DIOXIN LEVELS IN THE BLOOD OF CAMBODIANS LIVING NEAR THE AGENT ORANGE SPRAYED HO CHI MINH TRAIL AND IN NON-SPRAYED AREAS OF CAMBODIA

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INTRODUCTION

Cambodia is a non-industrial country where massive population disruption and a deliberate social movement back to "Year 1", or a society devoid of industrialization and culture, was initiated during the late 1970's under the Khmer Rouge. We previously collected and analyzed blood and milk from Cambodia and compared it with levels found in other countries, including America, Germany, Vietnam, and China (Table 1)[1,2,3]. We found dioxin levels in Cambodians to be either the lowest of any country sampled, or at that level[3,4]. In this paper, we present findings of blood dioxin levels from Cambodians living in the capital city of Phnom Penh, far from the Agent Orange-sprayed Ho Chi Minh Trail area used by Vietnamese military during the Vietnam-American War, and from Cambodians living nearer to the Ho Chi Minh Trail area.

MATERIALS AND METHODS

Pooled comparison blood from the capital of Cambodia, Phnom Penh, was collected from left-over blood at a blood center from 100 Cambodians and put into chemically-cleaned glass bottles. Then, ten individual blood samples were collected from the National Blood Collection Center in a village as close to the Ho Chi Minh Trail as was felt safe. Unexploded ordnance, bombs and land mines are a very real and deadly hazard in Cambodia, so we (AS) elected not to go to the actual Trail itself. One of us (AS) went to Kompong Cham Village, Prey Vang Province to collect individual samples from Cambodians nearer to the Ho Chi Minh Trail. The blood was frozen and kept frozen until delivered to the German dioxin laboratory. It was analyzed there by high-resolution gas chromatography-mass spectrometry by methods previously described[5,6]. The ERGO Laboratory has been certified by the World Health Organization for analysis of dioxins in human blood, human milk, and food.

RESULTS AND DISCUSSION

Our data from previous Cambodian samples collected in Phnom Penh showed extremely low dioxin and dibenzofuran levels. These compare with our much higher blood and milk dioxin levels from Germany and the USA, and low levels found in Siberia, Thailand, and the north of Vietnam. USA blood lipid dioxin levels have usually been between 20-40 ppt total dioxin toxic equivalents, and up to 60 ppt if dioxin-like PCBs are included, as shown on Table 1. We also have reported

even lower levels on human fetal tissue from the USA and in newborn samples, including tissue from sudden infant death syndrome babies in Germany during the first year of life[3,4,7].

We expect Phnom Penh blood dioxin levels to continue to be very low. We further expect elevated TCDD in Cambodian blood in the Kompong Cham Village persons, similar to what has been found by our group and others in Vietnamese living near Agent Orange sprayed areas of Vietnam. If elevated TCDD is not found in those closest to the Ho Chi Minh Trail area from these persons, the next collection of human blood will take place at the actual Cambodian part of the Ho Chi Minh Trail, despite the hazards from unexploded ordnance.

To date, of those potentially exposed to Agent Orange, only Vietnamese and American Vietnam veterans have had blood or milk measured for TCDD elevation. Some from both countries have had elevation, with the highest measured levels from Vietnam being 1,850 ppt in milk lipid, and the highest measured level in American veterans being about 660 ppt TCDD, from samples collected years after the spraying ended and the soldiers returned to the USA. The highest TCDD level we measured this year in Vietnamese, from 1999 blood samples, was 271 ppt of TCDD. This compares with the usual blood TCDD levels in Vietnam of 2-3 ppt[4,8].

Systematic sampling and measurement of Cambodians and of Laotians for elevated TCDD is indicated. The Ho Chi Minh Trail, heavily sprayed with TCDD containing Agent Orange by American military forces as a defoliant, is mainly in Vietnam, but it also extended through parts of Cambodia and in Laos.

If elevated TCDD levels are found in humans in Cambodia, public health action may well be indicated. This might include public health measures such as environmental remediation, medical surveillance, human and environmental surveys, and increased health care.

