
Follow-up study of the toxic effects of carbon disulfide in the occupational environment.

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Introduction

Carbon disulfide is a volatile organic solvent currently used in large amounts only in the viscose industry. The negative effects of occupational exposure to CS₂ on health parameters have been described at length. Despite the abundant literature, several contradictions remain unsolved, the dose-effect relationship being poorly understood. The prime reason for this is the lack of exposure measurement datasets of sufficient quality. Since 1978 our research group has been involved in interdisciplinary research on the toxic effects of occupational exposure to CS₂ in a Belgian viscose factory. A cross-sectional epidemiological study was first performed. It revealed high levels of exposure for most job titles, exceeding by far the TLV-TWA value (31 mg/m³). Moreover, medical investigations showed that 61% of the employees examined exhibited polyneuropathy or other signs of CS₂ intoxication. Since this study, the factory management has introduced a number of technical adjustments to lower staff exposure to CS₂ and thus to improve health conditions for the factory employees. The present study aimed to continue and extend the multidisciplinary study conducted in the nineteen-eighties. The problem was tackled from a twofold perspective. In the occupational hygiene part of the study, the efficacy of the technical measures taken was checked by means of an extensive sampling schedule of personal monitoring. In the epidemiological part, a follow-up study investigated the effect of exposure to low levels of CS₂ on health parameters after years of high exposure. In addition, a new cross-sectional study was implemented with recently recruited employees having no history of exposure to high levels of CS₂. The dose was estimated by biological monitoring.

Materials and methods

Personal monitoring was done by the NIOSH 1600 method, using personal sampling pumps worn on the employees' belts. The pump was connected to a charcoal tube (SKC, 100/50 mg), with a drier tube fixed in front of it. Sampling generally lasted for approximately two hours. Spinners, first spinner, viscose preparators, workers from the maintenance shift and dayshift of the spinning department, and workers from the bleaching department were sampled. During interventions on the spinning machines employees were required to wear fresh air masks (spinners, first spinner) or half-facemasks with carbon cartridges (maintenance, dayshift). Viscose preparators wore fresh air masks while cleaning the churns. If respirators were worn, samples for personal monitoring were taken inside these respirators. After sampling the charcoal tubes were transported under chilled conditions and deep-frozen upon arrival in the lab. Analysis of the tubes was done by the NIOSH 1600 method, using a gas chromatograph with a mass spectrometer for detection. Post-shift urine samples were taken for determining the 2-thiothiazolidine-4-carboxylic acid concentration for biological monitoring. Analysis was done according to Thienpont et al. (1990). An external quality assessment was conducted for the CS₂ and TTCA analyses in order to check accuracy and precision.

The medical examinations consisted of self-administered questionnaires, clinical examinations (inspection, palpation of abdominal arteries, percussion of the liver, auscultation of the heart and lungs, blood pressure readings, weight and height measurements, clinical neurological examination), biochemical tests (liver function tests, blood lipids, glycaemia), electroneuromyography of the legs, an electrocardiogram, ophthalmologic examination, neuropsychological examination, vascular examination, and examination of the semen. All examinations were performed on one day for each

employee. Ninety-three employees were prepared to take part in the medical examinations (60% response rate). Thirty-five employees from a few factories where no exposure to organic solvents occurs were used as a control population.

Results

The external quality assessment of CS₂ analysis (NIOSH 1600) shows that most labs that took part in this study had low accuracy for high and low levels of CS₂. Best results were obtained for medium levels of CS₂. Accuracy for TTCA was good for all the labs participating in the external quality assessment. Precision, however, was very poor for one of the four labs, although this lab performed best for accuracy. Generally, the intra-laboratory variation on the TTCA determination for replicate samples was rather high, implying that reproducibility is not fully guaranteed.

The personal monitoring results confirm that the technical measures taken in the viscose factory after the previous study reduced the levels of personal exposure to CS₂. In the spinning department especially, exposure is substantially reduced. Not for any job title did the TWA-value exceed the TLV-TWA of 31 mg/m³. Reduction of exposure was minimal for the viscose preparators. They, however, already wore respiratory protection with pressured air during the previous study, with exposure levels well below the TLV-TWA. Replacement of these masks with the fresh air masks used in the spinning department does not seem to reduce exposure any further. A total number of 781 TTCA analyses were performed. Detailed results are not yet available at the time of writing this report.

As this report is being written all medical examinations are finished. The data, however, have not yet been analysed. Twenty-six of the ninety-three employees examined were advised to apply to the Fund for Occupational Diseases for compensation. Fifteen of the new applications were filed by spinners, of which 11 are of foreign origin. Considering the high number of spinners among the applicants despite the low levels of exposure to CS₂ measured by personal monitoring, and the high proportion of workers of foreign origin among the spinners, it is possible that workers of foreign origin are more susceptible to CS₂ intoxication. For the time being, this conclusion remains speculative. Of the twenty-eight employees examined that had already been exposed during the previous study, only four were advised to apply to the Fund for Occupational Diseases. This is most probably due to the "healthy worker effect". At first sight there seems to be a correlation between being advised to apply to the Fund for Occupational Diseases and the TTCA concentration in the urine. This, however, needs to be substantiated through statistical analysis of the complete dataset.

Conclusions

It can be concluded that the technical measures taken by the factory management are effective. It should be stressed that proper use of the protective equipment is essential to maintaining this effectiveness. It is therefore recommended that routine personal monitoring be continued in the future, in conjunction with biological monitoring.

Dose-effect relationships could not yet be established, but preliminary results slightly indicate a correlation between levels of urine TTCA concentrations and the presence of signs of polyneuropathy, as deduced from the list of new applications to the Fund of Occupational Diseases.

External quality assessment of CS₂ shows that most labs have poor accuracy at high and low levels of CS₂. External quality assessment of TTCA analysis reveals that although accuracy is generally good, precision is limited and labs vary widely in this respect.