

Relationship between Termiticide Treatment and Human Pollution by Chlordane, Oxychlordane, and Nonachlor

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Chlordane (USEPA 1988) had been used as a termiticide for more than twenty years until September 1986 in Japan. The characteristic features of chlordane are that it is stable in an environment such as sediment (Oloffs et al. 1978, Hirai and Tomokuni 1989) and that its bioaccumulation in some species of bacteria, invertebrates, and fish is large (WHO 1984).

In the previous studies, we investigated the levels of chlordane, oxychlordane, and nonachlor on human skin and in human blood (Hirai and Tomokuni 1991, 1993). Oxychlordane is one of the metabolites of chlordane in mammals (Nomeir and Hajjar 1987). Nonachlor is one of major components of technical chlordane (Sovocool et al. 1977). The data obtained were discussed mainly in consideration of age and sex. We found some people whose blood nonachlor levels were remarkably higher than the geometric mean level. They were found not only in the group of higher level of skin chlordane but also in the group of lower level where some of them were males of middle age. Skin chlordane was used for evaluating direct exposure to chlordane (Wariishi and Nishiyama 1989, Sasaki et al. 1991).

The main purpose of this study was to investigate the relationship between the levels of chlordane, oxychlordane, and nonachlor on skin and in blood and the termiticide treatment of subjects' homes.

MATERIALS AND METHODS

The subjects were outpatients at Saga Medical School Hospital from May to September 1992. The purpose of the present study and the procedures were explained to each of about 200 subjects, and informed consent was obtained from 186 of subjects to wipe skin surface of antebrachium and/or to use for analyzing the rest of blood utilized for hematological examination. We asked each subject about job, termiticide treatment, and habit of fish and shellfish intake in relation to the compounds investigated. We also asked them about their efforts on general principles of

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health and sanitation in relation to everyday life. The subjects were different from those in our previous studies (Hirai and Tomokuni 1991, 1993) except four subjects.

The methods of sampling and pretreatment procedures for the analysis were the same as those described in our previous papers (Hirai and Tomokuni 1987, 1993). GC-MS was used to determine total amount of *cis*-chlordane and *trans*-chlordane($C_{10}H_6Cl_8$), oxychlordane ($C_{10}H_4Cl_8O$), and total amount of *cis*-nonachlor and *trans*-nonachlor ($C_{10}H_5Cl_9$). Blood data were adjusted by the mean recoveries obtained monthly by adding six samples with 1 ng of standards. The recoveries were 59-69%, 47-61%, and 60-69%, for *cis*-chlordane, oxychlordane, and *trans*-nonachlor. Skin data were described as the amounts detected on 25 cm² of skin surface. Mean recoveries of skin analysis were obtained monthly by adding five blank samples with 1 ng of standards. They were 54-64%, 39-55%, and 53-65%, for *cis*-chlordane, oxychlordane, and *trans*-nonachlor. Coefficients of variation of the determination were less than 10%(1 ng, n=10). Detection limits were 0.04 ng/g, 0.08 ng/g, and 0.02 ng/g for chlordane, oxychlordane, and nonachlor in blood, and they were 0.04 ng/25 cm², 0.08 ng/25 cm², and 0.02 ng/25 cm² for chlordane, oxychlordane, and nonachlor on skin surface. Student's t-test preceded by F test was used to analyze the difference of means.

RESULTS AND DISCUSSION

The subjects were classified into three groups with respect to the termiticide treatment, i.e., YES, NO, and NC. The subjects of YES group answered that their homes were treated with a termiticide before September 1986. The subjects of NO group answered that their homes were not treated before September 1986. The NO group includes the subjects whose homes were not treated before September 1986, but they were treated after September 1986. When the subjects' memories were not clear, they were classified into NC group. There were no subjects who were engaged in treating termiticide before September 1986.

Table 1. Relationship between termiticide treatment and the levels of chlordane and nonachlor detected on skin(ng)

treatment	chlordane				nonachlor			
	n	n*	median	range	n	n*	median	range
YES	52	45	0.30	nd-7.41	52	46	0.10	nd-2.30
NO	108	52	nd	nd-2.93	110	54	nd	nd-1.30
NC	20	14	0.13	nd-1.15	20	14	0.05	nd-0.42
total	180	111	0.07	nd-7.41	182	114	0.02	nd-2.30

n*, number of positive; nd, not detected.

