Preliminary Analysis of Levels of PCBs, PCDDs and PCDFs in Blood in Residents of Swan Hills and Surrounding Communities, Alberta, Canada

Weiping Chen[1], Donald Schopflocher[1], Tee L. Guidotti[2], Derek G. Muir[3], C. Lastoria[4], P. Pond[4], Sub Ramamoorthy[4], John Waters[1], Karen Grimsrud[1], Susan Shaw[1], Stephan Gabos[1]
[1] Alberta Health, P.O. Box 1360, 10025 Jasper Ave. Edmonton, AB, Canada, T5J 2N3
[2]Department of Public Health Sciences, University of Alberta, Canada [3] National Water Research Institute, Environmental Canada, Canada [4] MAXXAM Laboratory, Canada

Introduction

Blood sampling program was initiated in early 1997 after a Special Waste Treatment Center incident in order to examine potential of contamination in human blood. This study provides information on the human blood levels of these contaminants which indicates exposure from all sources and long-term exposure in addition to current exposure. Special efforts were made to determine the impact of regular consumption of wild game and fish. In addition, pooled blood samples were obtained from blood donors living in other areas of Alberta to serve as control samples.

Materials and Methods

Sampling

The target populations consisted of individuals over the age of 18 years who resided in communities of the study area. Two sub-populations were chosen for study: one sub-population with individuals living in the Town of Swan Hills and one with those living in all communities within a 100 km radius of the facility. During March and April 1997, a telephone interview was conducted to identify potential participants and their consumption patterns. A total of 65 participants including 6 aboriginal residents and 3 workers at the facility donated blood. Fifty ml of venous blood (about 25 ml serum) was collected from each non-fasting participant. Six composite samples containing 25 ml serum per composite sample were collected in northern Alberta. These samples were formed from six age and gender specific groups: males aged 17-35, males aged 35-55, males older than 55, females aged 17-35, females aged 35-55, and females older than 55. All specimens were kept frozen at - 20 °C prior to shipping to the laboratory.

Chemical Analysis

Analytical methods and QA/QC assurance were described in Environmental Canada EPS 1/RM/23 (1992), Environmental Canada AMD 96-05 (1996) and USEPA Method 1613 (1994). Each sample (20 ml serum) was homogenized and subsampled for analysis. Prior to the

initial extraction, samples were fortified with fifteen $^{13}C_{12}$-labeled PCDD/F with the exception of OCDF and eight $^{13}C_{12}$-labeled PCBs. Samples were digested overnight in concentrated hydrochloric acid and then extracted with 50/50 dichloromethane/hexane for one hour. This extraction was repeated several times. The extracts were subjected to an acid/base silica cleanup, reconcentrated and split into two equal portions by weight. One portion, for PCDD/F analysis, was cleaned up on alumina following the standard operating procedure for PCDDs/PCDFs. The PCB portion was cleaned up on a modified alumina column. Extracts were analyzed separately for PCBs and PCDD/Fs on an Autospec Ultima High Resolution Mass Spectrometer, interfaced with a Hewlett Packard Gas Chromatograph. PCBs were separated at EI 8,000 mode and PCDD/Fs at EI 10,000 mode. Fused silica capillary columns (60 meter, 0.25 mm ID, 0.25 μm film thickness) were used for determining PCDD/Fs and PCB congeners, respectively. Injector temperature was 265 °C. The total time of the GC run was 50 min. Congeners were detected in the selected ion monitoring (SIM) mode. Method detection limits were 0.03 μg/L for PCBs whole weight and 0.5 to 0.7 ng/L whole weight for PCDD/Fs. Lipid was determined by enzymatic method. Total lipid concentration was calculated by summation of the amount of triglycerides and total cholesterol.[1]

Results and Discussion

Of the 65 blood donors, 43 reported consuming wild game or fish taken from the study area in 1996. Multiple linear regression analysis of mean measures in relation to age and sex were conducted for all the samples. Both PCB and PCDD/F measures showed statistically significant increases with age ($p < 0.05$). Both non-parametric and parametric significance tests were performed to explore the relationships between mean concentration measures, communities of residents and wild game and fish consumption. No statistically significant differences ($P > 0.05$) were observed between community and reference residents or attributable to wild game and fish consumption status on any of the summary variables. It is important to note that the reported levels of $\sum PCB_{congener}$ and $\sum$PCDD/F TEQ were calculated based on the sum of measured congener levels at current detection limits and nondetectable levels were assigned as zero in each of the subjects in a given sample. Several congeners were not detected in community and pooled reference samples. As a result, the reported mean concentrations appeared to be lower than expected (31 to 34 μg/kg serum lipid for PCBs and 11 to 16 ng TEQ/kg serum lipid for PCDD/Fs). The comparison of these results with other jurisdictions is difficult because of the different background exposures, timing of exposure, laboratory analytical methods, and quantitative methods.

The PCB and PCDD/F congener patterns were compared in two sample groups. More PCB and PCDD/F congeners were detectable among individual community residents but not in pooled reference samples. PCB 138, 153, and 180 were major contributors in both sample groups. Hexa CDD, hepa CDD, OCDD and hepta CDF were abundant congeners in both groups of samples. Distinguishing congener patterns, in terms of the individual congeners isolated and the levels of PCBs and PCDD/Fs, between the facility's workers and the communities were observed (Figure 1 and 2). CB 28 and penta CDD were dominating congeners for workers. The presence of CB 209 at levels to close to PCBs 138, 153 and 180 was observed. Mean level of CB 209 in the facility's workers was higher than in other residents. This pattern is unusual. In most studies, CB 209 was a minor constituent in various media such as breast milk, Great Lake fish and voles near the facility, accounting for 0.1% to 0.5% of $\sum$PCB.[2-5] The high proportion of CB209 in $\sum$PCBs remains unexplained. However,

sample size for the worker group was too small to draw any conclusions. The company continues to monitor the blood levels of these contaminants for the workers.

