DECREASE IN MILK AND BLOOD DIOXIN LEVELS OVER TIME IN A MOTHER NURSING TWINS: ESTIMATES OF DECREASED MATERNAL AND INCREASED INFANT DIOXIN BODY BURDEN FROM NURSING

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Objectives: Higher levels of polychlorinated dibenzo-p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are consistently found in humans from highly industrialized countries, including the U.S.,[1] than from those developing countries. The majority of general population dioxin intake comes from food, specifically meat, milk, fish and their by-products.[2-4] Concern has been expressed about the high dioxin levels infants are exposed to during nursing.[5-7] From pooled American breast milk samples, we estimate an average infant's daily intake in the first year of life to be between approximately 35 to 53 picograms of dioxin toxic equivalents (TEqs) [8-10] per kilogram of body weight.[11]

The present study addresses this issue by reporting PCDD and PCDF levels in serial milk and blood samples from an American mother who is nursing twins. The mother's elimination of dioxins through nursing and estimated intake for the infants is calculated and dioxin and dioxin toxic equivalent (TEq) levels in milk and blood during nursing are compared. It is anticipated that collection will continue until the twins are two years old. Further data will be available after collection and analysis is complete in autumn, 1994.

Methods: Whole blood (200 ml) and breast milk (50 ml) samples were collected in chemically cleaned containers and kept frozen at -20°Centigrade. Samples were analyzed (by J.J.R.) using GC-MS as described previously.[12] The analytic methods were used in successful participation and "certification" in recent WHO interlaboratory validation studies on human tissues.[13]

Results: Table I presents measured PCDD, PCDF, and coplanar PCB levels as well as dioxin toxic equivalents in the first paired blood and milk samples from the now 32 year-old woman. Total PCDDs were 227 and 534 ppt, total PCDFs were 46 and 35 ppt, and total coplanar PCBs were 55 and 33 ppt on a lipid basis in milk and blood, respectively. Total PCDD dioxin toxic equivalents were similar at 9.6 and 11.2 ppt, PCDF TEqs were 7.3 and 4.9 ppt, and coplanar PCB TEqs were 3.0 and 3.0 on a lipid basis in milk and blood, respectively (using USEPA and WHO recommended PCB toxic equivalency factors).[10,14] These samples were collected in 1992, one year after the birth of the mother's first child in February, 1991. She subsequently became pregnant and gave birth to twins in December, 1992. Further serial milk and blood samples are being collected and will be analyzed prior to autumn, 1994. Calculation of the mother's decrease of dioxin body burden from nursing as well as the infants' estimated dioxin intake will be performed from these data.

Table II shows our current preliminary data and estimated calculations of the mother's dioxin TEq body burden, her excretion of TEqs through the breast milk by nursing, which is equivalent to the consumption of dioxin TEqs for her nursing twins. We assume, for purposes of calculation, that 30% of the mother's weight (65 kg) is lipid, and that dioxins are almost

exclusively in lipid. From the results of the mother's blood dioxin analysis we calculate that her PCDDs and PCDFs body burden prior to nursing the twins was 314 TEq ng . After birth of the twins, we calculate her PCDD/F excretion while nursing over a year's time (assuming the twins consume 1,200 g/day breast milk)[15] as 258 ng of TEqs. Assuming that each infant consumes the usual 600 grams of breast milk per day[15], during the first year of nursing, their individual intake would be 129 ng of dioxin toxic equivalents in a year.

Conclusions: This mother's almost identical PCDD/F TEq of 16.8 ppt for milk lipid and 16.1 ppt for whole blood lipid is lower than the mean of 32 ppt PCDD/F TEq previously reported in whole blood of 44 American adults.[16] The possibility that her dioxin body burden was lowered during the year she nursed her first child is consistent with two German studies that found significant decreases in mothers' dioxin body burden as they nursed their second and third infants.[3,17] Also, nursing mothers, typically younger than the general population, would be expected to have lower dioxin body burdens.

Our estimation of this mother's elimination of dioxins by nursing twins suggests that breastfeeding or milk extraction may be effective ways to lower a mother's dioxin body burden. On the other hand, the estimation of 353 pg TEq daily intake for the twins from nursing is of concern since it greatly exceeds tolerable daily intake values recommended by the U.S. Environmental Protection Agency of 0.006 pg/kg body weight per day over 70 years,[18] and the World Health Organization suggested levels of 10 pg TCDD/kg body weight per day.[19] Our calculations are conservative in that they do not include the dioxin-like PCBs of which the coplanar PCBs alone increase the mother's total TEq by about 3 ppt in milk on a lipid basis. The dioxin toxic equivalents for the coplanar PCBs are calculated using the World Health Organization's estimated toxic equivalency factors.[14]

