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Persistent organic pollutants in 9/11 world trade center rescue workers: Reduction following detoxification

James Dahlgren [a,*], Marie Cecchini [b,1], Harpreet Takhar [c,2], Olaf Paepke [d,3]

[a] UCLA School of Medicine, Occupational Medicine, 2811 Wilshire Blvd. Suite 510, Santa Monica, CA, USA
[b] Foundation for Advancements in Science and Education, 4801 Wilshire Blvd. Suite 215 Los Angeles, 90010 CA, USA
[c] James Dahlgren Medical, 2811 Wilshire Blvd. Suite 510, Santa Monica, CA, USA
[d] ERGO Laboratory, 22305 Hamburg, Germany

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Abstract

Exposure to toxins following the September 11, 2001 attack on and collapse of the World Trade Center (WTC) is of particular concern given the ultra fine particulate dust cloud, high temperature combustion, and months-long fire. Firefighters, paramedics, police and sanitation crews are among the approximately 40 000 personnel who labored for weeks and months on rescue and cleanup efforts. Many of the rescue workers have subsequently developed symptoms that remain unresolved with time. This study characterizes body burdens of polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), and polychlorinated dioxins (PCDDs) in rescue workers and citizens exposed following the WTC collapse. Our research includes a pilot evaluation of a detoxification method aimed at reducing toxic burden. Many congeners were found at elevated levels, in ranges associated with occupational exposures. Post-detoxification testing revealed reductions in these congeners and despite the small study size, some reductions were statistically significant. Health symptoms completely resolved or were satisfactorily improved on completion of treatment. These results argue for a larger treatment study of this method and an overall treatment approach to address toxic burden.

Keywords: Environment; Exposure; Dioxin; Dibenzofuran; PCB; Treatment

1. Introduction

Rescue workers present at the World Trade Center (WTC) following the September 11, 2001 terrorist attacks were exposed to large quantities of dust, smoke and fumes from the building's collapse and subsequent fire. The fire at the WTC site burned for months. Firefighters, paramedics, police and sanitation crews were among the approximately 40 000 personnel who labored for weeks and months in the immediate vicinity of the WTC. Personal Protective Equipment (PPE) use was inconsistent (Kipen and Gochfeld, 2002), and contaminant exposure occurred in a number of ways including dermal absorption and inhalation.

Many of the rescue workers developed persistent coughs, headaches, memory disturbances and other symptoms while working on the site. Two and a half years later, these symptoms persisted (Prezant et al., 2002). USEPA measured levels of benzene, dioxins and polychlorinated biphenyls (PCBs) in air and found these levels were elevated in the weeks after the collapse. (Litten et al., 2003) Dioxins slowly returned to normal background levels after three months. (Litten et al., 2003) The New York (NY) Department of Environmental Conservation (DEC) analyzed dust/ash samples collected nearby the WTC site.

* Corresponding author. Tel.: +1 310 449 5525; fax: +1 310 449 5526.
E-mail addresses: Dahlgren@envirotoxicology.com (J. Dahlgren), macecchini@comcast.net (M. Cecchini), htakhar@envirotoxicology.com (H. Takhar), olaf.paepke@web.de (O. Paepke).
[1] Tel.: +1 323 937 991.
[2] Tel.: +1 310 449 5525.
[3] Tel.: +49 40 69 70 96 23.

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The purpose of this study was two-fold: 1. To characterize body burdens of polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), and polychlorinated dioxins (PCDDs) in exposed rescue workers and citizen. 2. A pilot evaluation of a treatment method aimed at reducing toxic burden.

2. Methods and materials

Seven men who were present at the WTC collapse and involved in the rescue and cleanup effort received treatment at the New York Rescue Workers Detoxification Project in April 2004 and agreed to participate in this study. Five were employed by the New York Fire Department (FDNY), one was a volunteer rescue worker and one worked at the nearby at the NY Stock Exchange. All were at the site the day of and several weeks after the collapse when exposure would have been the highest. The rescue workers used little or no protective respiratory gear during the WTC cleanup and all currently live or work in New York. The average age was 44 (range is 37–53).

