

## CHLORINATED AND BROMINATED DIOXIN LEVELS IN THE BLOOD OF A CHEMIST WHO BECAME ILL AFTER SYNTHESIZING 2,3,7,8-TCDD AND 2,3,7,8-TBDD

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### ABSTRACT

Thirty-four years ago, a chemist who synthesized 20 to 30 grams of 2,3,7,8-TCDD and a similar amount of 2,3,7,8-TBDD, became ill with chloracne, headaches, and muscle pain. Because of leg pain on exertion he experienced marked difficulty walking, and was hospitalized for these conditions. Recently, blood was obtained from him. We found 20 ppt TCDD in a blood sample taken 34 years after initial exposure, whereas mean 2,3,7,8-TCDD is about 5 ppt in the general U.S. population. We estimate a possible blood TCDD level of between 195 and 1925 ppt at time of exposure, for half lives of 10 or 5 years respectively. This corresponds to approximately 2 to 20 micrograms of 2,3,7,8-TCDD, and a remarkable quantity of 2,3,7,8-TBDD, which caused the illness this patient experienced. The subject has no known medical problems at this time. His 2,3,7,8-TBDD was over 2000 ppt in serum Epid.

### INTRODUCTION

The longest previous time after exposure where elevated dioxin levels for TCDD were found was 32 years.<sup>1</sup> The present report is on a chemist who synthesized 2,3,7,8-TCDD and 2,3,7,8-TBDD in 1956, and subsequently became seriously ill with classical signs and symptoms characteristic of dioxin poisoning. This case was first reported by Baughman in 1974 in his doctoral thesis.<sup>2</sup> We interviewed the chemist and at his request, obtained a sample of his blood for dioxin analysis. An estimate of body burden is made, using half-lives and estimated body fat content at time of exposure and at present, to define a level of dioxins related to human acute ill health effects. The chemist made a rapid recovery from his two episodes of dioxin exposure and is currently in good health, although he may be potentially at increased risk of developing cancer from his exposure. The measured amount of TCDD and TBDD are of interest, because they permit estimations to be made of the amount which causes overt human illness in this person. The amount of TBDD measured however is of particular interest as this compound has not previously been reported on humans, although adipose tissue TBDD measurements and field studies have been performed by Stanley<sup>3</sup> where no TBDD was detected. The clinical manifestations noted in the hospital record, from the University of Chicago Hospitals, document several toxic end points, including headache, dull backache, severe leg pain on exertion while attempting to walk, and severe and extensive chloracne, confirmed by biopsy and histological examination.

### METHODS

Methods for determining PCDD/F levels have been described elsewhere<sup>4</sup> and will not be repeated here. Measurement of 2,3,7,8-tetrabromodibenzo-p-dioxin in the blood of this patient was done as follows. Sample extract was purified in the same method as measurement for PCDD/Fs. The standard used was a mixture of 20 picograms of 2,3,7,8-TBDD and 5 picograms of 1,2,4,6,7,9-HxCDD (recovery standard). The response of the extract was compared directly to the response of the standard (i.e. external standard method). It was assumed that 70% of 2,3,7,8-TBDD was lost in the isolation step, as was the case for 2,3,7,8-TCDD.

### RESULTS

Results for 2,3,7,8-TCDD are given in the Table I and Graphs I & II. Except for TCDD, the PCDD/F levels appear to be similar to the general U.S. population level. The 2,3,7,8-TCDD is 20 ppt in blood collected in 1990, 33 years after initial exposure. Since the average value for TCDD is 5 ppt in this country,<sup>5</sup> the TCDD value exceeds the mean by 15 ppt. Assuming approximate half-life values of 5 or 10 years for TCDD in humans, first order kinetics, and a single compartment model, as well as an average body fat content of about 15% in 1956 and also in 1990, we calculate the following: TCDD level at the time

of exposure if the half life is 10 years would be 185 ppt, and with a half life of 5 years, 1925 ppt, 34 years previously. This leads to a calculation of approximately 2-20 micrograms total body burden of 2,3,7,8-TCDD at time of exposure, assuming 15% of body weight of 162 pounds in each time period to be adipose tissue lipid, and most TCDD to be in adipose tissue. Results for the TBDD determination indicated a remarkable amount of 2000 ng/kg (ppt), on the basis concentration of 2,3,7,8-TBDD on whole blood lipid basis. His 2,3,7,8-TBDD level might have been between 20,000 - 256,000 ppt if the same assumptions are valued for TBDD as TCDD, for a body burden of 220 - 105,000 micrograms.