Also of interest is the difference in PCDD/F values between the milk and blood samples. On a lipid basis, we previously found the ratio of measured congeners in whole blood to adipose tissue to vary from 0.8 to 2.0 and whole blood to adipose to vary from 0.77 to 1.75.[20,21] The ratio of measured congeners in milk lipid to whole blood lipid in these two samples from the same person, taken while nursing, varies from 0.4 to 2.1 in a pattern that is slightly different from that of plasma to adipose or whole blood to adipose. Even with this variation, the PCDD/F TEq of the blood and milk samples are similar at 16.1 and 16.8 ppt on a lipid basis, respectively. With the anticipated analysis of more serial blood and milk samples it should be possible to better characterize the partitioning ratio which exists during nursing.

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Table I: Dioxins, Dibenzofurans, and Coplanar Polychlorinated Biphenyls in Whole Blood and Milk from the Mother of Twins (ng/kg{ppt}, on a lipid basis)

	TEF	Milk		Whole Blood		TEq Ratio (Milk/Blood)
		ng/kg	TEq	ng/kg	TEq	
2378-TCDD	1	3.3	3.3	2.2	2.2	1.5
12378-PnCDD	0.5	4.8	2.4	8.3	4.15	0.6
123478/123678-HxCDD	0.1	29	2.9	30	3	1.0
123789-HxCDD	0.1	4.5	0.45	6.2	0.62	0.7
1234678-HpCDD	0.01	38	0.38	81	0.81	0.5
12346789-OCDD	0.001	147	0.147	407	0.407	0.4
2378-TCDF	0.1	1.7	0.17	n.d. (4)	0.2	0.9
23478-PnCDF	0.5	4.4	2.2	7.3	3.65	0.6
123478/123678-HxCDF	0.1	24*	2.4	6.4	0.64	3.8*
234678-HxCDF	0.1	21*	2.1	2.5	0.25	8.4*
1234678-HpCDF	0.01	40	0.4	19	0.19	2.1
Tetra PCB #77	0.005	8.9	0.0445	n.d. (50)	0.125	0.4
Penta PCB #126	0.1	28	2.8	n.d.(50)	2.5	1.1
Hexa PCB #169	0.01	18	0.18	33	0.33	0.5
TOTAL PCDD		226.6	9.6	534.7	11.2	0.9
TOTAL PCDF		46.1	7.3	35.2	4.9	1.5
TOTAL PCDD/F		272.7	16.8	569.9	16.1	1.0
TOTAL COPLANAR PCBs		54.9	3.0	33.0	3.0	1.0
TOTAL PCDD/F & PCBs		327.6	19.9	602.9	19.1	1.0

n.d. = Not detected with detection limit in brackets, half of detection limit use for TEq calculation
* These levels may reflect outside contamination

Table II: ESTIMATED MOTHER'S BODY BURDEN AND ESTIMATED EXCRETION OF PCDD, PCDF, AND PCB TOXIC EQUIVALENTS IN HUMAN MILK (WHILE NURSING TWINS) ON A LIPID BASIS

	Whole Blood (TEq ng/kg)	Body burden (TEq ng)	Milk (TEq ng/kg)	Excretion (365 days) (TEq ng)
	TEq		TEq	
2378-TCDD	2.20	42.9	3.30	50.6
12378-PnCDD	4.15	80.9	2.40	36.8
123478/123678-HxCDD	3.00	58.5	2.90	44.5
123789-HxCDD	0.62	12.1	0.45	6.9
1234678-HpPCDD	0.81	15.8	0.38	5.8
12346789-OCDD	0.41	7.9	0.15	2.3
2378-TCDF	0.20	3.9	0.17	2.6
23478-PnCDF	3.65	71.2	2.20	33.7
123478/123678-HxCDF	0.64	12.5	2.40	36.8
234678-HxCDF	0.25	4.9	2.10	32.2
1234678-HpCDF	0.19	3.7	0.40	6.1
Tetra PCB #77	0.13	2.4	0.04	0.7
Penta PCB #126	2.50	48.8	2.80	42.9
Hexa PCB #169	0.33	6.4	0.18	2.8
TOTAL PCDD	11.19	218.1	9.58	146.8
TOTAL PCDF	4.93	96.1	7.27	111.4
TOTAL PCDD/F	16.12	314.3	16.85	258.3
TOTAL COPLANAR PCBs	2.96	57.6	3.02	46.4
TOTAL PCDD/F & PCBs	19.07	371.90	19.87	304.68

Lipid in milk = 3.78%
Lipid in whole blood = 0.289%
Assuming an average body weight of 65 kg for a woman with 30% of body weight being lipid, and that all dioxins are found in lipid.