

CHLORINATED DIOXIN, DIBENZOFURAN AND COPLANAR PCB
LEVELS IN BLOOD AND SEMEN OF MICHIGAN
VIETNAM VETERANS

Schechter, A.^A, McGee, H.^B, Stanley, J. and Boggess, K.,^C

^A Department of Preventive Medicine, Clinical Campus at Binghamton, College of Medicine, State University of New York Health Science Center - Syracuse, 88 Aldrich Ave., Binghamton, NY 13903 USA

^B Michigan Department of Public Health 3423 N. Logan, PO Box 30195, Lansing, Michigan 48909 USA

^C Midwest Research Institute, 425 Volker Blvd., Kansas City, Missouri 64110 USA

SUMMARY

Fifty Michigan Vietnam veterans who were potentially exposed to Agent Orange while serving in Vietnam approximately 20 years previously, were selected for this study. These included veterans with no health problems as well as veterans with histories of cancer or of adverse reproductive outcome in their offspring following Vietnam service. This study follows and expands our previous studies of dioxin levels in U.S. Vietnam Veterans and in Vietnamese⁽¹⁻⁴⁾.

One unit (450mL) of whole blood was collected from each of the veterans and analyzed for all measurable chlorinated dioxins and dibenzofurans, including 2,3,7,8-TCDD, the dioxin contaminant of Agent Orange. The coplanar PCBs, the mono-ortho substituted and di-ortho substituted PCBs were also measured. Total dioxin toxic equivalents were calculated from dioxins, dibenzofurans and PCBs, using current estimates of congener toxicity^(5,6).

In addition to the blood collection and analyses, because of concern about paternally mediated adverse reproductive outcomes, we attempted to measure the same chemicals in semen of selected veterans. Although dioxins and PCBs do appear to be present in the semen, at the time of this abstract preparation we are not prepared to provide quantitative data.

RESULTS AND DISCUSSION

At the time of abstract submission with 39 blood analyses completed, we find that as long as 20 years after Agent Orange exposure, clearly elevated TCDD levels from Agent Orange can still be found in six out of the first 39 subjects, in whole blood. For these veterans, the elevated TCDD serves as a semiquantitative marker of intake of Agent Orange, as has been shown previously in some Vietnamese exposed to Agent Orange^(1,4).

Table I presents the means, ranges, and standard deviations of the dioxins, dibenzofurans, and PCBs for the first 39 veterans. Although some veterans do not have elevated levels of 2,3,7,8-TCDD at this time, as can be noted by the minimum level of 0.9 ppt and the mean level of 10.7 ppt, the maximum level of 131 ppt clearly documents exposure to and uptake of this dioxin characteristic of Agent Orange.

Table II summarizes mean, range, and standard deviation of the total levels of dioxins, dibenzofurans, and PCBs for these 39 veterans.

As shown in Table III, the distribution of 2,3,7,8-TCDD levels was as follows: 29 veterans had values between not detected and 5.97 ppt; 4 veterans were between 6 ppt and 10 ppt; 3 veterans were between 11 ppt and 25 ppt; 1 veteran was between 26 ppt and 50 ppt; and 2 veterans were between 50 ppt and 132 ppt.

As shown in Figure I, on average, for these 39 veterans, using current estimates of PCB congener dioxin toxic equivalents, the PCBs account for 73% of the total dioxin toxic equivalents. In health studies, as well as in policy considerations as to allowable dioxin, dibenzofuran or PCB discharges or standards, exposure assessment to dioxin-like chemicals should be considered in addition to the dioxins. In the past such studies have frequently not characterized total dioxin toxicity^(7,8).

REFERENCES

1. Schecter, A.J., Ryan, J.J., Gross, M., Weerasinghe, N.C.A. and Constable, J.D. Chlorinated dioxins and dibenzofurans in human tissues from Vietnam, 1983-84. In: *Chlorinated Dioxins and Dibenzofurans in Perspective*, edited by Rappe, C., Choudhary, G. and Keith, L.H. Chelsea, Michigan: Lewis Publishing Co., 1986, p. 35-50.
2. Schecter, A.J., Constable, J.D., Arghestani, S., et al. Elevated levels of 2,3,7,8-tetrachlorodibenzodioxin in adipose tissue of certain U.S. veterans of the Vietnam war. *Chemosphere* 1987;16:8/9:1997-2002.
3. Schecter, A., Ryan, J.J., Constable, J.D., et al. Partitioning of 2,3,7,8-chlorinated dibenzo-p-dioxins and dibenzofurans between adipose tissue and plasma lipid of 20 Massachusetts Vietnam veterans. *Chemosphere* 1990;20:951-958.
4. Schecter, A., Fürst, P., Fürst, C., et al. Dioxins dibenzofurans and selected chlorinated organic compounds in human milk and blood from Cambodia, Germany, Thailand, The U.S.A., the U.S.S.R., and Viet Nam. *Chemosphere* 1991;23:11/12:1903-1912.
5. Pilot Study on International Information Exchange on Dioxins and Related Compounds. *Scientific Basis for the Development of the International Toxicity Equivalency Factor (I-TEF) Method of Risk Assessment for Complex Mixtures of Dioxins and Related Compounds*, NATO:North Atlantic Treaty Organization Committee on the Challenges of Modern Society, 1988. Ed. 176, and 178.
6. Safe, S. Polychlorinated biphenyls (PCBs), dibenzo-p-dioxins (PCDDs), dibenzofurans (PCDFs), and related compounds: Environmental and mechanistic considerations which support the development of toxic equivalency factors (TEFs). *Critical Reviews in Toxicology* 1990;21:51-88.
7. Saracci, R., Kogevinas, M., Bertazzi, P-A., et al. Cancer mortality in workers exposed to chlorophenoxy herbicides and chlorophenols. *Lancet* 1991;38:1027-1032.
8. Fingerhut, M.A., Halperin, W.E., Marlow, D.A., et al. Cancer mortality in workers exposed to 2,3,7,8-tetrachlorodibenzo-p-dioxin. *New England Journal of Medicine* 1991;324:212-218.

