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Reply to the Editor

Reply to Comment of Edmund A.C. Crouch and Laura C. Green, on: "Persistent organic pollutants in 9/11 world trade center rescue workers: Reduction following detoxification" by James Dahlgren, Marie Cecchini, Harpreet Takhar, and Olaf Paepke [Chemosphere 00/00 (2007) 000–000]

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Dear Sir,

We have reviewed the TEQ calculation in our accompanying article published in this issue of *Chemosphere* (Dahlgren et al., 2007). All calculations of concentrations by weight and other observations in this pilot evaluation are correctly represented. However, Drs. Green and Crouch are correct in noting that we did enter an error into the conversion of net weight to TEQ. We therefore submit the following as corrections to Table 1 and Fig. 1. On completion of the therapeutic regimen, WHO-TEQ for mono-ortho PCBs was decreased by 24.4%. The statistical analysis of the net reduction of each congener by weight (lipid based) presented in Table 2 remains correct. A number of individual congeners had statistically significant measured decreases at the completion of this therapeutic regimen. The 23.4% mean reduction by weight (lipid based) of all halocarbons measured is represented in Fig. 2 of this letter. This is encouraging data when considering the toxicity profiles of these compounds, and that their half-lives are measured in years, even decades.

The measured dioxin, dibenzofuran, and PCB congener levels and corresponding TEQ for each subject before and after detoxification is presented in Table 1. Prior to detoxification treatment, three subjects (WTC005, WTC006, H50605) had levels of 1,2,3,6,7,8-hexa-CCD or OCDD at or above the NHANES III 75th percentile. All subjects had levels of 2,3,3′,4,4′,5-HxCB (156) above the NHANES III 75th percentile with other congeners well above the NHANES III limit of detection. Patient H50605 was a firefighter who we initially tested in May 2003. Calculated mono-ortho PCB blood levels decreased by an average 23.5% (WHO-TEQ reduction of 24.4%), as shown in Fig. 1. Measured blood levels for all congeners averaged a 23.4% reduction (WHO-TEQs reduction of 12.9%) as shown in Fig. 2.

Despite a claim of "no conflict of interest," Drs. Green and Dr. Crouch are employed by Cambridge Environmental, an organization that provides scientific and medical litigation support for companies associated with the release of toxic materials, including PCBs. (http://www.cambridgeenvironmental.com/services/litigation.htm).

This paper was presented as a pilot evaluation that could inform further work. The remarks from Drs. Green and Crouch seem to be designed to rebut conclusions that were not stated or intended by the authors. In recognition of the small study size, we state in our original manuscript that no correlation can be drawn between the reductions measured and the improvements in self-reported symptoms from each subject's medical folder.

Reductions of adipose concentrations of PCBs through this regimen have been demonstrated in previous work. (Schnare et al., 1984). This pilot focused on these compounds because there is evidence of their presence at the WTC site and because they have a long half-life. Thus, they

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Table 1
Measured dioxin, dibenzofuran, and polychlorinated biphenyl levels* before and after treatment of WTC-exposed individuals, NY 2004

