PARTITIONING OF PCDDs, PCDFs, AND COPLANAR PCBs IN HUMAN MATERNAL TISSUES: BLOOD, MILK, ADIPOSE TISSUE AND PLACENTA

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ABSTRACT: To determine partitioning of dioxins, dibenzofurans, and the dioxin-like coplanar polychlorinated biphenyls (PCBs) in maternal tissues, we collected and analyzed the following tissues from a series of 5 American women having cesarean section deliveries during 1995-96: Whole blood, placenta, and adipose tissue at delivery, and whole blood and breast milk 4-8 weeks after delivery. A total of 25 samples, 5 from each woman, were collected from upstate New York hospitals, frozen and shipped to the dioxin laboratory. Preliminary data suggests that levels of dioxins in placental tissue may reflect levels in other maternal tissue. Also, lower levels of dioxins and furans were found in tissue samples analyzed thus far compared to earlier measurements of milk samples from American women taken in the late 1980's.

INTRODUCTION: The purpose of this pilot project is to build a database which will characterize the partitioning of dioxin (PCDD), dibenzofuran (PCDF), and the dioxin-like coplanar PCB congeners of interest in commonly sampled human tissues such as blood and breast milk, and also in less commonly sampled tissues, adipose and placenta. In addition, we wished to compare blood dioxin levels before and after delivery in order to better understand the effects of pregnancy on dioxin metabolism. Adipose tissue dioxin measurements are currently considered the "gold standard" in estimating body burden, but we as well as others have shown that congener-specific partitioning varies in different tissues, even when reported on a lipid normalized basis.[1-7] For example, in previous work reports we noted higher measured levels of PCDD/Fs and calculated dioxin toxic equivalents (TEQs) in blood than in milk and subtle congener differences in autopsy obtained organs from the same individual even when reported on a lipid basis.

One study objective is to begin compiling a series of data on maternal tissue dioxin levels prior to delivery in order to better characterize the relationship between maternal dioxin levels during pregnancy and after delivery. These values may be of use in clinical medicine for predicting levels in milk from maternal blood or placenta. In previous work with American and with Taiwanese Yucheng placentas we found that the high levels of PCDD/Fs in Yucheng mothers were reflected in the elevated placental levels.[8] This suggests that placental tissue may be useful for estimating dioxin exposure.

METHODS: Tissues samples were collected from five American women, mean age 21.6 years (range 21-34), residing in upstate New York, and undergoing cesarean section deliveries between 9/95 and 1/96. Blood, placenta, and fat were collected at time of delivery. The milk and second blood was collected about 4-8 weeks afterwards. Specimens were placed in chemically clean containers, frozen, and shipped to the dioxin laboratory for

analysis. The analytic methodology has been previously described.[9-10]

Sample Collection: The following tissues were collected from each mother: Maternal blood (100 ml) on the day of delivery; maternal adipose tissue, collected during C-section (10 grams); placenta (400 grams) at delivery; maternal blood (100 ml) collected during first 3 months of nursing; maternal milk (25 ml) collected at the same time as the second maternal blood.

RESULTS: Table 1 reviews our previous finding for American and Yucheng placentas and for American milk and blood from the general population. The elevated PCDF level characteristic of Yucheng can be seen in the measured placental levels (20,659 ppt) and in the TEQ, 3901 ppt, as compared with American PCDF levels of 23.5 ppt and 2.9 ppt TEQ. Measured PCDD/F and coplanar PCB congeners and calculated dioxin TEQ values for the mean of the five individually analyzed new breast milk samples are presented in Table 2. Total PCDD/Fs and TEQs are 189.3 ng/kg (ppt) (range 168.5-221) and 8.16 ppt, (range 6.25-9.7) respectively. Mean coplanar PCB values are 30.9 ppt and 2.02 ppt TEQ. The 20 remaining new samples are at ERGO laboratory awaiting analysis at the time of manuscript preparation.

DISCUSSION: Dioxin levels in adipose tissue, milk, and blood tissue have been used to estimate body burden in the general population and in those with special exposures. We, as well as others, have reported congener-specific differences in dioxin levels between various tissues when analyzed on a lipid normalized basis. In this study we address the question of PCDD/F/PCB partitioning in several tissue samples from the same women obtained during pregnancy and after delivery. This study adds to the database for dioxin levels in various maternal tissues before and after delivery. These values can be of use in clinical medicine for predicting levels in milk from maternal blood or placenta. Finally, it appears, from the newly collected and analyzed breast milk samples, that current measured levels of PCDD/Fs in American breast milk (189 ppt) may be declining as compared with samples collected in the late 1980's (398 ppt).[6]

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Table 1. Dioxin and Dibenzofuran Levels and Dioxin Toxic Equivalent Values in Human Placentas, Breast Milk, and Blood (ppt, lipid)

