CHLORINATED DIOXIN AND DIBENZOFURAN LEVELS IN U.S. HUMAN PLACENTAS AND FETAL TISSUE IN COMPARISON WITH U.S. ADULT POPULATION DIOXIN LEVELS

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Objective: Placental tissue is believed to reflect dioxin body burden in both mother and child. However, partitioning between mothers' blood, milk, adipose tissue, and placenta dioxin levels, as well as tissue levels in the fetus and newborn has not been fully characterized, on a population or individual basis. This paper reports dioxin levels in a pooled sample of fourteen American placentas and in whole fetuses aborted between 8 and 14 weeks of gestation. These data are compared to our previously published U.S. blood,[1] human milk,[2] and human adipose tissue dioxin levels data as well as those published by Stanley et. al., 1986[3] and the U.S. Environmental Protection Agency, 1991.[4] Placental dioxin levels from a woman poisoned in the YuCheng incident are included to illustrate the potential use of placental tissue to document exposure of women and presumably the fetus and child. The use of placental tissue analyses for individual and population dioxin data and for documentation of exposure has several advantages. Placental tissue would normally be discarded; its collection avoids other somewhat invasive procedures, such as fat biopsy, or blood collection, where relatively large amounts of blood are usually needed for dioxin, dibenzofuran, and PCB congener specific analyses. At the time this abstract was prepared, placental analysis were complete but frozen fetal tissue samples were awaiting analysis. These results will be presented as part of the full paper.

Methods: Fourteen individual placentas were collected anonymously in Binghamton, New York immediately after delivery and frozen until being processed at the dioxin laboratory. Over 30 aborted fetus were also collected anonymously and frozen. Tissue was combined into a pooled sample, then homogenized with sodium sulfate resulting in a flowing powder. A column was filled with this powder and elution was performed with a mixture of Cyclohexane and Dichlormethane. Analysis was performed as previously described in detail.[5]

Results: Table I presents dioxin, dibenzofuran, and dioxin toxic equivalent (TEq) levels in a pooled sample of fourteen American placentas, an individual U.S. placenta collected and analyzed previously, and for comparison, a placenta from a mother who was poisoned in the YuCheng PCDF/PCB incident in Taiwan 7 years prior to sampling.[6] The pooled sample of fourteen American placentas has a TEq of 10.1 parts per trillion (ppt) lipid, and the single U.S. placenta analyzed in a different dioxin laboratory has a similar TEq level of 14.4 ppt. The placenta from Taiwan has a TEq of 1866 ppt, a middle value among the six Taiwan placentas previously reported by us.[6] Table II presents the average level of PCDD/Fs' TEqs in blood, and human milk in the U.S. general population compared to the pooled placental tissue. The highest dioxin TEq level is found in the blood, 27 ppt TEq (lipid), followed by human milk, with the placenta having the lowest level, 10 ppt TEq (lipid). Table III presents dioxin levels found in

human adipose tissue from samples collected during the 1980s, reported by Stanley et. al.[3] and the U.S. EPA.[4] Total TEqs were 46 ppt in the 1982 and 26 ppt in the 1987 samples. The 10 - 14 ppt TEq in U.S. placental tissue on a lipid basis is similar to, but somewhat lower, than levels found in other (adult) U.S. tissues.

Conclusions: In this study, we compare dioxin values in blood, human milk, placenta, fetal tissue, and adipose tissue in the U.S. population. These data suggest that placental tissue may offer a useful source of tissue to estimate maternal, fetal, and newborn dioxin body burden. Clearly, further work will be needed to exploit this potential. We expect the fetal tissue analysis to provide useful body burden data during critical period of organ formation and differentiation.

To illustrate the potential usefulness of placental tissue in exposure assessment, PCDD/F data from a YuCheng placenta is presented. The dioxin TEq is 185 times higher in the Taiwan contaminated placenta than the U.S. placentas. As a result of her substantial elevated body burden, primarily of the dioxin like PCDFs, the Taiwanese woman whose placenta we analyzed suffered from pigmented eyelids, lips, gums, and chloracne on the forehead and nose, and had pains in the joints and muscles. This woman's baby was born with hyperpigmented skin, and died as result of a cardiac abnormality, which may or may not have been related to chemical exposure.

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Table I

CHLORINATED DIOXINS, DIBENZOFURANS AND DIOXIN TOXIC EQUIVALENTS IN AMERICAN PLACENTAS AND A PLACENTAL FROM A TAIWANESE YUCHENG PATIENT (lipid, ppt)