Identification		WTC002 Age 48		WTC005 Age 38		WTC006 Age 52		WTC009 Age 46		WTC0011 Age 32		WTC0013 Age 45		H5065 Age 41		Comparison: NHANES III	
Congener	TEF	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	L.O.D.	75th
2.3.7.8-Tetra-CDD	1	1.9	1.3	3.2	2.1	2.2	1.8	1.4	1.7	3	1.4	1.6	1.6	2.6	2	4.8	
pg/g	n.d.																
1.2.3.7.8-Penta-CDD	1	5.3	4.1	7.1	7	8.1	7.3	5.8	7.1	4.1	3.5	4.1	5.7	**6.3**	**6.2**	5.3	n.d.
1.2.3.4.7.8-Hexa-CDD	0.1	4	3.5	6.5	5.6	6.1	4.8	5.8	6.3	2.4	n.d.(2)	n.d.(4)	n.d.(4)	**6**	**9.6**		
1.2.3.6.7.8-Hexa-CDD	0.1	31	29	38	35	49	44	33	40	20	14	15	16	**40.6**	**36**	7.5	36.1
1.2.3.7.8.9-Hexa-CDD	0.1	2.8	3.4	5.6	5.9	5.1	6.2	4	5.8	5.4	3.4	n.d.(3)	n.d.(3)	**5.6**	**6.3**	7.6	n.d.
1.2.3.4.6.7.8-Hepta-CDD	0.01	26	27	56	54	48	42	51	63	21	26	24	25	**47.4**	**55**	24.7	61.9
OCDD	0.0001	94	95	272	250	437	426	195	242	66	79	134	114	**185.9**	**251**	145	445
2.3.7.8-Tetra-CDF	0.1	n.d.(1)	n.d.(1)	1.2	1.2	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	1.3	1.4	**1.3**	**1.4**	4.6	n.d.
1.2.3.7.8-Penta-CDF	0.05	n.d.(1)	n.d.(1)	1.3	1.3	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	1.1	1.1	**1.9**	**1.9**	5	n.d.
2.3.4.7.8-Penta-CDF	0.5	3.4	4	10	9.8	7.7	7.9	4.7	6	3.5	2.9	6.6	6.3	**9.1**	**10**	4.8	n.d.
1.2.3.4.7.8-Hexa-CDF	0.1	4.3	4.7	9.2	8.8	8.2	6.8	7.3	7.3	3.8	4.2	6	6.6	**10.4**	**13**	4.7	n.d.
1.2.3.6.7.8-Hexa-CDF	0.1	3.2	3.4	7	7.1	7.5	6.6	3.9	6.1	2.3	3.3	4.8	5.6	**7.2**	**10**	4.8	n.d.
1.2.3.7.8.9-Hexa-CDF	0.1	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(1)	n.d.(2)	n.d.(1)	n.d.(2)	n.d.(2)	n.d.(2)	n.d.(3)	n.d.(3)	**n.d.(5)**	**n.d.(5)**	4.6	n.d.
2.3.4.6.7.8-Hexa-CDF	0.1	1.4	n.d.(2)	3.5	2.7	2.3	1.5	2.5	2.1	1.6	n.d.(1)	5.4	5.4	**2.1**	**6**	4.8	n.d.
1.2.3.4.6.7.8-Hepta-CDF	0.01	3.1	2.7	4.8	5.5	5.7	6.5	5.9	8.3	3.6	5	5.7	4.4	**6.1**	**6.8**	5.2	n.d.
1.2.3.4.7.8.9-Hepta-CDF	0.01	n.d.(2)	n.d.(1)	n.d.(1)	n.d.(2)	n.d.(1)	n.d.(3)	n.d.(1)	n.d.(2)	n.d.(2)	n.d.(3)	n.d.(5)	n.d.(5)	**n.d.**	**n.d.(8)**		
OCDF	0.001	n.d.(4)	n.d.(3)	n.d.(3)	n.d.(5)	n.d.(3)	n.d.(10)	n.d.(4)	n.d.(5)	n.d.(6)	n.d.(11)	n.d.(22)	n.d.(24)	**n.d.**	**n.d.(33)**	12.6	n.d.