## DISCUSSION

Approximation by measurement of current PCDD/Fs and calculation to estimated level of TCDD at time of exposure suggest that this organic chemist had a total intake of between 2 and 20 micrograms of TCDD, plus an even higher level of TBDD. 2,3,7,8-TBDD is believed to have similar toxicity to TCDD.<sup>8</sup> Consequently, these amounts do appear to be causally related to the patient's clinical symptoms: chloracne, headaches, muscle aches and pains, difficulty walking (the mechanism of which is not clear, whether neurologic, muscular or vascular in origin), and a feeling of being quite sick, sufficient to warrant hospitalization. This case report contributes to case reports on the amount of dioxin and various toxic end points involved in human illness. Previously, in the case of six German workers who became ill after TCDD exposure during a cleanup following an explosion, we calculated a mean body burden of 44 micrograms, with a range from 9.7 to 124 micrograms.<sup>1</sup> This finding of elevated TCDD and TBDD levels so long after the last known exposure, documents the usefulness of human tissue measurement of dioxins as long as thirty-four years following exposure. It should be noted that no liver abnormalities were noted in blood tests from this patient and laboratory values in general were unremarkable at the time of hospitalization at the University of Chicago Hospitals in 1957. The current estimate of 2 to 20 micrograms for TCDD leading to illness in this person must also take into account the 2,000 ppt of 2,3,7,8-TBDD detected which is much higher than 2,3,7,8-TCDD levels found in some individuals even 34 years after initial exposure.

## REFERENCES

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TABLE I Comparison of Dibenzofurans and Dioxins in Whole Blood, Analyzed on a Lipid Extractable Basis from a Person Exposed to TCDD 34 Years Ago, and Pooled Blood from New York (PPT,Lipid)								
Congeners	Value (American Controls) N=100	TEQ <sup>7,8</sup> (American Controls) N=100	PCDD/F Level 1990	TEQ	Calculated Value in 1956 <sup>*</sup>	TEQ	Calculated Value in 1956 <sup>**</sup>	TEQ
2378-TCDF	3.1	0.31	6.3	0.63				
2378-TCDD	5.2	5.2	20.0	20.0	150		1500	
1,2,3,7,8-PnCDF	2.8	.14	NA	NA				
23478-PnCDF	13.0	6.5	9.9	4.95				
12378-PnCDD	21	10.5	17	8.5				
123478/123678-HxCDF	29	2.9	21	2.1				
234678-HxCDF	3.6	0.36	ND(2)					
123478/123678-HxCDD	97	9.7	91	9.1				
123789-HxCDD	15	1.5	13	1.3				
1234678-HpCDF	36	0.36	60	0.6				
1234678-HpCDD	187	1.87	204	2.04				
OCDD	1174	1.174	1620	1.62				
OCDF	4.2	.0042	NA	NA				
Total PCDDs	1499	30	1965	43	2110		3880	
Total PCDFs	92	11	97	8	97		97	
Total PCDD/PCDFs	1591	41	2062	51	2207	216	3977	1956

Note: Totals are rounded

\* Tissue level on date of exposure assuming 10 year half-life with following assumptions:

One compartment model

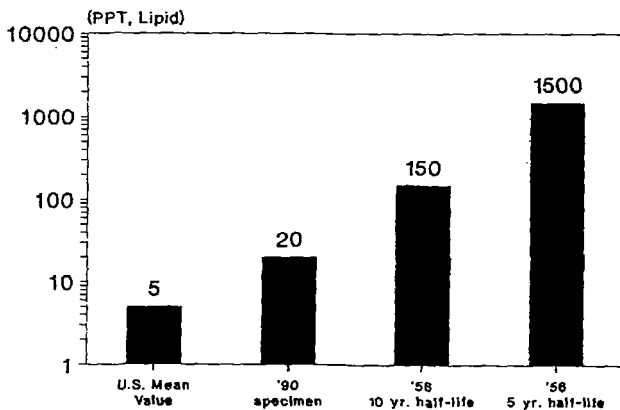
First order kinetics

5ppt mean, whole blood lipid 2378-TCDD level U.S.

dioxins and dibenzofurans, other than 2378-TCDD assumed to be at the same level in 1956 and 1990.

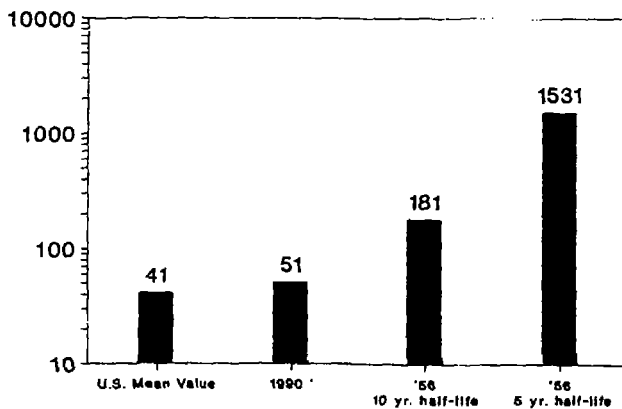
\*\* Tissue level on date of exposure assuming a 5 year half-life with same assumptions stated above.

**GRAPH I: BLOOD 2,3,7,8-TCDD LEVEL**  
Exposure occurred 34 years ago



Values for '56 are estimated see Table I

**GRAPH II: DIOXIN TEQs OF PCDD/Fs**  
Exposure occurred 34 years ago



Values for '56 are estimated see Table I