours (**24-h**), day-time activity (**DAY**) and night-time rest (**NIGHT**) were calculated, with the Staessen's standards of arterial blood pressure (11) as the reference values. Owing to limited technical capacities, ABP monitoring was performed in 127 subjects (**80** from Group C, 20 from Group B and 27 from Group A).

## RESULTS

In all the groups more than 50% of subjects reported cardiovascular symptoms (52% in Group A, 72% in Group B and 52% in Group C). The presence of the typical risk factors of ischaemic heart disease (cholesterol level, overweight, cigarette smoking, diabetes, and positive family history) in particular groups resembled those in the age-matched groups of the general Polish population (12). Arterial hypertension diagnosed by a routine method was reported by 11 subjects from Group A, 13 from Group B and 10 from Group C. ABP confirmed hypertension in 3 subjects from Group A (27%), in 2 from Group B (15%), and 2 from Group C (20%).

The mean systolic and diastolic pressures for the **24** hours, day-time and night-time were found to be normal in all the groups. The daily pressure pattern with the physiological

night lowering of not less than **10%** was also retained. Detailed **data** are displayed in the **table 1**.

**Table 1.** Blood pressure level (mm Hg) in the **groups** examined

	GROUP A	GROUP B	GROUP C
<b>BPS 24-h</b>	124.7 ± 13.9	121.4 ± 11.0	122.1 ± 13.8
<b>BPD 24-h</b>	76.3 ± 7.1	77.6 ± 6.2	74.7 ± 8.8
<b>BPS DAY</b>	127.2 ± 13.7	124.4 ± 11.0	124.8 ± 14.2
<b>BPD DAY</b>	78.6 ± 7.6	80.5 ± 6.9	76.7 ± 9.1
<b>BPS NIGHT</b>	105.6 ± 11.5	109.7 ± 13.6	109.4 ± 11.8
<b>BPD NIGHT</b>	67.4 ± 6.8	77.6 ± 6.2	64.6 ± 6.2

Abnormal 24h ECG **records** were found in **46%** of subjects **from** Group **A**, **37%** subjects **from** Group B and **17%** subjects **from** Group C. In Group A, with the longest exposure time, the heart rhythm disturbances were most notorious, including ExV in **16** subjects, ExSV in **1**, and both the types in **1** subject. Only in **5** subjects these **disturbances** could be detected also in the resting ECG. Four subjects revealed traits of repolarization disturbances which were not recorded **by** resting ECG. In Groups B and C, with shorter exposure **periods**, repolarization impairments dominated: in **13** subjects **from** Group B and **8** subjects **from** Group C. Only in **3** subjects **from** Group B and **1** **from** Group C these abnormalities were confirmed **also** by the resting ECG records. Heart rhythm abnormalities were found in **6** subjects **from** Group B (ExV in **4** and ExSV in **1** subject) and **3** subjects **from** Group C (ExV - in **2** and ExSV in **1** subject) These did not appear in resting ECG records. Conduction impairments were not frequent; they were found only in **3** subjects **from** Group **A**, **5** **from** Group **B** and **5** **from** Group C. The 24-h heart rate exceeded the reference **values** (24-h HR > **87**) in **2** subjects **from** Group **A**, **8** **from** Group B and **11** **from** Group C.

## CONCLUSIONS

The frequency of abnormalities in Holter **24-h** ECG was found to be higher than in the general population and it was correlated with the duration of exposure. **There** was also a high consistency between the ailments reported in medical history and the pathological findings in Holter ECG records. No such concordance was found for Holter and resting ECG. **Therefore**, it seems advisable that in people reporting cardiovascular symptoms the 24-h ECG monitoring be performed even if no abnormalities have been found in resting ECG records.

Elevated BP was noted only in **27 %** of the subjects with long-term, in **15%** with **medium-term** and in 20% of subjects with short-term exposure. **Thus** we attempted a conclusion that the high frequency of arterial hypertension diagnosed routinely in workers exposed to CS<sub>2</sub> may have been associated with the phenomenon of the "white coat hypertension" due to personality changes deriving from the neurotoxic **effect** of CS<sub>2</sub>. Accordingly, it is

essential that long-term ECG and ABP monitoring be applied to detect cardiovascular impairments and to **confirm** diagnosis of **arterial** hypertension in workers under conditions of CS<sub>2</sub> exposure.

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