

AN EPIDEMIOLOGICAL STUDY OF WORKERS IN PLANTS MANUFACTURING ETHYLENE DIBROMIDE

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ABSTRACT

Ethylene dibromide (EDB) is used as a scavenging agent in antiknock additives in gasoline and as a pesticide. It has been shown to produce cancer, when administered at high dose rates, and to be a cause of infertility, in animals.

EDB has been produced in Britain for over 35 years in two plants, each situated remotely from any other chemical industry and producing no other halogenated hydrocarbon than EDB. One plant ceased production in 1970; the second plant started production in 1954 and is still operating. Mortality data for individuals who had been employed during this period for five years or more at either plant, and who were potentially exposed to EDB, have been examined and compared with published data for the local general populations. A hundred and seventeen individuals from the older plant and 234 from the presently operating plant were included in the groups studied. No evidence of any increase in the death rates from cancer could be detected.

The fertility of 41 married men employed at one of the plants and potentially exposed to EDB was assessed, by comparison of the numbers of children born in each family before and after the employee joined the Company with similar data for a group of 41 who were not exposed to EDB. Comparative data were also provided from a control group of the local population with no known exposure to EDB. No evidence of chemically induced infertility could be detected statistically nor was any concern expressed by employees.

Similar surveys of employees of American producers of EDB are understood to have yielded comparable results.

Ethylene dibromide (EDB) has been used for many years as a scavenging agent in antiknock compounds added to motor gasoline and as a pesticide. It has been recognised to be capable of causing severe chemical burns of the skin; it has also been shown¹ to impair the fertility of bulls and hens when present as a contaminant in foodstuffs previously heavily dosed with EDB pesticide.

The publication of results of animal experiments² which showed EDB to be carcinogenic to rats and mice when administered orally, in relatively large doses by intubation, led to the warning by the National Institute for Occupational Safety and Health (NIOSH) in the U.S.A., in 1975, that it should be regarded as potentially carcinogenic to man also.

The more recent notification by NIOSH in 1977 of evidence of impaired fertility, or complete sterility, in a group of men engaged in the production of the chemically related compound dibromochloro-propane (DBCP), also used as a pesticide, caused additional concern over the potential occupational health hazards of EDB. The various companies involved in the manufacture and use of EDB have therefore carefully studied the health records of employees engaged in the production of the compound. This paper will report the findings of one such company in Britain.

MANUFACTURING PROCESS

EDB has been produced at two factories during the period from 1940. The process involves the extraction of bromine from sea water and its subsequent reaction with ethylene to form EDB. It has been this Company's practice to manufacture the EDB at the location of bromine production; the requirements of a suitable coastal location for bromine extraction have resulted in these factories being remote from any other chemical industry activity; the potential exposure to hazard has therefore been restricted to those factors involved in bromine and EDB production. Most other manufacturers transport the bromine to alkylation units on larger, chemical complexes, where potential exposure is to a much greater variety of halogenated chemicals.

Factory A started production of EDB in 1940 and continued until 1970; factory B started production in 1954 and is still operating.

MORTALITY SURVEYS

To evaluate the extent of any hazard of carcinogenicity in the production of EDB, the causes and rates of death of personnel from both factories have been determined. The remote situation of both factories resulted in relatively low rates of labour turnover and also considerably facilitated the follow-up of previous employees.

Factory A had closed by the time the survey was undertaken (1977) and complete data on all personnel were no longer available, especially for those employed during the initial, wartime, years. It was, however, possible to compile a list of 117 men who had been employed at the plant, with potential exposure to EDB, for at least four years during the period 1940 to 1970; this list is thought to contain all individuals involved for over four years. Thirty-four of these had died by the date of the survey, the remaining 83 were still alive. Table 1 summarises the information available for those who had died. The 83 still alive in 1977 had an average age of 59 ± 8 years. They had been employed on the EDB process for an average of 21 ± 6 years, and had been away from the process (which ceased in 1970) for an average of 9 ± 7 years.

The size of the group studied was too small to enable meaningful comparison to be made of each year's death rate with that of the local population. As a basis for comparison a table was constructed in terms of the numbers of

TABLE 1
Mortality data from Factory A.

Cause	No.	Age	Years employed	Years left
Cardio-vascular disease	18	62 (44-79)	18 (4-33)	5 (0- 9)
Cerebro-vascular disease	2	66 (—)	22 (19-25)	1 (—)
Cancer	4	66 (53-76)	16 (9-23)	14 (0-26)
Other	10	60 (37-80)	13 (4-23)	6 (0-15)

man-years falling in each of four age ranges over the period of study. The death rates from all causes, and from cancer, within each age group during the entire period were then compared with the values for the general population in the same part of the country over a similar period. The findings are summarised in Table 2. It is apparent that little change in local mortality rate occurred over a ten-year period and that the studied group compared favourably with the general population — both overall and as regards cancer in particular.

TABLE 2
Deaths and death rates from all causes and from cancer, Factory A.

Age range (years)	Factory population					Local population			
	No. of man-years	No. of deaths		Death rate per 1000 man-years		Death rate per 1000 men			
		Total	Cancer	Total	Cancer	1961		1970	
						Total	Cancer	Total	Cancer
25-44	1797	3	0	1.67	0	1.62	0.30	1.38	0.32
45-64	1440	15	1	10.42	0.69	12.49	3.43	12.95	3.44
65-74	177	9	2	50.85	11.30	52.65	11.04	49.53	11.65
75 and over	47	7	1	148.94	21.28	136.52	16.15	135.78	16.99

Factory B opened in another part of the country in 1952 and regular EDB production started in 1954. A few individuals transferred from Factory A as supervisors. Health records were more complete than for Factory A, although data on the current state of health of individuals who had left the Company during the period had to be obtained through local enquiry.

