An Exposure Investigation at a 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin Contaminated Residential Site

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Introduction

A private driveway off a residential street was found to be contaminated with 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) at levels as high as 1,173 parts per billion (ppb) in surface and subsurface soils. The driveway only serves one house, but is also bordered by two other homes (Figure 1). Several interior dust samples were collected from the on-site residence, which is completely surrounded by dioxin-contaminated soils, and from the other two residences adjacent to the private drive. The interior dust sampling identified TCDD concentrations up to 6.04 ppb within several rooms of the on-site residence (1). An estimated 25 people live along the street, some of whom may have been exposed to the TCDD contamination for 25 years (2). In September 1997, the Missouri Department of Health and Agency for Toxic Substances and Disease Registry conducted an Exposure Investigation (EI) to assess the local residents' exposure to TCDD.

Materials and Methods

All residents (>18 years of age) who were living on LeMar Drive west of Mar-El Court (see Figure 1), and had lived there for at least one year, were invited to participate in the EI by answering a questionnaire and giving a blood specimen for analysis. The questionnaire confirmed the presence of absence of exposures to dioxin-like compounds from sources other than the site (e.g. occupations, formerly lived at other TCDD sites, etc.)

A licensed phlebotomist collected blood samples by venipuncture from 11 participants on September 10, 1997. The blood samples were collected at the Saxony Clubhouse in Manchester, Missouri, which is approximately 3 miles from LeMar Drive. Blood samples were obtained from three other participants at their homes during October or November 1997. One unit of blood was collected from each participant. A smaller blood sample (approximately 100 milliliters) was collected from four participants because of medical conditions (heart disease, pregnancy, age). The blood specimens were centrifuged to separate the serum fraction. The serum fraction was removed, frozen, and sent on dry ice via overnight mail to the National Center for Environmental Health (NCEH) laboratory for analyses. The serum samples were analyzed by isotope-dilution, high-resolution, mass-spectrometry. Samples were analyzed for 20 chlorinated dibenzodioxins, chlorinated

dibenzofurans, polychlorinated biphenyls, and lipids. Concentrations of dioxin-like compounds were normalized by expressing them as a blood lipid concentration.

Results and Discussion

A total of 14 residents participated in the EI. The age of the participants ranged from 24 to 73 years. Table 1 reports the concentrations of all the serum dioxin-like analytes detected in blood samples from the EI participants.

The NCEH has conducted a comprehensive survey of published studies and compiled data from studies of people who had presumably not been occupationally exposed to these chemicals (3). They found the range of TCDD means in these studies to be 3.2 - 10.1 ppt, with a reference range of non-detected to 38 ppt. The mean values and the ranges of dioxin-like compounds detected in serum samples from the participants were within the national reference ranges. As the comparison group for a dioxin incinerator emissions exposure study at Times Beach, Missouri, serum TCDD concentrations were measured in 74 residents of a community in Manchester, Missouri. This population had no known exposure to dioxins other than background levels. The concentrations of TCDD in this population ranged from non-detected to 3.8 ppt, with a mean concentration of 1.4 ppt (2). While there were five EI participants with serum TCDD levels above those found in the Manchester, Missouri group, all of the EI participants are well within the national range of TCDD concentrations seen in non-occupationally exposed people (2). Currently, research results are mixed on whether TCDD exposure at the levels found in this EI would result in significant adverse health effects, although the majority would indicate that they would not be observed.

The NCEH has not developed a reference range for total dioxin Toxic Equivalents (TEQs) in blood. In the published literature, however, it has been reported that the average background range for dioxin TEQs in the general population ranges from 36 to 58 picograms TEQs/gram (4). Using published Toxicity Equivalent Factors (TEFs) (3), the sum of the dioxin TEQs in this EI ranged from 2.78 to 27.37 picograms/gram lipid. All of the individual TEQs found in the EI were less than these average TEQs reported for the general population.

The EI demonstrated that a portion of the population around this site had serum TCDD levels exceeding those found locally. Elevated concentrations of the other dioxin-like compounds were not detected in the EI. Appropriate measures should be taken to remove exposure to TCDD-contaminated soils at this site.