CONGENER	TEF	Pooled American (n=14) Measured	TEq	American* (n=1) Measured	TEq	Taiwan Patient* YuCheng Measured	TEq
2,3,7,8-TCDD	1.0000	2.4	2.400	2.0	2.030	1.3	1.280
1,2,3,7,8-PeCDD	0.5000	4.0	2.000	9.5	4.737	14.8	7.390
1,2,3,4,7,8-HxCDD	0.1000	2.4	0.240	6.4	0.639	-	-
1,2,3,6,7,8-HxCDD	0.1000	15.9	1.590	11.2	1.120	197.8	19.780
1,2,3,7,8,9-HxCDD	0.1000	3.2	0.320	5.3	0.534	18.9	1.890
1,2,3,4,6,7,8-HpCDD	0.0100	36.2	0.362	47.7	0.477	74.4	0.740
OCDD	0.0010	282.1	0.282	236.0	0.236	912.3	0.910
2,3,7,8-TCDF	0.1000	1.9	0.190	0.5	0.053	1.6	0.160
2,3,4,7,8-PeCDF	0.5000	3.6	1.800	6.8	3.383	5.7	2.830
1,2,3,7,8-PeCDF	0.0500	<1.0	0.025	0.5	0.023	2718.9	135.940
1,2,3,4,7,8-HxCDF	0.1000	4.0	0.400	8.6	0.865	16902.8	1690.280
1,2,3,6,7,8-HxCDF	0.1000	2.0	0.200	1.8	0.180	-	-
2,3,4,6,7,8-HxCDF	0.1000	n.d.(1.0)	0.050	<0.2	0.011	<0.3	<0.007
1,2,3,7,8,9-HxCDF	0.1000	1.7	0.170	0.8	0.075	<0.2	<0.006
1,2,3,4,6,7,8-HpCDF	0.0100	6.3	0.063	4.6	0.046	463.1	4.630
1,2,3,4,7,8,9-HpCDF	0.0100	<1.0	0.005	<0.6	0.003	41.1	0.410
OCDF	0.0010	<5.0	0.003	4.0	0.004	6.7	0.010
Total PCDDs		346.2	7.2	318.2	9.8	1219.6	32.0
Total PCDFs		23.5	2.9	27.9	4.6	20139.9	1834.3
Total PCDD/Fs		369.7	10.1	346.1	14.4	21359.5	1866.3

TEF - Toxic Equivalent Factor
TEq - Toxic Equivalency
"-" indicates this peak was fused with other peak(s) on the gas chromotography analysis
"<" half of < value was used to calculate totals and TEq
American 1 (n=1) = 1.33% lipid
Average American (n=14) = 0.85% lipid
* see reference number 6

Table II
AVERAGE CONCENTRATIONS AND TOXIC EQUIVALENCY OF DIOXINS AND DIBENZOFURANS IN BLOOD, HUMAN MILK, AND PLACENTAL TISSUE IN U.S. GENERAL POPULATION
parts per trillion (lipid)

		Blood Mean value (n=50)		Human Milk* n = 43		Pooled American Placentas (n=14)	
CONGENER	TEF	Measured	TEq	Measure	TEq	Measure	TEq
2,3,7,8-TCDD	1.0000	3.8	3.800	3.3	3.300	2.4	2.400
1,2,3,7,8-PeCDD	0.5000	9.3	4.626	6.7	3.350	4.0	2.000
1,2,3,4,7,8-HxCDD	0.1000	9.8	0.978	6.0	0.595	2.4	0.240
1,2,3,6,7,8-HxCDD	0.1000	72.1	7.208	6.2	0.620	15.9	1.590
1,2,3,7,8,9-HxCDD	0.1000	11.9	1.192	30.5	3.050	3.2	0.320
1,2,3,4,6,7,8-HpCDD	0.0100	118.6	1.186	42.0	0.420	36.2	0.362
OCDD	0.0010	793.9	0.794	233.0	0.233	282.1	0.282
2,3,7,8-TCDF	0.1000	2.3	0.226	2.9	0.285	1.9	0.190
2,3,4,7,8-PeCDF	0.5000	8.8	4.380	7.3	3.650	3.6	1.800
1,2,3,7,8-PeCDF	0.0500	1.2	0.059	0.5	0.023	<1.0	0.025
1,2,3,4,7,8-HxCDF	0.1000	10.6	1.064	5.6	0.555	4.0	0.400
1,2,3,6,7,8-HxCDF	0.1000	6.9	0.693	3.2	0.320	2.0	0.200
2,3,4,6,7,8-HxCDF	0.1000	2.8	0.283	1.9	0.185	n.d.(1.0)	0.050
1,2,3,7,8,9-HxCDF	0.1000	2.8	0.278	NA	NA	1.7	0.170
1,2,3,4,6,7,8-HpCDF	0.0100	19.6	0.196	4.1	0.405	6.3	0.063
1,2,3,4,7,8,9-HpCDF	0.0100	3.1	0.031	4.1	0.041	<1.0	0.005
OCDF	0.0010	9.3	0.009	4.1	0.004	<5.0	0.003
Total PCDDs		1019.3	19.78	327.7	11.568	346.2	7.2
Total PCDFs		67.4	7.22	33.5	5.47	23.5	2.9
Total PCDD/Fs		1086.8	27.00	361.1	17.04	369.7	10.1

NA = Not Available
"<" half of < value was used to calculate totals and TEq
U.S. Human Milk* = Average value of two pooled samples: Binghamton, NY (n=21) and Los Angeles, Cal. (n=22).

Table III
TOTAL PCDD/F CONCENTRATION AND TOXIC EQUIVALENTS IN ADIPOSE TISSUE OF THE U.S. GENERAL POPULATION 1982 AND 1987*, parts per trillion (lipid)

CONGENER	FY82*	TEq	FY87*	TEq
Total PCDDs	756.00	29.63	936.88	21.23
Total PCDFs	132.10	16.45	17.36	5.10
Total PCDD/Fs	888.10	46.08	954.24	26.30

* = See reference 3 and reference 4, respectively.