Skin levels of chlordane and nonachlor were described in Table 1. We could not detect oxychlordane. Chlordane and nonachlor were detected in about 90% of the YES group. About 80% data of the YES group was included in the chlordane level of more than 0.10 ng. Chlordane and nonachlor were detected even in about 50% of the NO group. However, more than 80% data of the NO group was included

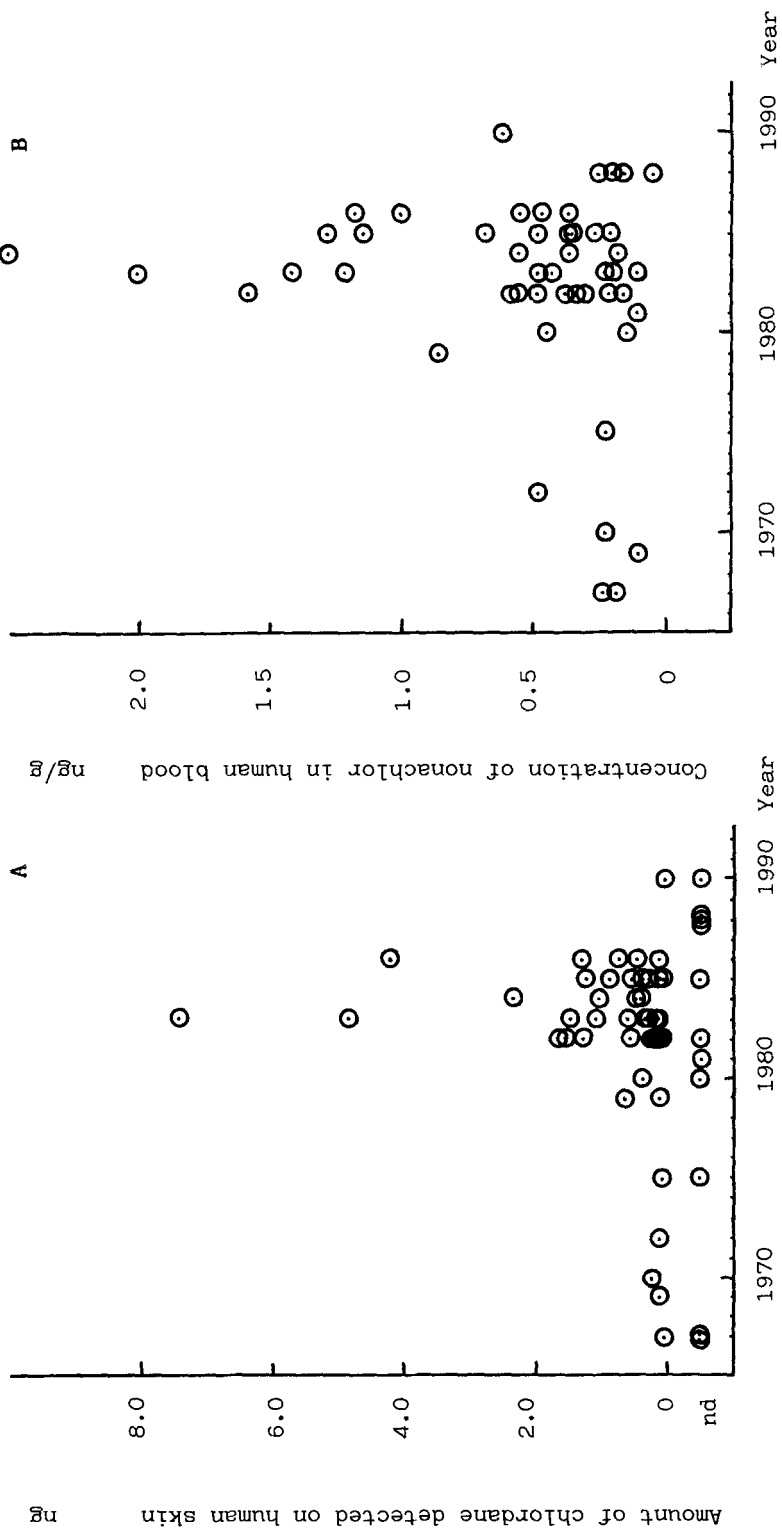


Figure 1. Relationship between the year of termiticide treatment and the amount of chlordane detected on human skin (A) and concentration of nonachlor in human blood (B)