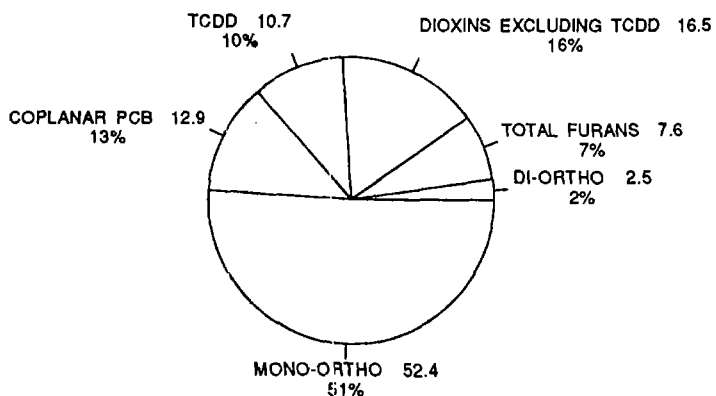
TABLE I
DIOXIN, DIBENZOFURAN, AND PCB LEVELS IN 39 VIETNAM VETERANS FROM
MICHIGAN ppt, lipid

Dioxins and Dibenzofurans	MEAN	MIN	MAX	SD
2,3,7,8-TCDD	10.7	0.9	131.0	21.9
1,2,3,7,8-PECDD	9.7	4.0	35.5	5.2
1,2,3,4,7,8-HXCDD	21.8	5.4	84.0	20.1
1,2,3,6,7,8-HXCDD	61.4	19.2	120.0	24.9
1,2,3,7,8,9-HXCDD	12.6	4.0	35.9	6.9
1,2,3,4,6,7,8-HPCDD	122.9	40.8	333.0	68.0
1,2,3,4,6,7,8,9-OCDD	832.9	316.0	3110.0	539.9
2,3,7,8-TCDF	2.5	0.6	7.3	1.9
1,2,3,7,8-PECDF	1.2	0.6	4.9	0.7
2,3,4,7,8-PECDF	9.4	2.3	29.2	5.6
1,2,3,4,7,8-HXCDF	11.3	4.4	43.1	6.6
1,2,3,6,7,8-HXCDF	6.6	1.3	14.6	3.3
2,3,4,6,7,8-HXCDF	2.6	1.3	6.0	0.9
1,2,3,7,8,9-HXCDF	2.8	1.5	5.1	0.7
1,2,3,4,6,7,8-HPCDF	20.0	9.7	49.1	7.7
1,2,3,4,7,8,9-HPCDF	3.2	1.5	4.8	0.9
1,2,3,4,6,7,8,9-OCDF	9.3	4.1	19.9	3.3
Coplanar PCBs				
3,3,4,4-Tetra PCB	79.5	22.1	336.0	62.5
3,3,4,4,5-Penta PCB	96.3	29.2	432.0	78.9
3,3,4,4,5,5-Hexa PCB	48.7	19.7	98.6	16.5
Mono-ortho PCBs				
2,4,4-Tri PCB	5776	340	31179	6065
2,4,4,5-Tetra PCB	15529	4621	47000	10821
2,3,3,4,4-Penta PCB	7572	1500	37039	7844
2,3,4,4,5-Penta PCB	17816	4177	125000	19306
2,3,3,4,4,5-Hexa PCB	5988	330	24200	4794
Di-ortho PCBs				
2,2,4,4,5-Penta PCB	12677	2612	54300	12008
2,2,3,3,4,4-Hexa PCB	2244	215	12000	2181
2,2,3,4,4,5-Hexa PCB	28279	12500	102000	17643
2,2,4,4,5,5-Hexa PCB	43015	23957	123000	20456
2,2,3,3,4,4,5-Hexa PCB	7174	814	23400	5946
2,2,3,4,4,5,5-Hepta PCB	20279	4226	48400	10163
2,2,3,4,4,5,6-Hepta PCB	2584	484	10061	2122
2,2,3,4,5,5,6-Hepta PCB	1269	205	7360	1367
2,2,3,4,5,5,6-Hepta PCB	7624	1000	23057	4468

	MEAN	MIN	MAX	SD
TOTAL DIOXINS	1072	409	3492	620
TOTAL DIBENZOFURANS	69	34	125	22
TOTAL COPLANAR PCBs	224	93	613	119
TOTAL MONO-ORTHO PCBs	52369	15614	232660	40224
TOTAL DI-ORTHO PCBs	125145	55454	394700	62344

ND - 5.99	6.0 - 10	11 - 25	26 - 50	50 - 130+
29	4	3	1	2

FIGURE I: PERCENT CONTRIBUTION OF MEAN PCDD/F AND PCB TEQ LEVELS FOR 39 VIETNAM VETERANS FROM THE MICHIGAN STUDY



PPT, lipid
PCB TEQ: ref 6.