

Dioxins, Dibenzofurans, and Coplanar and Marker PCBs in Blood of Persons Residing near a PCB Manufacturing Facility in the United States

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Introduction

Congener specific dioxin, dibenzofuran and PCB analysis of human blood has been employed for a relatively short time to identify persons or populations occupationally or environmentally exposed to these compounds who have elevated body burdens. Elevated levels have usually been reported from occupational exposure and less commonly from environmental exposure (1).

In this case study we report blood measurements from ten persons residing near a PCB manufacturing facility in the United States and compare the findings with those from a pooled sample of 100 Americans collected and analyzed in the same year, 1997.

Materials and Methods

In 1997 whole blood was collected from ten potentially exposed residents living near the facility. A comparison sample of blood was also collected in 1997 from surplus hospital blood from 100 adults. The blood samples were frozen and shipped on dry ice to ERGO laboratory where they were frozen at -20 degrees C. The analytic methods have been previously described and will not be discussed here (2).

Results and Discussion

Table 1A summarizes the measured dioxins, dibenzofurans and coplanar PCB levels. Total dioxin levels in the comparison sample is 977 parts per trillion (ppt) lipid, and the range for persons residing near the facility is 765-6324. For dibenzofurans the comparison group level is 52 ppt and the range for the residents is 60-442. Coplanar PCB 77 was not detected in the comparison blood or in 5 of the 10 residents' blood. For the other residents the level varies from 41 to 713 ppt. For coplanar PCB 126 the comparison group value is 48 and the range among

the residents is 104 - 4050 ppt. Coplanar PCB 169 was measured at 35 ppt in the comparison group and between 136 and 2807 ppt for the residents.

Table 1B presents the data as dioxin toxic equivalents (TEQ) (3,4). PCDD TEQ is 18.5 for the comparison group and 16.3 to 38.9 ppt for the residents. PCDF TEQ is 8.3 in the comparison blood and 6.7 to 131 ppt in residents. In blood of the five residents for whom it was detected the TEQ for PCB 77 does not exceed 0.4 ppt, and for one of them the value is rounded off to zero. PCB 126 TEQ is 4.8 ppt in comparison blood and 10.4 - 405 ppt in residents' blood. PCB 169 TEQ is 0.4 ppt in comparison blood and 1.4 - 28.1 ppt for residents.

Figure 1 shows elevated coplanar PCB TEQ levels for most of the residents. Elevated PCDF TEQ is also noted in some residents. Smaller elevations of PCDD TEQ can sometimes be seen.

Table 2 presents "marker PCBs," used by ERGO in screening human blood to evaluate elevated PCB body burden. These congeners can be analyzed more rapidly with less blood and at lower cost than the coplanar PCBs. The range is 2.7 - 124 parts per billion (ppb) for 9 of the 10 residents. Analysis of the blood of one resident could not be performed.

Whereas the actual contamination may best be shown by the measured levels given in Table 1A and Table 2, the dioxin toxic equivalents are of more interest from a public health perspective. Table 1B and Figure 1 show a TEQ level of 32 ppt in the comparison group and levels from 290 to 442 ppt for the four highest residents. It also is of interest that coplanar PCBs are contributing a substantial portion of the TEQ where levels are most elevated. An external comparison value is not available.

This study of ten persons residing near a PCB manufacturing facility demonstrates that increased blood levels of PCB congeners from presumably air borne environmental exposures can be measured by the methods used. PCDFs sometimes contaminate PCB mixtures, and some cases of elevated dibenzofuran levels also were found.

References

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2. Pöpke O, Ball M, Lis Z.A and Scheunert K. PCDD/PCDF in whole blood samples of unexposed persons, *Chemosphere*, 1989, 19:941-8.
3. North Atlantic Treaty Organization, Committee on the Challenges of Modern Society, *International Toxicity Equivalency Factor (I-TEF) Method of Risk Assessment for complex Mixtures of Dioxins and Related Compounds*, Report 176, Pilot Study on International Information Exchange on Dioxins and Related compounds, 1988.
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Table 1. Dioxin, Dibenzofuran and Coplanar PCB Levels in Persons Residing near a PCB Factory in Alabama and in a Comparison Group
pg/g (ppt), Lipid Basis

A. Measured concentration in Blood

Person	1	2	3	4	5	6	7	8	9	10	Comparison N=100
Total PCDDs	6324	862	1570	1260	2210	856	765	1185	1825	1331	977
Total PCDFs	98	442	160	83	66	63	60	78	63	73	52
Total PCDD/Fs	6422	1304	1730	1342	2276	919	825	1262	1888	1404	1029
Coplanar PCBs											
77 3,3,4,4-TCB	713	41	327	175	n.d.	n.d.	n.d.	n.d.	n.d.	120	n.a.
126 3,3,4,4,5-PeCB	2288	1712	2082	169	104	488	709	803	277	4050	48
169 3,3,4,4,5,5-HxCB	380	2028	2807	297	136	1235	236	582	631	347	35
Total Coplanar PCBs	3381	3781	5216	641	240	1723	945	1385	909	4517	83
Total PCDD/F/PCBs	9803	5085	6946	1983	2516	2642	1770	2647	2797	5848	1112