CONGENER	TEF	American Placentas (n=14)(a)		Yu-Cheng Placentas (n = 6)(b)		American Milk (n = 43)(c)		American Blood(d) (n=44)	
		Measured	TEQ	Measured	TEQ	Measured	TEQ	Measured	TEQ
2,3,7,8-TCDD	1	2.4	2.4	2.1	2.1	3.3	3.3	3.8	3.8
1,2,3,7,8-PeCDD	0.5	4.0	2.0	16.81	8.40	6.7	3.35	9.3	4.63
1,2,3,4,7,8-HxCDD	0.1	2.4	0.2	0.22	0.02	6.0	0.60	9.8	0.68
1,2,3,6,7,8-HxCDD	0.1	15.9	1.6	210	20.99	6.2	0.62	72	7.21
1,2,3,7,8,9-HxCDD	0.1	3.2	0.3	22.5	2.25	30.5	3.05	12	1.19
1,2,3,4,6,7,8-HpCDD	0.01	36.2	0.4	44.1	0.44	42	0.42	119	1.19
OCDD	0.001	282	0.3	599	0.60	233	0.23	794	0.79
2,3,7,8-TCDF	0.1	1.9	0.2	3.61	0.36	2.9	0.29	2.3	0.23
2,3,4,7,8-PeCDF	0.5	3.6	1.8	4.19	0.21	7.3	3.65	1.2	0.06
1,2,3,7,8-PeCDF	0.05	<1.0	0.0	4679	2339	0.5	0.03	8.8	4.38
1,2,3,4,7,8-HxCDF	0.1	4.0	0.4	15405	1540	5.6	0.56	10.6	1.06
1,2,3,6,7,8-HxCDF	0.1	2.0	0.2	167.5	16.7	3.2	0.32	6.9	0.61
2,3,4,6,7,8-HxCDF	0.1	nd (1.0)	0.1	0.22	0.02	1.9	0.19	2.8	0.28
1,2,3,7,8,9-HxCDF	0.1	1.7	0.2	0.18	0.02	--	--	2.8	0.28
1,2,3,4,6,7,8-HpCDF	0.01	6.3	0.1	355.7	3.56	4.1	0.04	19.6	0.20
1,2,3,4,7,8,9-HpCDF	0.01	<1.0	0.005	39.1	0.39	4.1	0.04	3.1	0.03
OCDF	0.001	<5.0	0.003	5.35	0.01	4.1	0.004	9.3	0.01
Total PCDDs		**346**	**7.2**	**895**	**35**	**367**	**12**	**1020**	**19**
Total PCDFs		**23.5**	**2.9**	**20659**	**3901**	**31**	**8**	**67**	**7**
Total PCDD/Fs		**370**	**10.1**	**21554**	**3936**	**398**	**20**	**1087**	**27**

(a) American placentas were combined for one analysis (ERGO July, 1994), (n = 14) = 1.33% lipid
(b) Average of 6 Individual Yu-Cheng placentas, collected between October, 1984 and June 1985 for Dr. George Lucier with the National Institute of Environmental Health Sciences
(c) Average of two pooled samples: Binghamton , NY (n=21); Los Angeles, CA (n = 22), collected and analyzed in the late 1980's
(d) Blood measured is a mean of 44 individual analyses and TEQs for 44 males

Table 2. PCDD/Fs and Coplanar PCBs in Human Breast Milk from Five Binghamton, NY Women 1995-6 (ng/kg (ppt), lipid)

CONGENER		MEAN (N = 5)*	
	TEF**	LEVEL	TEQ
DIOXINS			
2,3,7,8-TCDD	1	1.45	1.45
1,2,3,7,8-PeCDD	0.5	2.48	1.24
1,2,3,4,7,8,-HxCDD	0.1	3.01	0.30
1,2,3,6,7,8-HxCDD	0.1	20.10	2.01
1,2,3,7,8,9-HxCDD	0.1	3.50	0.35
1,2,3,4,6,7,9-HpCDD	0.01	--	0.00
1,2,3,4,6,7,8-HpCDD	0.01	34.03	0.34
OCDD	0.001	104.28	0.10
DIBENZOFURANS			
2,3,7,8-TCDF	0.1	0.91	0.09
2,3,4,7,8-PeCDF	0.5	2.81	1.40
1,2,3,7,8,-PeCDF	0.05	0.51	0.03
1,2,3,4,7,8-HxCDF	0.1	3.88	0.39
1,2,3,6,7,8-HxCDF	0.1	2.40	0.24
1,2,3,7,8,9-HxCDF	0.1	0.15	0.02
2,3,4,6,7,8-HxCDF	0.1	1.41	0.14
1,2,3,4,6,7,8-HpCDF	0.01	5.43	0.05
1,2,3,4,7,8,9-HpCDF	0.01	0.53	0.01
OCDF	0.001	2.46	0.002
COPLANAR PCBs			
77 3,3',4,4'-Te-PCB	0.0005	5.92	0.003
126 3,3',4,4',5-Pe-PCB	0.1	19.59	1.96
169 3,3',4,4',5,5'-Hx-PCB	0.01	5.37	0.05
TOTAL PCDDS		**168.84**	**5.79**
TOTAL PCDFS		**20.48**	**2.37**
TOTAL PCDD/Fs		**189.32**	**8.16**
TOTAL COPLANAR PCBs		**30.89**	**2.02**
TOTAL PCDD/Fs and PCBs		**220.21**	**10.17**

* Mean of five individual samples analyzed

** PCB TEFs from Ahlborg UG, Becking, GC, Birnbaum LS et al. Toxic equivalent factors for dioxin-like PCBs. Chemosphere 28:1049-1067, 1994.