This preliminary analysis provides insight into congener profiles in participants from the general population. Meanwhile, the similar studies focusing on aboriginal population are also being conducted. Further investigations with better detection limits would be required in order to obtain more detailed background exposure information.

References

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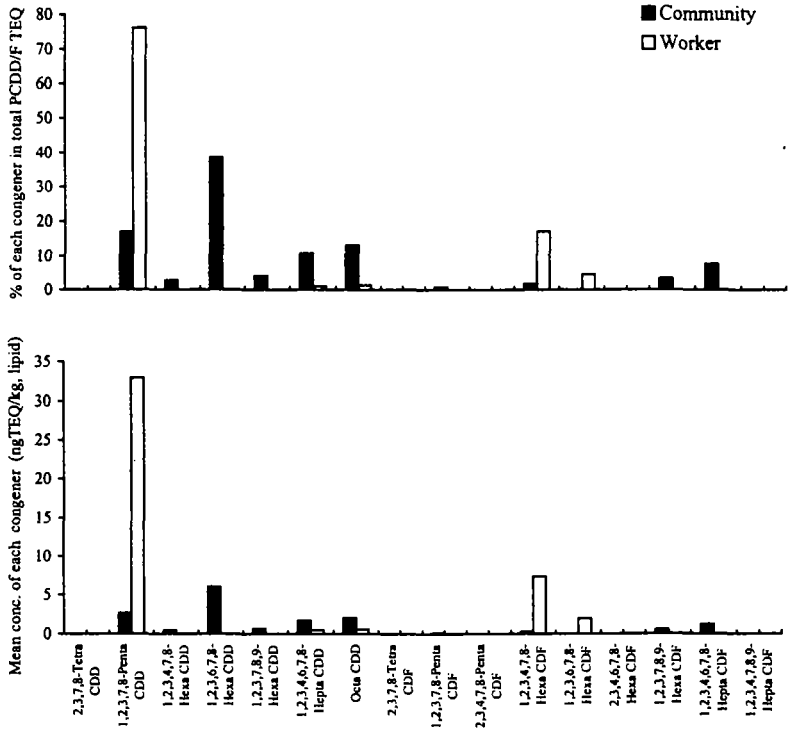

Figure 1 PCDD/F TEQ Congener Patterns in Residents of Communities and the Facility's Workers Samples

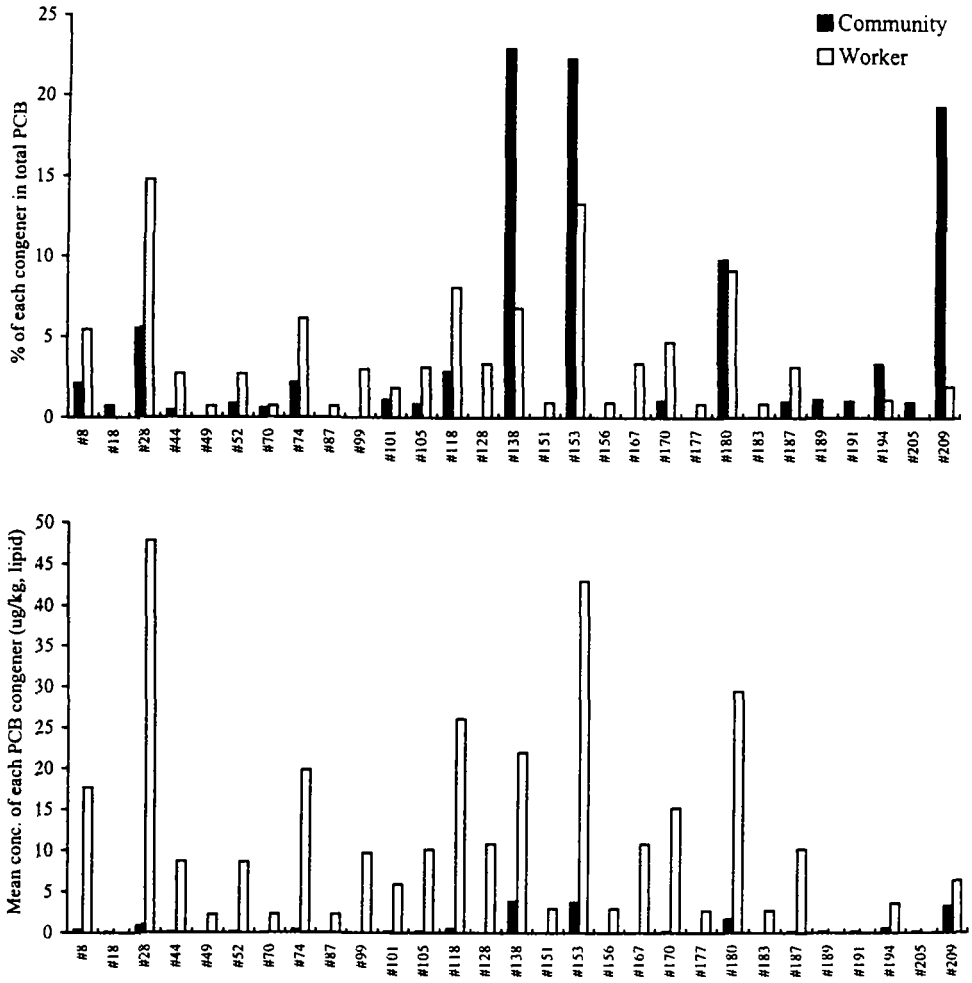

Figure 2 PCB congener Patterns in Residents of Communities and the Facility's Worker Samples (Note: the non-detected congeners in both groups are not shown)