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Serum profiles of PCDDs and PCDFs, in individuals near the Escambia Wood Treating Company Superfund site in Pensacola, FL

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Abstract

The Escambia Wood Treating Company (ETC) Superfund site, Pensacola, FL, is contaminated with polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/F), benzo(*a*)pyrene, lead and arsenic from pentachlorophenol (PCP), creosote, and other compounds used to treat utility poles and foundation pilings. Although ETC's operations ceased in 1982, soils in the areas surrounding the facility continue to exhibit elevated levels of contaminants attributable to ETC operations. In July 2000, individuals who may have been affected by contamination from the ETC site, including current and former residents and former workers and their household members were invited to participate in a study, which included a health and exposure history and routine blood analysis. We also conducted a toxicological health evaluation of a subset of these eligible workers/residents by analyzing serum levels of 17 PCDD/F congeners. Members of the ETC cohort exhibited elevated serum PCDD/F relative to the general population, and congener profiles in members of the cohort reflected patterns commonly observed in persons exposed to PCP. Hypertension prevalence in the cohort was found to correlate with PCDD/F levels, although no other significant relationships were identified with monitored health indices.

Keywords: Pentachlorophenol (PCP); Polychlorinated dibenzo-*p*-dioxins (PCDD); Polychlorinated dibenzofurans (PCDF); Serum; Wood treatment

1. Introduction

The City of Pensacola, FL is located at the western end of the Florida Panhandle in Escambia County near the Alabama border. The region currently contains eight Superfund sites that are at different stages of site evaluation and remediation. One of these sites, the Escambia Treating Company (ETC), is located within a mixed industrial, commercial, and residential neighborhood. ETC operated as a wood treatment facility in Pensacola between 1942 and 1982. Initially, the facility treated utility poles and foundation pilings with creosote (ATSDR, 1995) and in 1963, pentachlorophenol (PCP) dissolved in diesel fuel was added to the wood treatment operation. Creosote use was discontinued after 1970. Wastewater and runoff contaminated with excess wood preservative were initially collected in an unlined impoundment. In 1955, impoundments made of concrete and treated wood and a runoff collection/separation system were constructed (Landers-Atkins Planners, 2000). After ETC closed, monitoring of groundwater and soil at the site revealed extensive contamination with polycyclic aromatic hydrocarbons (PAHs), PCP, and polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzofurans (PCDD/F) (ATSDR, 1995). In 1994, the U.S. EPA added the ETC site to the National Priorities List.

Between 1991 and 1992, as an interim measure to prevent further contamination of groundwater at ETC, the

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EPA excavated the contaminated soil on the ETC site and stockpiled it under a high-density polyethylene liner (CDM Federal Programs Corporation, 2005) . During the excavation, nearby residents reported strong odors, increased respiratory distress, and eye and skin irritation. In July 1995, analysis of soil from the adjacent residential areas revealed levels of dioxins, benzo(*a*)pyrene, arsenic, and lead that exceeded the State of Florida Residential Cleanup standards (CDM Federal Programs Corporation, 2005). Benzo(*a*)pyrene and PCDD/F in several soil samples exceeded the 1×10^{-4} risk level. In response, in 2004, the EPA permanently relocated 361 households from four residential areas surrounding ETC.

In 2000, the Florida Department of Health Escambia County Health Department (ECHD) initiated a census of current and past residents of neighborhoods surrounding ETC. This program provided for health screenings of individuals who were potentially exposed to the contaminants at ETC and the adjacent Agrico Chemical Company Superfund site. The health screening identified an elevated prevalence of diabetes, hypertension, and hepatitis A, B, and C, relative to national levels (Davis et al., 2005). The prevalence of overweight and obese persons in the ETC cohort also exceeded national averages, which suggested that excess weight in the cohort could be a major factor in the etiology of diabetes and hypertension. As a follow-up to the preliminary health screenings, a subset of participants from the initial investigation returned for additional testing, including analysis of serum PCDD/F. Serum PCDD/F were used as surrogates of exposure to other organic contaminants that were detected in the surrounding environment. We report herein the results of the PCDD/F screening and describe their relationship to the results of the health screening.

2. Methods

2.1. Target population

Participation in the present study was restricted to former workers, their household members, and individuals who lived in the surrounding neighborhoods. Both relocated and non-relocated residents were included. The study plan was reviewed and approved by the University of West Florida Institutional Review Board. All participants were provided detailed information on the study and completed appropriate consent forms. During the initial health screening (Davis et al., 2005), participants were given a physical exam and queried about their medical history using a fixed panel of questions. These questions investigated demographics, exposure history, and health conditions such as cancer, hypertension, diabetes, alcohol usage, and smoking history. Blood samples were collected for routine tests including complete metabolic profile (CMP), complete blood count (CBC), and hepatitis panel. Fasting serum glucose levels were measured twice.

2.2. Sample collection

Serum samples for PCDD/F analysis were obtained from 47 participants who returned for additional screening. Participants were requested to abstain from eating a fatty meal prior to sampling. A phlebotomist collected blood in eight 10 ml Monoject collection tubes (Sherwood Medical Co., St. Louis, MO) using a standardized protocol. Collection tubes were labeled and placed upright at room temperature for clotting. After 30 min, samples were centrifuged for 15 min at 1000*g*. Using a disposable glass pipette, 20–30 ml of serum was transferred from each tube into one pre-cleaned 30 ml glass vial with a Teflon coated top, frozen at −20 °C and shipped overnight on dry ice to Analytical Perspectives (Wilmington, NC) for PCDD/F analysis.

Fasting blood samples were also drawn for total lipid analysis. The sample was drawn into a 10 ml Monoject collection tube and subsequently separated into two Corvac blood collection tubes (6 ml; Sherwood-Davis & Geck, St. Louis, MO) for duplicate analysis of total lipids. The samples were allowed to clot for ~30 min, centrifuged for 15 min, and analyzed for total lipids by LabCorp (Pensacola, FL) using a colorimetric assay (Bragdon, 1951).

2.3. Analysis of PCDD/F

The serum samples were analyzed by Analytical Perspectives (Wilmington, NC) for 17 2,3,7,8-substituted PCDD/F congeners according to an enhanced version of USEPA Method 8290. Following the addition of extraction standards (1 ng for each congener and 2 ng for $^{13}C_{12}$-OCDD/F dissolved in 10 μl toluene or 1 ml acetone plus acetone rinses) to 20–25 g serum, each serum sample was converted into a free flowing powder using Hydromatrix™ (Varian) or pre-cleaned sodium sulfate and placed on a 50 g acid-coated silica gel (44% sulfuric acid) column built in the bottom of a fritted glass thimble. The extraction was carried out by Soxhlet Dean–Stark using hexane for 16 h. The water collected inside the Dean–Stark arm at the end of the extraction cycle was disposed. The solvent was concentrated and fortified with cleanup standards (1 ng of each labeled congener) before subjecting the extracts to a multi-column cleanup procedure described in EPA method 8290. The purified final extracts were then prepared in 10 μl tetradecane containing the labeled injection standards (1 ng each congener).

The final extract (1 μl) was injected in a splitless mode onto a 60 m DB-5MS capillary column coupled to a magnetic sector instrument and analyzed under high-resolution GC (Agilent 6890 Series; Palo Alto, CA) and MS conditions (Waters AutoSpec Ultima; <100 ppm mass resolution at 5% peak width). Characteristic ions were monitored in the selected ion recording mode as described in USEPA Method 8290. The GC was equipped with an autosampler (CTC Analytics AG, Zwingen, Switzerland). The carrier gas was helium at a constant flow rate (EPC). The total