3,3',4,4'-TCB (77)	0.0001	n.d.(24)	n.d.(14)	n.d.(13)	n.d.(17)	n.d.(12)	n.d.(22)	n.d.(18)	n.d.(27)	n.d.(17)	n.d.(23)	n.d.(26)	n.d.(28)	**68**	**n.d.(31)**		
3,4,4',5-TCB (81)	0.0001	n.d.(2)	2.6	2.5	3.8	n.d.(2)	2.4	2.4	4.6	n.d.(3)	3.3	5.2	9	**12**	**9**	25.8	n.d.
3,3',4,4',5-PeCB (126)	0.1	23	28	44	41	64	65	41	44	20	14	36	39	**197**	**163**	9	n.d.
3,3',4,4',5,5'-HxCB (169)	0.01	21	28	23	23	48	49	26	43	23	16	31	28	**51**	**56**	9.9	n.d.
2,3,3',4,4'-PeCB (105)	0.0001	1203	1006	7908	5222	537	443	4050	3626	1881	1184	1782	1886	**41765**	**31469**	6400	n.d.
2,3,4,4',5-PeCB (114)	0.0005	675	581	1906	1380	1253	1000	980	887	771	500	1236	1289	**17746**	**13986**	6400	n.d.
2,3',4,4',5-PeCB (118)	0.0001	6153	4955	31225	22656	4665	3266	20163	16772	9408	5355	10062	9705	**207921**	**152910**	6400	14700
2',3,4,4',5-PeCB (123)	0.0001	232	234	492	556	283	227	245	421	149	174	310	373	**1900**	**2853**		
2,3,3',4,4',5-HxCB (156)	0.0005	8045	6807	6987	4598	9759	7214	6478	6403	7501	4290	9977	9371	**95751**	**66304**	6400	n.d.
2,3,3',4,4',5'-HxCB (157)	0.0005	1596	1548	1396	1086	2042	1606	1480	1523	1550	1003	2485	2293	**18706**	**16126**	6400	n.d.
2,3',4,4',5,5'-HxCB (167)	0.00001	756	798	2029	1601	1096	911	1683	1802	1047	2123	1918	1867	**18881**	**16344**	6400	n.d.
2,3,3',4,4',5,5'-HpCB (189)	0.0001	531	629	475	430	952	955	594	790	523	413	846	738	**2324**	**2336**		
Total PCDDs/PCDFs		180.4	178.1	425.4	396	586.9	561.4	320.3	395.7	136.7	142.7	210	193	**332.5**	**415.2**		
Total non-ortho-PCBs		44	58.6	69.5	67.8	112	116.4	69.4	91.6	43	33.3	72	76	**328**	**228**		
Total mono-ortho-PCBs		19191	16558	52418	37529	20587	15622	35673	32224	22830	15042	28616	27521	**404994**	**302328**		
TEQ (WHO) non-ortho PCB		2.5	3.1	4.6	4.3	6.9	7.0	4.4	4.8	2.2	1.6	3.9	4.2	**20.2**	**16.9**		
TEQ (WHO) mono-ortho PCB		6.0	5.2	9.2	6.4	7.2	5.4	7.0	6.6	6.1	3.6	8.2	7.8	**91.7**	**67.3**		
TEQ (WHO) based on PCDD/F		13.9	12.1	23.1	21.3	22.6	20.6	15.8	19.3	12.7	9.2	12.6	14.3	**21.4**	**22.2**		
TEQ (WHO) based on PCB		8.5	8.2	13.8	10.8	14.1	12.4	11.4	11.4	8.3	5.2	12.1	11.9	**111.9**	**84.2**		
TEQ(WHO)		22.4	20.3	36.9	32.1	36.6	33.0	27.1	30.7	21.0	14.3	24.7	26.3	**133.3**	**106.4**		

