Time course of PCDD/PCDF concentrations in a mother and her second child during pregnancy and lactation period

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1. Introduction

Infants are exposed to PCDDs and PCDFs prenatally[1)] and via mother's milk[2,3)], and with the duration of breast-feeding an increasing body burden of these compounds can be expected in the infant, concomitantly with a decreasing body burden in the mother. After six to seven months of nursing the concentrations measured in blood lipids of infants were distinctly higher than those of their mothers. In contrast, concentrations measured in formula-fed infants at the end of the first year of life were more than 10-times lower[3,4)].
In order to get more information of toxicokinetics of PCDDs and PCDFs during pregnancy and lactation period in mother and child, concentrations of these compounds were measured in 14 samples, taken from the mother (before her second pregnancy, in the peripartal period, and 5 and 12 months after delivery), and her first (age 12 months) and second child (perinatal period, age 12 months).

2. Experimental conditions

First and second child (boys) of a healthy mother were born (after pregnancies without major problems, in 4/93 and 1/95, gestational age 40 weeks) with almost the same body weight (3.74 vs. 3.80 kg). They were breast-fed for the equivalent of about 7 months full nursing time (weaning at 11 months). Both infants were healthy and had a very similar weight gain during the first year of life (body weight 11.9 vs. 12.3 kg at 12 months).

The first-born child participated in a dioxin balance study (infant B-2 in Ref. 3), and his mother's milk was analyzed at the age of 4 weeks and 11 months (shortly before weaning). One month later blood was obtained from infant and mother. The second child was born 9 months later. To determine the extent of prenatal dioxin transfer, samples were taken at birth from mother's blood, placenta, cord blood, meconium and transitional stool. Mother's milk was collected 4 weeks later and again at the age of 5 months, together with a blood sample. Blood was once more obtained from the mother and the second infant at the end of the first year of life.

Whole blood was drawn by venipuncture (about 20 ml in the infants, 40 ml in the mother) before breakfast and collected in heparinized vials. For umbilical cord blood (about 14 ml) venipuncture with

a large lumen needle was applied. All these samples as well as those of placental tissue (about 100 g) and mother's milk (about 100 ml) were immediately frozen at -18°C until analysis. Meconium and transitional stool as collected in diapers was also frozen and later lyophilized. PCDDs and PCDFs were analyzed as described elsewhere[1]. 2378-T4CDD toxicity equivalents (I-TEq) for PCDDs and PCDFs were calculated using I-TEFs[5]. Concentrations below the limit of detection were taken into consideration as one half of the value defining this limit.

3. Results and discussion

Concentrations of PCDDs and PCDFs measured in different samples of the mother and her two children are listed in Table 1 for the main congeners, based on the lipids extracted.

- During pregnancy no important change of concentrations was observed in maternal blood (10.5 and 11.9 pg I-TEq/g blood fat).
- Placental concentrations of 2378-T4CDD, 23478-P5CDF and 12378-P5CDD were found to be higher than those in maternal blood, as observed in other placental samples[1,6]
- Concentrations of PCDDs and PCDFs were in the same range in cord blood, meconium and transitional stool (8.4, 6.5 and 6.3 I-TEq/g fat, respectively). Irrespective of their origin, all samples seem to be suitable for a representative analysis of PCDD/PCDF body burden at birth, as shown in other perinatal samples[1].
- Prenatal transfer rates for I-TEq (comparison to maternal blood fat) were 71% (cord blood), 55% (meconium) and 53% (transitional stool). This is in the range observed in other term newborns[1].
- Concentrations of PCDDs and PCDFs were found to be higher in mother's milk fat compared to her blood fat (for I-TEq: +22% in 4/94, +31% at second delivery, +88% in 6/95).
- Compared to his cord blood, the I-TEq concentration was 1.9-times higher in the second infant's blood at the age of 12 months. At the same time, the maternal concentration had decreased 2.1-fold. This is in accordance with a recent report[7] on a considerable decrease of PCDD/PCDF concentrations in blood and milk samples of a mother who nursed twins for 2 years.
- Due to a decreasing maternal body burden during lactation, the PCDD/PCDF concentrations at 12 months of life were only about half as high in the second infant compared to the first one at the same age (16.0 vs. 37.5 pg I-TEq/g blood fat). Both infants were fully breast-fed for about seven months.
- In the first and second child a distinct accumulation of the xenobiotics was observed after several months of breast-feeding: At the end of the first year of life, I-TEq concentrations in blood fat were 3.6 and 2.9-times higher compared to maternal values. Lower values were found only for higher chlorinated PCDDs/PCDFs, obviously due to relatively lower concentrations in mother's milk and lower absorption rates[2,3]. These accumulation factors are influenced by increased infants' body burden as well as decreased maternal body burden. Since I-TEq concentrations in lipids of maternal milk are higher than those in blood fat, these factors were only 1.7 and 1.0 in the first and second infant, respectively.