These individuals volunteered to have their blood drawn to measure the levels of polychlorinated biphenyls (PCBs), polychlorinated dibenzofurans (PCDFs), and polychlorinated dioxins (PCDDs). Fifty milliliters of whole blood was drawn in chemically cleaned glass containers prepared by the analytic laboratory with anticoagulant with Teflon® tops containing no paper products. Blood was frozen and sent frozen on dry ice to Germany for polychlorinated dioxin and furan analysis at ERGO Laboratory, a World Health Organization certified dioxin laboratory. Analysis was performed by gas chromatography/high-resolution mass spectrometry by methods previously described (Päpke et al., 1989). Measured levels were converted to dioxin toxic equivalents (TEQ) using the 1998 WHO toxic equivalency factors (TEFs) (Van den Berg et al., 1998).

These subjects also participated in a series of testing including thorough medical examination, structured health and symptom questionnaires, and neurophysiological testing.

All tests, evaluations, and sample collections were repeated approximately one month after initial testing in order to provide a comparison. Following the second period baseline evaluation, the study subjects enrolled in the detoxification treatment regimen developed by Hubbard, which included exercise, sauna bathing and vitamin and mineral supplements developed to reduce the adverse effects of chemical exposures. (Schnare et al., 1982; Tretjak et al., 1990) On completion of treatment, all subjects had their blood drawn for post-treatment evaluation.

3. Results

The measured dioxin, dibenzofuran, and PCB congener levels and TEQ for each subject before and after detoxification is presented in Table 1. Prior to detoxification treatment, five rescue workers (HB50605, WB5005, WB8008, WB9009, WB13013) had elevated levels of 2,3,3′,4,4′-PeCB (105), 2,3′,4,4′,5-PeCB (118) and/or 2,3,3′,4,4′,5-HxCB (156). Patient H 5-0605 was a firefighter who we initially tested in May 2003. Pre treatment, total mono-ortho PCB blood levels ranged from 19 ppb to 404 ppb (WHO-TEQ 8.2–133.3) with a geometric mean of 41 ppb (WHO-TEQ of 29.3). Pre-treatment, total non-ortho PCB blood levels ranged from 43 ppt to 328 ppt (WHO-TEQ 3.9–111.9), with a geometric mean of 81.8 ppt (WHO-TEQ of 13.1).

Table 2 displays the mean and median difference for each congener following detoxification. The *p*-value is calculated using the Wilcoxon singed-rank test, which is a non-parametric test that uses ranks of the data consisting of matched pairs. By using ranks, this test takes the magnitudes of the differences into account. Due to the small sample size, we cannot assume normality of the data. A non-parametric test is the best test for our study. The means and medians listed in Table 2 are for the differences between the congener before and after detoxification. Therefore, a positive score reflects a mean/median where the average levels of dioxin, dibenzofuran and PCBs dropped, while a negative score reflects where the average levels increased.

Following detoxification, calculated WHO-TEQs for mono-ortho PCB blood levels decreased by an average 65%, as shown in Fig. 1. Measured levels ranged from 15 ppb to 302 ppb (WHO-TEQ 3.6–133.3) with a geometric mean of 32 ppb (WHO-TEQ of 8). Non-ortho WHO-TEQs averaged a 57% decrease as shown in Fig. 2. Measured levels ranged from 33 ppt to 229 ppt (WHO-TEQ 1.6–17).

Mono-ortho and non-ortho PCB levels in rescue workers were measured twice in one month prior to detoxification to determine the change in levels, or the lack thereof, with the absence of treatment. As shown in Fig. 3, during this one-month period of no treatment, PCB mean concentration levels had a 4% insignificant increase. In contrast, all rescue workers had measurable decreases in these PCBs following treatment. Brominated dioxins, brominated dibenzofurans, and polybrominated diphenyl ether congeners were at low levels or below the limit of detection (data not shown).

Subjects reported a similar pattern of health complaints and manifested symptoms including respiratory impairment, mental/emotional distress (two met PTSD criteria), decreased sensory systems, chronic muscle and joint pain, gastrointestinal disorders, and skin rashes. These symptoms were completely resolved or were satisfactorily improved on completion of treatment. The neurophysiological test results also improved. Fig. 4 shows the change in mean severity of self-reported symptoms as measured by a questionnaire.

4. Discussion

In view of the documented persistence of adverse health effects in individuals exposed during the collapse of the WTC, it is important to not only document symptoms and possible causes but to identify workable treatment