Values in pg/g (ppt), lipid based; samples from human blood.
+ Patient H 5-0605 blood tested in 5/2003 [firefighter sent us his PCB value of 32 ppb (Webb and McCall) on 1/9/02].
NHANES III data from Second National Report on Human Exposure to Environmental Chemicals. US Dept of Health and Human Services NCEH Pub. No. 02-0716 March 2003.

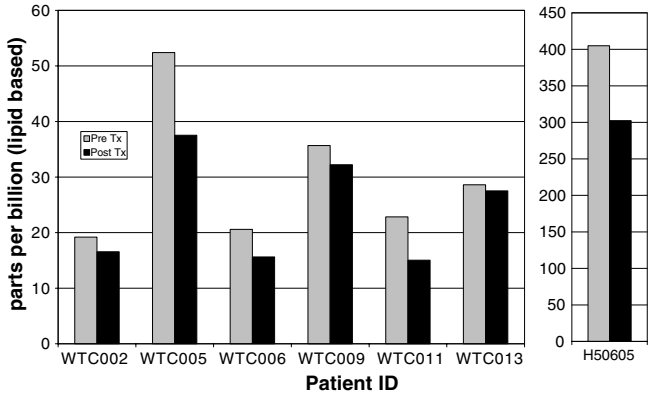

Fig. 1. Changes in blood mono-ortho PCB levels with detoxification (mean reduction 24.4%).

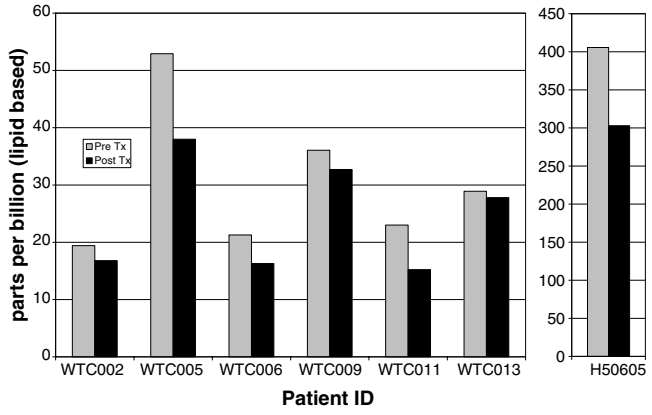

Fig. 2. Changes in the levels of all congeners with detoxification (mean reduction 23.4%).

might serve as a useful marker to evaluate a multi-modal therapy (further described below), aimed at reducing body burden and addressing adverse health effects following chemical exposures.

To evaluate natural fluctuation in blood PCB concentrations in these particular individuals, subjects provided samples twice during a one-month period immediately prior to beginning the therapeutic regimen. The manuscript presents our measurements reflecting an insignificant mean increase of 4% during this one month period. In contrast, all subjects had measurable decreases in these PCBs following the approximately one month treatment regimen described in more detail below. (Dahlgren et al., 2007) Again, the small size of the group argues against attaching any specific meaning to this observation.

The analytic lab run by co-author Dr. Paepke utilizes a method of analysis that has a more sensitive limit of detection then the method used for reporting in NHANES III. For NHANES, it is "ordinary" that even the 75th percentile is below the limit of detection for many congeners. The question of whether or not blood toxicant levels between the 75th and 90th percentiles reported for all persons aged 20 is uncertain. There is a substantial body of emerging data regarding the adverse health effects of low level exposures and/or unknown mixtures that may have multiple and varying effects and on multiple organ systems. (Carpenter et al., 1998; 2002). More is unknown than known and evaluation of health effects resulting from exposure to mixtures has been proposed as one of six priority areas identified by the ATSDR. (Centers for Disease Control, 2004; de Rosa et al., 2004) Literature specific to WTC impacts on firefighter health agrees that exposures to complex mixtures during the rescue and recovery efforts resulted in impaired health (Banauch et al. 2005).

First published in 1978 (Hubbard, 2002), this standardized therapeutic regimen is currently in use in a variety of medical settings to address a diverse range of chemical exposures including environmental chemicals and illicit drugs. A previous study of 103 individuals found the regimen to be safe with no serious side effects. (Schnare et al., 1982). Additional studies have demonstrated reductions in organohalides and other lipophilic chemicals (Schnare et al., 1984; Tretjak et al., 1990) while improving symptoms associated with exposures (Kilburn et al., 1989).