n.a. not analyzed because of interference

n.d. not detected: detection limit = 20 pg/g

B. Dioxin Toxic Equivalent Levels

Person	1	2	3	4	5	6	7	8	9	10	Comparison N=100
Total PCDDs	38.9	37.5	32.4	20.4	23.2	22.1	21.6	16.3	23.1	22.1	18.5
Total PCDFs	18.8	131	34.4	12.4	6.7	10.5	12.2	17.1	10.5	11.6	8.3
Total PCDD/Fs	57.7	169	66.8	32.8	29.9	32.6	33.8	33.4	33.6	33.7	26.8
Coplanar PCBs											
77 3,3,4,4-TCB	0.4	0.0*	0.2	0.1	-	-	-	-	-	0.1	-
126 3,3,4,4,5-PeCB	229	171	208	16.9	10.4	48.8	70.9	80.3	27.7	405	4.8
169 3,3,4,4,5,5-HxCB	3.8	20.3	28.1	3.0	1.4	12.3	2.4	5.8	6.3	3.5	0.4
Total Coplanar PCBs	233	191	236	19.9	11.8	61.2	73.3	86.1	34.1	409	5.2
Total PCDD/F/PCBs	291	360	303	52.7	41.7	93.8	107	120	67.7	442	32.0

* value < 0.05

Figure 1. Dioxins, Dibenzofurans, and Coplanar PCBs in Blood of Persons Residing near a PCB Factory and of a Comparison Group
Dioxin TEQ pg/g (ppt), lipid basis

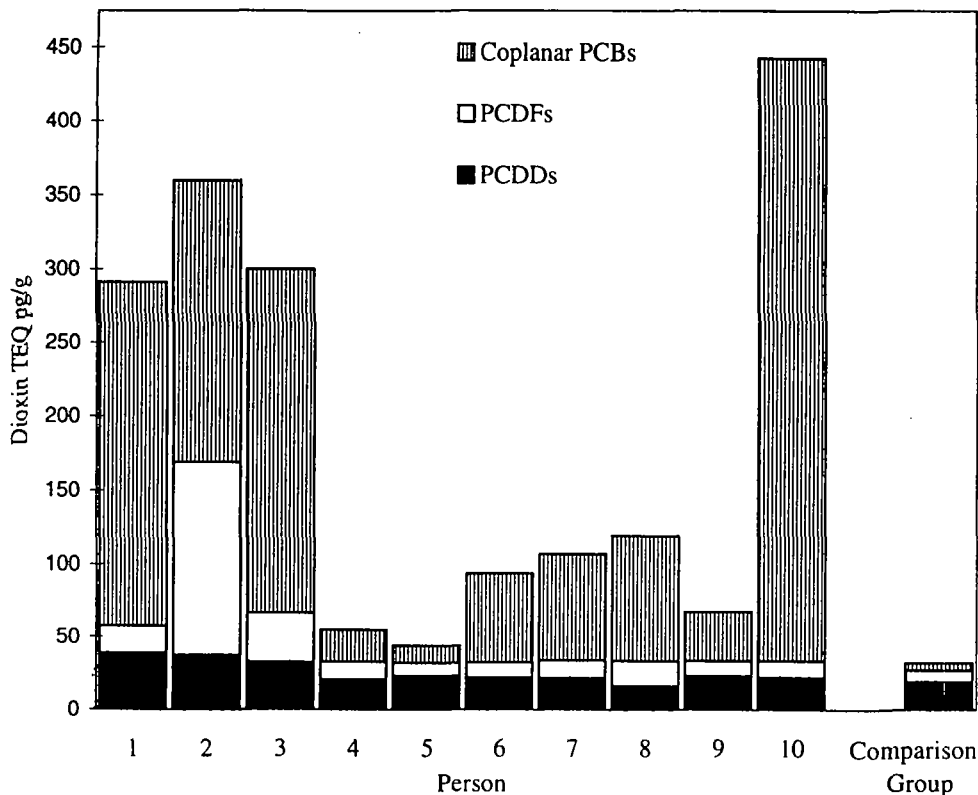


Table 2. Marker PCBs in Blood of Persons Residing near a PCB Factory
 $\mu\text{g}/\text{kg}$ (ppb)

IUPAC No.	Person									
	1	2	3	4	5	6	7	8	9	10
28	0.07	0.04	0.06	0.02	0.03	0.04	0.03	n.a.	0.02	0.09
52	0.04	0.02	0.02	n.a.	0.02	0.05	0.03	n.a.	0.03	0.03
101	0.13	0.07	0.17	n.a.	0.04	0.17	0.15	n.a.	0.06	0.13
153	9.4	30.0	18.6	1.1	0.77	10.1	10.0	n.a.	3.3	6.9
138	8.8	34.5	16.5	0.82	0.56	8.6	9.0	n.a.	2.6	2.5
180	5.5	59.1	13.7	1.4	1.3	12.8	6.1	n.a.	2.5	5.1
Total	23.9	124	49.1	3.3	2.7	31.8	25.3	-	8.5	14.8

n.a. not analyzed because of interference