The records showed that 297 individuals had been employed at the factory up to the end of 1975. Of these only 14 had never been potentially exposed to EDB.

Of the 297 individuals it proved impossible to discover the state of health, at the end of 1975, of 23. Of these, however, 15 had been employed for one year or less, a further five for less than three years and three for between four and five years.

Of the 130 individuals employed at the end of 1975, 31 had been employed for less than five years, 26 less than three years.

For comparison with the data from Factory A, all individuals potentially exposed to EDB for at least four years by the end of 1975 have been considered as a group. Only three individuals have had to be ignored through lack of information. One was employed between February 1953 and September 1957, and known to have been alive in 1964; another was employed from September 1952 until June 1957 and the third from May 1951 until July 1956. A total of 195 individuals remained. Twenty-six had died by the end of 1975. Details of these deaths are given in Table 3. A further five deaths occurred among those who were exposed for less than four years.

TABLE 3
Mortality data from Factory B.

Cause	No.	Age	Years employed	Years left
Cardio-vascular disease	11	52 (44-68)	11 (5-19)	4 (0-10)
Cerebro-vascular disease	4	53 (38-68)	13 (7-21)	3 (0-8)
Cancer	8	53 (44-73)	10 (5-20)	5 (0-15)
Other	3	53 (47-59)	10 (6-12)	3 (0-4)

TABLE 4
Deaths and death rates from all causes and from cancer. Factory B.

Age range (years)	Factory population					Local population	
	No. of man-years	No. of deaths		Death rate per 1000 man-years		Death rate per 1000 men (1975)	
		Total	Cancer	Total	Cancer	Total	Cancer
25-44	1795	3	1	1.7	0.6	1.9	0.3
45-64	1445	20	6	13.8	4.2	14.1	4.0
65-74	81	3	1	37.0	12.3	52.0	12.9
75 and over	1	0	0	—	—	126.0	21.5

The 169 still alive at the end of 1975 had an average age of 52 ± 10 years and had been employed for an average of 15 ± 7 years. Those who had left employment before to 1975 had been away, on average, 11 ± 3.5 years.

The number of man-years in each of four age ranges over the period of the study were again calculated, as for Factory A. Mortality rates from all causes and from cancer, were derived and compared with the rates for the local population, as shown in Table 4. The rates for the two groups were virtually identical.

FERTILITY SURVEYS

When concern over the potential effect of EDB on fertility arose, only Factory B was in operation. There had never been any overt evidence of problems of fertility among employees exposed to EDB at either factory nor had concern been expressed by any individuals to the Medical Officers.

As a preliminary step it was decided to determine the numbers of children born in the families of married employees at Factory B before and after they joined the Company. The survey was limited to those individuals employed at the time.

There were 82 employees, half of whom were judged to have had insignificant exposure to EDB whereas the remaining 41 had a varied but more frequent exposure pattern. Thirteen were regularly engaged in processing EDB; a further 17 were process operators with variable exposure, and 11 were engaged on maintenance work with irregular potential exposure.

Details of the number and ages of children were obtained and summarised in relationship to the date on which the father joined the Company, the father's age at the date of birth of each child and his years of service at that time. The results are shown in Table 5. Six families, four in the unexposed and two in the potentially exposed groups, were childless at the time of the study; they have been included in the calculations of average family sizes.

TABLE 5
Summary of data on family size relative to degree of potential exposure to EDB.

Degree of exposure		None	Regular process	Irregular	
				Process	Maintenance
No. of men		41	13	17	11
Age on joining (years)		31.8	32.2	30.5	29.8
No. of children when first employed	Total	41	29	23	14
	Average	1.02	2.23	1.35	1.27
	Range	0-4	0-7	0-3	0-2
No. of children born while employed	Total	39	8	14	13
	Average	0.95	0.62	0.82	1.18
	Range	0-4	0-3	0-3	0-3
Years employed when child born	Average	5	1.5	4	4.5
	Range	0-17	0-3	0-10	1-16

The 41 men in the unexposed group had an average age of 31.8 (20–48) years on joining the Company. The average number of children on joining was 1.02 and this had increased to 1.97 by the time of the survey. The average length of service with the Company was 15 years. The 41 men with greater potential exposure to EDB had an average age of 30.9 (20–42) years on joining the Company and an average length of service at the time of the survey of 15 years. They had an average of 1.61 children per family on joining, which had increased to 2.46 by the time of the survey. Thus the average increase in family size during employment was 0.95 for the unexposed group, and 0.85 for the exposed group. The increases for the various groups of exposed men were 0.62 for the regularly exposed process workers, 0.82 for the process workers with variable exposure and 1.18 for the maintenance workers.

As a further stage in the study the personal records of all married employees who had worked at the factory for more than five years during the period 1952 to 1977, but had left employment by the time of the survey, were examined. An additional group of 75 men who had worked within the process areas of the factory was obtained, all of whom had joined the Company between 1952 and 1958 at an average age of 34 years (20–54) and who had remained for an average of 11 years. It is believed that all children born up to the date of leaving the Company, have been included; information is not available on children born after this time. The average number of children per family at the date of joining was 1.27 and this increased by 0.7, to 1.97 during the period of employment.

A sample of 80 married men randomly selected from among the patients of a local general practitioner, but excluding any present or past employees of the Company, had an average family size of 1.98 children.

The ultimate average family size is remarkably constant among all these groups. The fact that fewer children were born after the date of the fathers joining the Company is probably much more closely related to their age at joining, which was over 30 years, than to any influence of the nature of the products manufactured. The unexposed group showed a similar ratio and both groups achieved a similar average family size to that of the controls.

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