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Key terms: [car painter](#); [exposure](#); [hepatotoxicity](#); [liver](#); [liver enzyme](#); [organic solvent](#); [serum activity](#); [short communication](#); [toluene](#)

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Car painters' exposure to a mixture of organic solvents

Serum activities of liver enzymes

by Kari Kurppa, MD,¹ Kai Husman, MD²

KURPPA K, HUSMAN K. Car painters' exposure to a mixture of organic solvents: Serum activities of liver enzymes. *Scand j work environ health* 8 (1982) 137-140. The serum activities of liver enzymes of car painters (N = 102) exposed to a mixture of solvents [toluene, xylene, and other constituents; about half the threshold limit value recommended by the American Conference of Governmental Industrial Hygienists (ACGIH) in 1981] were compared with those of age-matched referents (N = 102). The activities of aspartate aminotransferase, alanine aminotransferase, ornithine carbamoyl transferase, and gamma glutamyl transferase did not differ between the exposed and the nonexposed groups. Simultaneous neurophysiological and ophthalmological examinations of the same car painters had distinguished subgroups of "solvent-affected" and "non-affected" car painters. The enzyme activities were not higher in the "affected" subgroups than in the "nonaffected" ones. The results suggest that car painters' exposure to organic solvents (at the overall level of half the threshold limit value of the ACGIH) does not increase liver enzyme activities in routine tests.

Key terms: hepatotoxicity, toluene.

Car painters are exposed to a mixture of organic solvents (mostly toluene, but also xylene, isopropanol, and other constituents), some of which are considered potentially hepatotoxic. [For a review see the reports of Davidson et al (4), Steinborn (11) and Tamburro (12).] Routine monitoring of the activities of liver enzymes has been recommended, and also applied (9, 11), for the periodic examination of workers exposed to organic solvents. This recommendation is based mainly on the assumption that organic solvents (a heterogeneous group) may be hepatotoxic in concentrations found in the air at worksites.

Few controlled studies on the hepatic effects of exposure to solvent mixtures in industry have been reported. An uncontrolled cross-sectional study of industrial workers has implicated a mixture of solvents as the cause of increased liver enzyme activities (9) at exposure levels largely comparable to that of the car painters of the present study.

This study is part of a comprehensive survey of car painters' health. More abnormalities in the functions of the peripheral nervous system had been found for car painters than for their referents (10), and ophthalmological examinations revealed an increased frequency of lens changes among car painters (7). Thus, the car painters studied comprised both "solvent-affected" and "nonaffected" subgroups. The results of the car painters' liver enzyme tests were compared with those of nonexposed referents, and the results of the "solvent-affected" subgroups with those of the "nonaffected" ones.

Subjects and methods

Subjects. The exposed group comprised 102 car painters, all men, from 27 car repair shops in Helsinki, Finland. The sample was drawn from all active car painters in Helsinki (N = 166) by a stratified sampling method so that painters with different durations of exposure were evenly represented. The duration of exposure varied from 1 to 40 (mean 15, SD 9) a, and the age of car painters from 20 to 65 (mean 35, SD 11) a.

A comparable reference group of 102 men was chosen from locomotive engineers

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Table 1. Mean concentrations of the solvents in the breathing zone of 40 car painters. (Number of car repair shops = 6, number of samples = 54, sampling period = 1 h)

Solvent	Highest concentration found (ppm)	Mean concentration (ppm)	Percentage of the TLV ^a	TLV ^a (ppm)
Toluene	250	30.6	30.6	100
Xylene	36	5.8	5.8	100
Butyl acetate	130	6.8	4.5	150
White spirit	150	4.9	4.9	100
Methyl isobutyl ketone	39	1.7	3.4	50
Isopropanol	85	2.9	0.7	400
Ethyl acetate	33	2.6	0.7	400
Acetone	25	3.1	0.3	1,000
Ethanol	27	2.9	0.3	1,000
Total			49.2	

^a TLV = threshold limit value recommended by the American Conference of Governmental Industrial Hygienists in 1981.

Table 2. Serum activities of liver enzymes among car painters and referents.

Enzyme (U/l)	Car painters (N = 102)		Referents (N = 102)	
	Mean	SE	Mean	SE
Aspartate aminotransferase	20.4	0.9	22.2	1.3
Alanine aminotransferase	25.0	1.6	28.0	1.5
Gamma glutamyl transferase	26.3	2.7	26.2	2.6
Ornithine carbamoyl transferase	0.11	0.01	0.10	0.01

Table 3. Number of workers with enzyme activities higher than the reference values.