Laotians will also be sampled soon, completing our dioxin surveillance from the three countries contaminated with TCDD from Agent Orange. Although hopeful, we do not expect Laotian blood analyses to be ready for the presentation at Dioxin 2000. As noted above, our most recent Vietnamese blood samples (1999) have been analyzed for dioxins, and surprisingly show marked elevation of TCDD in many persons sampled[9].

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Table 1 Levels of Dioxins and Dibenzofurans in Human Milk From Various Countries (ppt, lipid basis) [1,2]

Congener	TEF	Hanoi, Vietnam Pooled N=39		Dong Nai, Vietnam Pooled N=11		Phnom Penh, Cambodia Pooled N=6		Bankok, Thailand Pooled N=10		U.S.A Pooled N=42		Siberia, U.S.S.R. Pooled N=23	
		Measured	TEQ	Measured	TEQ	Measured	TEQ	Measured	TEQ	Measured	TEQ	Measured	TEQ
2,3,7,8-TCDD	1	2.1	2.1	10	10	0.49	0.49	0.3	0.3	3.3	3.3	2.7	2.7
1,2,3,7,8-PnCDD	1	2.9	2.9	7.2	7.2	1.6	1.6	1.1	1.1	6.7	6.7	3.3	3.3
1,2,3,4,7,8-HxCDD	0.1	1.8	0.18	2.1	0.21	0.6	0.06	0.5	0.05	4.95	0.5	1.6	0.16
1,2,3,6,7,8-HxCDD	0.1	5.2	0.52	10	1	3.4	0.34	1.1	0.11	30.5	3.05	5.6	0.56
1,2,3,7,8,9-HxCDD	0.1	1.8	0.18	4	0.4	1.1	0.11	0.7	0.07	6.2	0.62	1.2	0.12
1,2,3,4,6,7,8-HpCDD	0.01	11.5	0.115	28	0.28	11	0.11	10	0.1	4.2	0.42	8.1	0.081
OCDD	0.0001	78.3	0.0078	119	0.0119	59	0.0059	68	0.0068	233	0.023	50.2	0.005
2,3,7,8-TCDF	0.1	2	0.2	1.6	0.16	0.52	0.052	1.8	0.18	2.85	0.29	2.9	0.29
1,2,3,7,8-PnCDF	0.05	1	0.05	1	0.05	0.32	0.016	0.7	0.035	0.45	0.02	1.2	0.06
2,3,4,7,8-PnCDF	0.5	6.1	3.05	13	6.5	1.6	0.8	2.6	1.3	7.3	3.65	10.3	5.15
1,2,3,4,7,8-HxCDF	0.1	4.2	0.42	19	1.9	0.74	0.074	1.2	0.12	5.55	0.56	7.7	0.77
1,2,3,6,7,8-HxCDF	0.1	3.1	0.31	11	1.1	0.79	0.079	0.9	0.09	3.2	0.32	2.9	0.29
1,2,3,7,8,9-HxcCDF	0.1	ND (0.5)		ND (0.5)		ND (0.5)		ND (0.5)		ND (0.5)		ND (0.5)	
2,3,4,6,7,8-HxCDF	0.1	1.4	0.14	2.1	0.21	0.41	0.041	0.6	0.06	1.85	0.19	0.9	0.09
1,2,3,4,6,7,8-HpCDF	0.01	3.4	0.034	6.2	0.062	2.2	0.022	0.9	0.009	4.05	0.04	1.2	0.012
1,2,3,4,7,8,9-HpCDF	0.01	ND (0.5)		ND (0.5)		ND (0.5)		ND (0.5)		ND (0.5)		ND (0.5)	
OCDF	0.0001	2.1	0.00021	0.9	0.00009	2.4	0.00024	0.6	0.00006	4.1	0.0004	1.2	0.00012
Total PCDDs		104	6	180	19	77	3	82	2	327	15	73	7
Total PCDFs		23	5	55	10	9	1	9	2	29	5	28	7
Total PCDD/PCDFs		127	11	235	29	86	3	91	4	356	20	101	14

note: totals are rounded