

## THE MORTALITY OF GERMAN VINYL CHLORIDE (VC) AND POLYVINYL CHLORIDE (PVC) WORKERS

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### ABSTRACT

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In order to determine standardized mortality ratios (SMRs) for workers exposed to vinyl chloride (VCM) basic data for two exposed and one non-exposed cohorts were analyzed. The results of a German mortality study demonstrate a considerable increase in certain specific SMRs in exposed workers. The study clearly demonstrated the importance of establishing a cohort of workers not exposed to VCM since an increase in SMR for ischemic heart disease was found in both exposed and non-exposed groups. Without a cohort of non-exposed workers this effect would have been falsely attributed to exposure to VCM.

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Several considerations led to the design of the mortality study described in this paper. Since 1972 there have been 90 reports of sickness following exposure to vinyl chloride monomere (VCM) in workers of the vinyl chloride as well as polyvinyl chloride producing industry in the Federal Republic of Germany. In 1974 Creech and Johnson<sup>1</sup> reported three cases of hemangiosarcoma of the liver in PVC-producing plants in USA. In the same year we could detect two cases in PVC-workers. In the meantime there have been twelve deaths due to hemangiosarcoma of the liver in PVC-workers in Western Germany<sup>2</sup>. Toxicological investigations of Maltoni and co-workers, who suggested cancerogenicity of VCM, have stimulated epidemiological studies in exposed workers.

The aims of the German mortality study were to determine standardized mortality ratios (SMR) for male workers exposed to VCM, using the mortality ratios of the West German male population as reference, and to investigate the SMRs of a cohort of workers of the chemical industry without exposure to VCM as comparison group, and of a cohort of workers in PVC-processing plants.

This study was initiated by the Ministry of Labour, Health and Social Affairs of Northrhine-Westfalia and supported by the PVC-producing industry. It covers the period from the beginning of VC- and PVC-production in various plants until December 31st, 1974.

The basic data of the three cohorts ascertained are in Table 1. Standardized mortality ratios (SMR) were calculated, applying the national mortality statistics for the respective years for total mortality. For specific causes of death the statistics of 1968 were applied for the years before 1968, and the statistics for the respective years for 1969–1974. Weighting was done according to the number of deaths in which the cause of death could not be ascertained, as has been done by Tabershaw<sup>4</sup>.

SMR for total mortality came out highest in Groups I and III. Assuming the "healthy worker effect", as demonstrated by Ott and co-workers<sup>3</sup> for workers in the chemical industry, the SMR for total mortality in Group I and Group III has to be considered as relatively increased.

The results of the German mortality study (Table 2) demonstrate considerable increases in certain specific SMRs in Group I (VCM and PVC production). In Group I there is a significantly increased SMR for malignant tumors (ICD 140–209), ischemic heart disease (ICD 410–414) and accidents (ICD 800–949). SMR for ischemic heart disease is also increased in Group II and Group III. When differentiating the SMR for malignant tumors, it will be seen that there is an extraordinary increase in tumors of the liver not only in Group I but also – to a slightly lesser extent – in workers of Group II, who should have been without contact with VCM. In Group I there are also increased SMRs for systemic malignancies (ICD 200–209) and in Group III an elevation of SMR of brain tumors was demonstrated.

Analyses were made according to both age groups and duration of exposure. For Group I the SMRs were broken down according to the site of the plant (industrial vs. agricultural). In all these analyses the most remarkable result is the increase of SMR of malignancies of the liver with increasing duration of exposure.

TABLE 1  
Basic data for the cohorts investigated in a German Mortality Study of PVC-workers.

	Group I VCM- and PVC-production	Group II without exposure (comparison)	Group III PVC processing
Population (Germans and Austrians)	7021	4910	4007
Man years	73734	76029	52896
Follow-up %	93.2	89.8	92.1
Deceased, observed	414	417	360
expected	435	533	380
Cause of death unknown (%)	7.2	11.3	13.1
Total mortality SMR	95	78	95
Workers of foreign nationality (excluding Austrians)	882	711	1454
Deceased	6	6	10

TABLE 2  
Standardized mortality ratios for specific causes of death according to German Mortality Study of PVC-workers.

ICD 8	Cause of death	Group I			Group II			Group III		
		VCM and PVC production			Without exposure (comparison)			PVC-processing		
		Obs.	Exp.	SMR	Obs.	Exp.	SMR	Obs.	Exp.	SMR
140-199	Malignant tumors	79	82.9	103	77	104.8	83	60	75.6	89
200-209	Tumors of blood and hematopoietic system	15	7.7	214**	6	8.9	77	2	6.3	34
150-159	Malignant tumors of GI-tract and peritoneum	45	32.7	149*	27	41.8	71	15	30.3	56
151	Stomach	18	14.4	138	10	18.6	62	7	13.5	57
153	Colon	6	5.8	109	3	7.3	42	1	5.3	26
155	Liver	12	0.9	1523**	4	1.1	401*	3	0.8	434
160-163	Respiratory system	24	26.6	96	30	34.0	100	25	24.4	113
162	Trachea, bronchus, lung	22	24.6	95	30	31.5	108	24	22.6	116
188	Urinary bladder	1	2.9	36	2	3.7	63	2	2.8	77
191	Brain	2	1.3	162	2	1.6	184	5	1.1	535**
410-414	Ischaemic heart disease	91	76.5	127*	115	96.7	131*	96	69.4	158**
410	Acute myocardial infarction	66	61.8	114	83	77.1	120	69	55.0	143**
430-438	Cerebrovascular disease	29	29.4	104	25	39.2	70	23	29.7	82
490-493	Bronchitis, emphysema, asthma	6	14.4	44	10	19.2	59	4	14.2	30
571	Cirrhosis of liver	14	18.4	82	17	21.3	92	14	15.4	105
800-949	Accidents	61	49.0	137*	44	51.3	99	32	35.5	110
950-959	Suicide	24	25.5	101	10	27.3	70	15	19.0	92
011	Tuberculosis of lung	4	5.5	75	4	6.9	65	0	4.8	-
	Total mortality	414	434.7	95	417	533.0	78	360	379.6	95

\*Beyond 95% confidence interval

\*\*Beyond 99% confidence interval

In our opinion this study demonstrates the importance of establishing a cohort of workers not exposed to VCM. In all the cohorts investigated there was an increase in SMR of ischemic heart disease. Without a cohort of non-exposed workers this effect would have been falsely attributed to exposure to VCM.

#### REFERENCES

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