References

1. Kudlinski, J.; Request for a removal action at the LeMar Drive site, Ellisville, St. Louis County, Missouri Action Memorandum, U.S. Environmental Protection Agency, **1997**.
2. Agency for Toxic Substances and Disease Registry, Exposure Investigation LeMar Drive Property Site Ellisville, Missouri, **1997**.
3. Needham L, Patterson D, Burse V, Paschal D, Turner W and Hill R; Reference range data for assessing exposure to selected environmental toxicants, Toxicol. Indus. Health. **1996**, 12, 507-513.
4. Devito M, Birnbaum L, Farland W, Gasiewcz T; Comparisons of estimated human body burdens of dioxinlike chemicals and TCDD body burdens in experimentally exposed animals, Environ. Health Perspec. **1995**, 103, 820-831.

TABLE 1

Mean and Range of Dioxin Concentrations in Blood Serum (picograms/ gram lipid)

Chemical	Residents[1]	Reference[2]	Manchester[3]
2,3,7,8-Tetrachlorodibenzo-*p*-dioxin	6.28 (0-18.6)	3.2-10.1 (ND*-38)	1.4 (ND-3.8)
1,2,3,7,8-Pentachlorodibenzo-*p*-dioxin	3.22 (1-6.2)	6.6-32 (ND-180)	
1,2,3,4,7,8-Hexachlorodibenzo-*p*-dioxin	NR**(NR)	6.3-13 (3.1-58)	
1,2,3,6,7,8-Hexachlorodibenzo-*p*-dioxin	NR (NR)	45-85 (17-494)	
1,2,3,7,8,9-Hexachlorodibenzo-*p*-dioxin	3.88 (1.6-6.1)	7.1-21.9 (3.5-51)	
1,2,3,4,6,7,8-Heptachlorodibenzo-*p*-dioxin	13.4 (6.4-56)	80.3-230 (ND-1260)	
1,2,3,4,6,7,9-Heptachlorodibenzo-*p*-dioxin	0 (0)	No Data (ND)	
Octachlorodibenzodioxin	223 (81.3-405)	560-1000 (64-2550)	
2,3,7,8-Tetrachlorodibenzofuran	0.07 (0-1)	1.1-9 (ND-32)	
1,2,3,7,8-Pentachlorodibenzofuran	0 (0)	ND (ND)	
2,3,4,7,8-Pentachlorodibenzofuran	3.54 (1.5-6.4)	5-27 (ND-77)	
1,2,3,4,7,8-Hexachlorodibenzofuran	3.85 (1.7-7.6)	4.5-11 (1.7-28)	
1,2,3,6,7,8-Hexachlorodibenzofuran	3.24 (1.7-5.2)	4.5-8.5 (1.8-18)	
1,2,3,7,8,9-Hexachlorodibenzofuran	0 (0)	ND (ND)	
2,3,4,6,7,8-Hexachlorodibenzofuran	0.16 (0-1)	ND (ND)	
1,2,3,4,6,7,8-Heptachlorodibenzofuran	7.27 (2.6-14)	8.7-22.8 (ND-55)	
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0 (0)	ND (ND)	
Octachlorodibenzofuran	0 (0)	ND (ND)	
3,3',4,4'-Tetrachlorobiphenyl	1.85 (0-19.3)	11.7 (ND-27.9)	
3,4,4',5-Tetrachlorobiphenyl	0 (0)	10.5 (1.5-21.3)	
3,3',4,4',5-Pentachlorobiphenyl	4.84 (0-12.9)	135 (14.6-371)	
3,3',4,4',5,5'-Hexachlorobyphenyl	9.46 (2.3-23.4)	69 (29.5-174)	

1 = Mean concentration (and range of concentrations in parenthesis) (picograms/gram lipid) in Exposure Investigation participants

2 = Range of mean concentrations (and range of individual values in parenthesis) (picograms/gram lipid) from selected reference studies (3)

3 = Mean concentration (and range of concentrations in parenthesis) (picograms/gram lipid) in 74 residents of Manchester, Missouri.

*ND = Not detected

**NR = Not reported

Figure 1

Lemar Drive Dioxin Site Map, Ellisville, MO.