The program is an approximately four week daily regimen that includes (a) medical examination and determination of fitness for participation (b) daily monitoring of vital signs, weight (which is kept constant throughout the regimen) and all treatment events; (c) aerobic exercise; (d) sauna at 60–82 °C (140–180°F); (e) nutritional supplements (vitamins and minerals) centered around gradually increasing doses of crystalline niacin; (f) calcium and magnesium supplements; (g) polyunsaturated oil supplement; (h) water and salts taken as needed to avert dehydration or salt depletion due to sweating; and (i) an orderly daily schedule with balanced meals and adequate sleep. No alcohol or illegal drugs are permitted during the period of the regimen, and concurrent use of medications is only as reviewed and approved by the program physician. The regimen length is participant specific, averaging 33 days. All participants in this evaluation volunteered and signed informed consent documents.

Although the meaning of the term "detoxification" can be debated, the physiology definition is the metabolic processes by which the toxic qualities of a poison or toxin are reduced by the body. This would include metabolic changes that make a compound less toxic as well as elimination through many pathways — potentially including cholesterol transport to the liver or lumen of the intestine and elimination through feces, respiration, sweat, sebum and urine, resulting in net reduction of body burden.

In this context, this therapeutic regimen employs a number of relevant modalities. Treatment with crystalline niacin at therapeutic levels has long been known to substantially improve blood lipid profiles (Parsons and Flinn, 1959; Altshul et al., 1995) as well as reducing subcutaneous cholesterol deposits (xanthoma tuberosum). Recent discovery of a receptor that responds to nicotinic acid and increases expression of the ABCA 1 membrane cholesterol transporter has renewed interest in niacin's therapeu-

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tic benefits in line with its safety profile, lipid-metabolic and vitamin effects (Carlson 2005; Pike 2005). The effect of any changes in blood lipid profiles on the relationship between blood levels and body burdens of PCBs has not been investigated. However, the variations in cholesterol profiles measured in this group did not correlate with the measured PCB reductions (data not shown). Exercise has been shown to mobilize fatty acids as well as toxins. (Findlay and DeFreitas, 1971; deFreitas and Norstrom 1974) Sauna exposure induces physiological responses such as increased circulation through the skin and subtle endocrine changes. Sweating mediated by the hypothalamus is associated with an increase in levels of noradrenalin and beta-endorphin and activation of the renin-angiotensin–aldosterone system. (Kukkonen-Harjula and Kauppinen, 1998). Body weight of all treatment subjects is monitored daily and weight loss did not occur, thus, weight reduction is not a mechanism of action for release or elimination of toxicants that may be in fat stores. All subjects had normal body mass index based on height and weight.

Ideally, a large-scale evaluation would also include certain metals and perhaps toxicants specific to the destruction of the World Trade Center. However, as suggested by Drs. Green and Crouch, it is not clear that even this would provide definitive answers. What is known is that settled dust, air, runoff, and window film samples did contain these toxicants, therefore they could have contributed to the overall exposure pattern. However, duration of contact and resulting health issues are complex in an exposure setting where levels and types of gases and particulate matter released and/or resuspended changed with time, location, wind direction, rain as well as changing staff at rescue, recovery, clean-up and demolition activities. Although dust samples have been characterized in detail, the mixtures of particles and gases suspended in the air remain unknown (Lioy and Georgopoulas, 2006).

Reduction of symptoms is a worthwhile objective, for the many victims of the 9/11 catastrophe. The persistent symptoms observed in this sample and their improvement following this rehabilitative therapy are consistent with medical records from nearly 800 WTC-exposed men and women who have completed the program to date (personal communication, Phyllis Gelb, MD). In view of the increasing prevalence of serious illness among those exposed to toxic material during the rescue and recovery operations, as well as the existence of a large population with unresolved symptoms more than five years after their exposures, we are convinced that additional studies are warranted.

Disclosure: The authors had no financial interests at the time this research was completed or presented as a paper in Dioxin2004. In 2005 Dr. Dahlgren began to offer sauna detoxification services at his medical clinic in Santa Monica, CA. With 35 years experience as an internist diagnosing and treating patients with toxic poisoning, Dr. Dahlgren also acts as a toxicology expert in toxic tort cases across North America.

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