4. References

1) Abraham K., U. Steuerwald, O. Päpke, M. Ball, A. Lis, P. Weihe and H. Helge (1995) Concentrations of PCDDs, PCDFs and PCBs in human perinatal samples from Faroe Islands and Berlin. Organohalogen Compounds 26, 213-218

Table 1 Concentrations of PCDDs and PCDFs in samples of the mother and her first and second child, based on lipids extracted. Bold face: childrens' samples.

samples taken	**before 2nd pregnancy**				**at or shortly after 2nd birth**						**5 mo. after 2nd birth**		**11 mo. after 2nd birth**	
origin	milk*	milk	blood	blood	blood	pla-centa	cord blood	meco-nium	transit. stool	milk	milk	blood	blood	blood
person	mother	mother	mother	**1st child**	mother		**2nd child**	**2nd child**	**2nd child**	mother	mother	mother	mother	**2nd child**
date	5/93	3/94	4/94	4/94 (age 12 mo)	1/95	1/95	1/95	1/95	1/95	2/95	6/95	6/95	1/96	1/96 (age 12 mo)
body weight			65 kg	**11.9 kg**	80 kg		**3.8 kg**					68 kg	68 kg	**12.3 kg**
compound														
2378-T4CDD	2.5	1.5	1.8	**4.3**	2.7	3.3	**1.5**	**1.0**	**1.4**	2.1	1.4	1.2	1.1	**3.7**
23478-P5CDF	21.9	9.7	7.1	**31.5**	7.4	18.5	**4.8**	**4.8**	**4.1**	13.4	10.0	3.7	3.5	**9.8**
12378-P5CDD	8.9	5.4	3.6	**13.8**	3.8	7.7	**2.5**	**2.4**	**2.3**	5.7	3.8	1.9	1.9	**5.9**
123478-H6CDF	4.4	3.6	3.1	**11.2**	3.6	3.1	**2.5**	**1.8**	**2.6**	4.7	3.3	2.0	2.6	**7.8**
123678-H6CDF	4.1	2.6	3.0	**9.7**	2.8	1.5	**2.3**	**1.3**	**1.5**	3.2	2.2	1.5	1.7	**4.1**
234678-H6CDF	1.0	1.0	1.7	**3.5**	1.6	0.6	**3.2**	**0.6**	**1.9**	1.7	1.1	1.2	1.3	**<2.0**
123478-H6CDD	3.0	4.2	3.5	**13.4**	3.1	3.7	**2.9**	**2.6**	**n.d.**	5.2	3.7	1.7	n.d.	**n.d.**
123678-H6CDD	21.3	18.5	12.7	**47.5**	14.9	7.5	**14.2**	**7.9**	**6.5**	17.3	14.5	6.1	7.5	**22.4**
123789-H6CDD	4.0	3.3	2.7	**11.3**	2.4	1.7	**4.0**	**1.4**	**n.d.**	2.7	1.9	1.4	n.d.	**5.2**
1234678-H7CDF	2.9	3.2	5.0	**9.0**	4.2	1.2	**6.3**	**1.3**	**n.d.**	2.0	1.3	2.9 m	3.4 m	**<4.6**
1234678-H7CDD	36.2	12.1	28.0	**58.1**	28.6	11.6	**22.4 m**	**17.6**	**14.8**	25.3	18.6	18.0	22.1	**17.9**
OCDD	104	111	205	**236**	210	52	**n.a.**	**92**	**108**	101	72	144	139	**100**
I-TEq	22.2	12.8	10.5	**37.5**	11.9	18.5	**8.4**	**6.5**	**6.3**	15.6	11.3	6.0	5.6	**16.0**

* analyzed by *Lebensmitteluntersuchungsamt Oldenburg*[3)]
m = maximum value, due to possible contribution of a contaminant
n.d. = not detected
n.a. = not analyzed

2) Abraham K., A. Hille, M. Ende and H. Helge (1994) Intake and fecal excretion of PCDDs, PCDFs, HCB and PCBs (138, 153, 180) in a breast-fed and a formula-fed infant. Chemosphere 29, 2279-2286
3) Abraham K., A. Knoll, M. Ende, O. Päpke and H. Helge (1996) Intake, fecal excretion and body burden of polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) in breast-fed and formula-fed infants. Pediatric Research (in press)
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5) NATO (1988) Pilot study on international information exchange on dioxins and related compounds. International equivalency factors (I-TEF) method of risk assessment for complex mixtures of dioxins and related compounds. NATO Report No. 176, 1-26
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7) Schecter A., O. Päpke, A. Lis, M. Ball, J.J. Ryan, J.R. Olson, L. Li and H. Kessler (1996) Decrease in milk and blood dioxin levels over two years in a mother nursing twins: estimates of decreased maternal and increased infant dioxin body burden from nursing. Chemosphere 32, 543-549