in the chlordane level of less than 0.10 ng. Compared with the NO group, the increase over 7 times in the median level of skin chlordane was observed in the YES group. Remarkably higher amount was also detected on the skin of a few subjects of the NO group.

Table 2. Relationship between termiticide treatment and the levels of chlordane, oxychlordane, and nonachlor in blood(ng/g)

treatment	n	chlordane n* range	oxychlordane n* range	nonachlor g.mean(-SE,+SE)	range
YES	47	16 nd-0.32	25 nd-0.51	0.42(0.38,0.47)	0.11-2.50
NO	105	8 nd-0.13	29 nd-0.28	0.22(0.20,0.23)	0.03-1.37
NC	14	1 nd-0.07	2 nd-0.11	0.15(0.12,0.18)	0.04-0.43
total	166	25 nd-0.32	56 nd-0.51	0.25(0.24,0.27)	0.03-2.50

n*, number of positive; nd, not detected; SE, standard error.

Blood levels of chlordane, oxychlordane, and nonachlor were described in Table 2. They were detected in 34%, 55%, and 100%, respectively, of the YES group, and in 8%, 27%, and 100% of the NO group. Increases in the rate by the termiticide treatment were 4.5 times for chlordane, and 2 times for oxychlordane. The increase in the geometric mean(g.mean) level of blood nonachlor was about 2 times. The difference in the blood nonachlor levels between YES group and NO group was significantly detected at 0.001 level($t=5.01$).

Figure 1A shows the relationship between the year of termiticide treatment and the amount of chlordane detected on skin. Higher amounts were detected in the subjects answered the year of treatment between 1982 and 1986. The levels after 1986 were lower. Figure 1B shows the relationship between the year of termiticide treatment and the concentrations of nonachlor in blood. Higher concentrations were also detected in the subjects answered the year of treatment between 1982 and 1986. However, the tendency was not as sharp as that observed in Fig. 1A. The levels after 1986 were lower.

Table 3. Regression equations between the amount of chlordane and nonachlor detected on skin (X, ng) and the concentration of chlordane, oxychlordane, and nonachlor in blood (Y, ng/g)

X	Y	treatment	regression equation	r	n
chlordane	chlordane	YES	$Y=0.08+0.012X$	0.20	16
		NO	$Y=0.08-0.013X$	0.22	5
chlordane	oxychlordane	YES	$Y=0.18+0.031X$	0.46*	23
		NO	$Y=0.15+0.006X$	0.03	15
chlordane	nonachlor	YES	$Y=0.45+0.19X$	0.50**	42
		NO	$Y=0.30-0.01X$	0.02	49
nonachlor	nonachlor	YES	$Y=0.42+0.51X$	0.56**	43
		NO	$Y=0.29-0.004X$	0.003	52

*, $p<0.05$; **, $p<0.001$.