Enzyme	Car painters (N = 102)	Referents (N = 102)
Aspartate aminotransferase (ASAT)	3	3
Alanine aminotransferase (ALAT)	14	18
Gamma glutamyl transferase (γ -GT)	27	28
Ornithine carbamoyl transferase (OCT)	4	3

Reference values: ASAT $\leq$ 40 U/l, ALAT $\leq$ 40 U/l, γ -GT $\leq$ 28 U/l, OCT $\leq$ 0.4 U/l.

Table 4. Serum activities of liver enzymes of car painters with normal and abnormal neurophysiological findings (9).

Enzyme (U/l)	Neurophysiological findings			
	Normal (N = 43)		Abnormal (N = 11)	
	Median	Range	Median	Range
Aspartate aminotransferase	20	7—61	20	15—38
Alanine aminotransferase	23	7—88	20	10—71
Gamma glutamyl transferase	23	7—147	24	6—37
Ornithine carbamoyl transferase	0.08	0—0.66	0.13	0.03—0.28

Table 5. Serum activities of liver enzymes of car painters with normal and abnormal ophthalmological findings (6).

Enzyme (U/l)	Ophthalmological findings			
	Normal (N = 44)		Abnormal (N = 47)	
	Median	Range	Median	Range
Aspartate aminotransferase	18	7—61	19	10—51
Alanine aminotransferase	20	7—83	19	7—88
Gamma glutamyl transferase	17	3—126	18	6—147
Ornithine carbamoyl transferase	0.07	0—0.66	0.06	0—0.56

and assistants of the Finnish State Railways. The referents and the exposed subjects were age-matched within 2 a.

The medical histories were collected with a questionnaire. Alcohol consumption was assessed by a standardized questionnaire developed at the Finnish Social Research Institute of Alcohol Studies (6). (The car painters' alcohol consumption and their use of drugs were similar to the referents' alcohol consumption and use of drugs.)

Abnormally slow motor and sensory conduction velocities or prolonged motor distal latencies of the peripheral nerves had been found in 12 of the 59 car painters studied (10). The ophthalmological examination had revealed lens opacities in 48 of the 92 car painters examined (7). The liver enzyme activities of these two "solvent-affected" subgroups were compared with the "nonaffected" car painters.

Exposure. The car painters were exposed to a mixture of organic solvents, mostly to toluene (more than half of the solvent mixture), and to a less degree to xylene, butyl acetate, white spirit, and other ingredients (table 1). The exposure conditions have been described in detail elsewhere (5). In spray-painting an average of 5 m² a day, the car painters used 3 l of the solvent mixture. The average solvent exposure was about 50 % of the current threshold limit value recommended for solvent mixtures by the American Conference of Governmental Industrial Hygienists in 1981 (1).

Laboratory tests. The liver enzyme tests included the serum activities of aspartate aminotransferase (3), alanine aminotransferase (3), gamma glutamyl transferase

(Boehringer cat no 15631), and ornithine carbamoyl transferase (2, 8).

Results

Table 2 shows the liver enzyme activities of the car painters and the referents. The results for both groups were similar. The prevalence of abnormal results for the car painters was not higher than that for the referents (table 3).

The liver enzyme activities of the car painters with abnormal neurophysiological (table 4) or ophthalmological (table 5) findings were similar to those of the car painters with no corresponding abnormalities. A scrutiny of the medians and ranges of the results did not indicate a need for testing the statistical significance of the differences between the groups under study.

One car painter had had liver disease of an unknown origin several years ago. His liver enzyme activities were normal at the time of the present investigation.

Discussion

The results indicate that, at the exposure level under study, the liver enzyme activities of car painters are not affected by exposure to solvents.

A cross-sectional study must consider the effect of possible selection due to liver diseases. Yet none of the car painters who had left their trade in the 5 a preceding the present examination reported that liver disease or abnormality was the reason (5). Liver function tests were often routine parts of their periodic medical examinations, but the plant physicians told us that they had not restricted spray-

painting because of increased enzyme activities. Thus health selection has probably been negligible with regard to liver enzyme test results.

In conclusion, the liver enzyme tests under study did not separate the group of car painters from the nonexposed referents or the subgroups of "nonaffected" car painters from those with abnormal findings in the peripheral nervous system or eye lens. We conclude that the commonly examined liver enzyme activities are not readily affected by car painters' exposure to solvents even though the painters in question may show abnormal neurophysiological and ophthalmological findings at the group level. Etiologies other than solvent exposure should be actively sought when liver enzyme activities above normal are found in workers exposed to this type and intensity of solvent mixture.

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