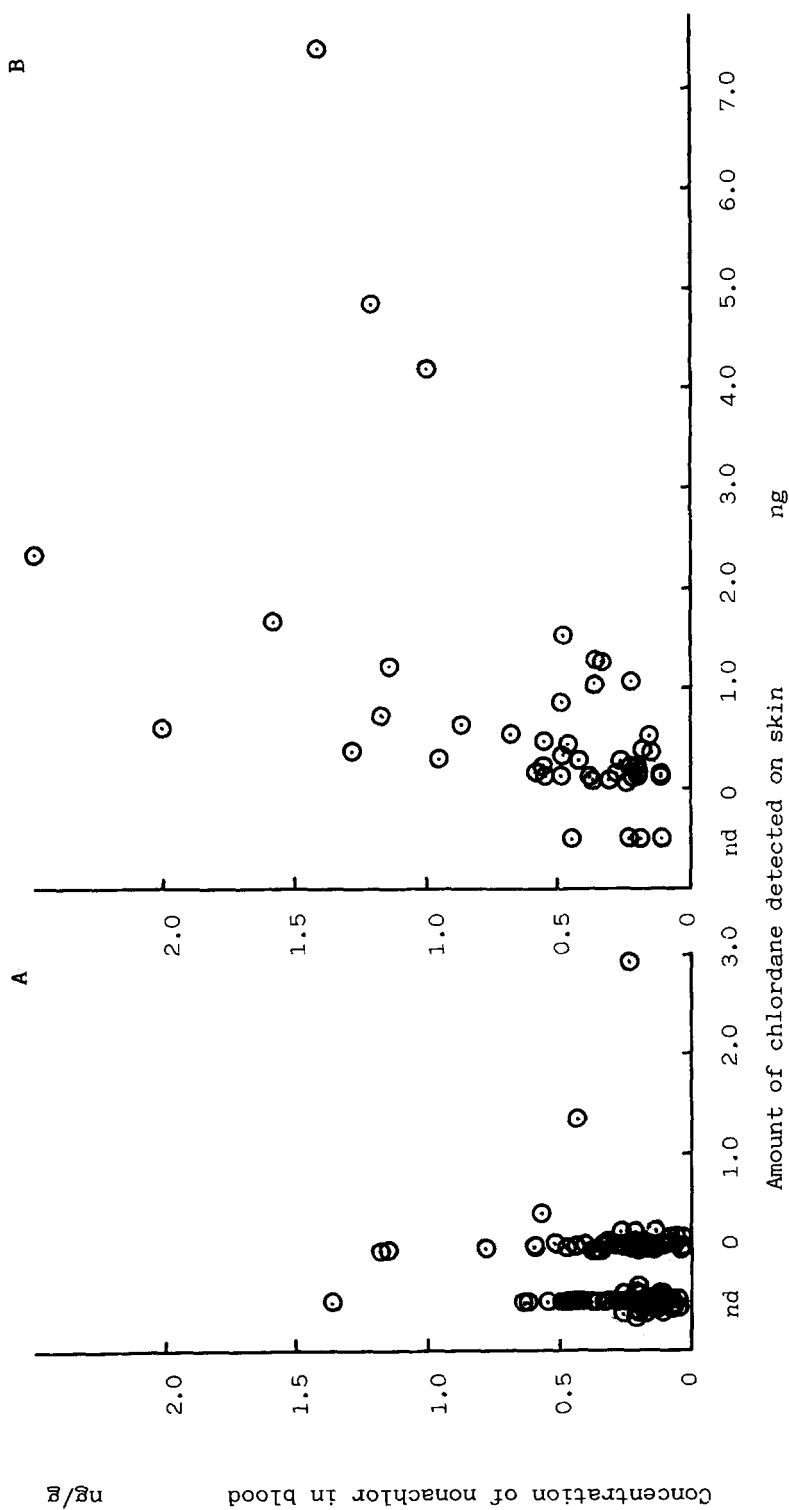


Figure 2. Relationship between the amount of chlordane detected on skin and concentration of nonachlor in blood
 Termiticide treatment: A, NO (n=100); B, YES (n=46).

Table 3 shows regression equations and correlation coefficients between the amount detected on skin and the concentration in blood. Although there are some exceptions, intercept, slope, and correlation coefficient were higher in the YES group than those in the NO group. Slopes were larger and positive in the equations of YES group, whereas they were smaller and negative in almost equations of NO group.

Figure 2 shows the relationship between the amount of chlordane detected on skin and the concentration of nonachlor in blood. Both data were generally lower and negative correlation was observed in the NO group (Fig. 2A). In contrast to the data in the NO group, the data in the YES group showed the higher levels and positive correlation (Fig. 2B). However, large ranges in concentrations of blood nonachlor were observed at the lower level of skin chlordane (Fig. 2A) as well as its higher level (Fig. 2B). We suppose there are some factors other than age, sex, and termiticide treatment affecting both skin and blood levels.

Further investigations are in progress to elucidate the levels of chlordane, oxychlordane, and nonachlor in human.

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