

POLYCHLORINATED BIPHENYLS (PCBS) HEALTH EFFECTS IN TRANSFORMER MANUFACTURING WORKERS

Dahlgren JG^{1,2}, Takhar H²

1. UCLA School of Medicine, 2811 Wilshire Blvd Suite 510, Los Angeles, California, 90403 USA 2. Envirototoxicology, 2811 Wilshire Blvd Suite 510, Los Angeles, California, 90403 USA

Introduction

PCBs have been associated with neurological impairment¹ and certain types of cancers². We examined 115 workers from a transformer manufacturing plant exposed to PCBs. The plant had been operating from 1952 until the late 1970s using PCB dielectric fluid. The plant was involved in primary manufacture of transformers and removing PCB oil while reconditioning used transformers up until the late 1990s. Precise records of PCB use are not available. Our purpose was to assess the health status and PCB levels of these workers. The subjects of this study worked from 2 years to 45 years at the plant and all described some contact with PCB oil. The subjects completed questionnaires, performed a battery of neurophysiological tests and submitted blood and urine tests. The blood PCB levels using the Webb McColl technique revealed 97 subjects with values over 3 PPB (Mean = 9.5 PPB, Range < 3.0 to 66 PPB). The coplanar PCBs were measured in 12 subjects and found to be elevated above 20 PPT in 6 of the 12 subjects. There was an excess prevalence of cancer (i.e. 5.2 %) which correlated significantly with PCB blood levels ($r = 0.30$, $p < 0.05$). The data also reveals elevated levels of central nervous system dysfunction. This is the first report finding increased cancer morbidity in transformer workers and further studies are needed of this population. Most notable is the increasing occurrence of cancer with increasing blood PCB level.

Methods

We performed a health evaluation of 115 worker volunteers from a transformer plant. The transfer plant was located in the city of Crystal Springs, MS. All exposed subjects were plaintiffs in a lawsuit against the manufacturer of the PCBs. The legal case has now been settled. We compared the results of the same battery of tests on referents without chemical exposure. All subjects of the study were fully informed and signed an informed consent to participate in the study. The subjects completed questionnaires, performed a battery of neurophysiological tests and submitted blood and urine tests. The questionnaire included 36 review-of-systems questions which had 11 possible levels of severity. The lowest score was one (1), which corresponds to never having had a problem with that symptom, and the highest score was eleven (11) if the problem was always present. This scale for the review of symptoms allowed a greater range of severity than a simple yes/no or selection of slight, moderate, or severe. The basic questionnaire has been in use for many years on both exposed and unexposed populations^{3,4}.

The laboratory studies, PCBs (Webb McColl Technique), chemistry 25 panel, complete blood count, and urinalysis were performed by standard techniques in a commercial clinical laboratory (Pacific Toxicology Laboratories, Woodland Hills, CA). Pentachlorophenol and Chlorinated Dioxins and Furans performed in whole blood collected in chemically cleaned glass containers prepared by the analytic laboratory with anticoagulant and also with Teflon® tops containing no paper products. Blood was frozen and sent frozen on dry ice to Germany for PCP and polychlorinated dioxin and furan analysis at ERGO Laboratory. Analysis was performed by gas chromatography/high-resolution mass spectrometry by methods previously described⁵. The battery of neurological studies was performed following previously published protocols⁴. Simple and discriminate visual reaction time speeds were measured using a computerized visual stimulus generator for the letter A (simple) and for the letters A and S (two-choice). Static body balance was measured by head positional tracking measuring sway speed, with eyes first open and then closed with feet together and arms folded.

Results

One hundred and five of the 115 subjects are male. The blood PCB levels using the Webb McColl technique revealed 97 subjects with values over 3 PPB (Mean = 9.5 PPB, Range < 3.0 to 66 PPB). The coplanar PCBs were measured in 12 subjects and found to be elevated above 20 PPT in 6 of the 12 subjects. There was an excess prevalence of cancer morbidity (i.e. 5.2 %) which correlated significantly with PCB blood levels ($r = 0.30$, $p < 0.05$). Age and PCB interacted because PCB blood level rises significantly with time at work and age; however, the pattern of cancers was atypical (Figure one). There is a preponderance of hematopoietic and kidney cancer as well as colon cancer but no lung cancers. The mean age of the subjects is 49 years with a range from age 24 to 82. There is an even distribution of ages with the median and mean ages being almost identical. That means an equal number of younger and older workers.

There is a correlation of time in the plant and abnormal neurological testing for sway speed (Figure two).

Discussion

We evaluated 115 employees from a transformer plant who had PCB exposure in comparison to general population reference values. The wide range of ages, duration of PCB exposure and the relatively small numbers of subjects make it difficult to achieve statistical significance. It is noteworthy that there are significant findings of elevated PCB, including coplanar PCBs, in several of the workers. Finding an increase in the types of cancer that have been previously associated with dioxin exposure support the carcinogenicity of the PCBs in this setting. Lymphomas have been associated with dioxin exposures in numerous studies⁶. TCDD also been associated with increasing overall cancer risk⁶ and are considered to be cancer promoters⁷. Elevated PCBs levels were linked to kidney cancer in one study⁸.

PCBs poisoning has been reported to cause nervous system symptoms in the Yusho and Yucheng victims. The objective testing of these cohorts has been limited to peripheral nervous system testing. The complaints of headache and dizziness were most common in these two PCB poisoning incidents^{9,10}. Our findings of increased abnormal sway speed are consistent with central nervous system dysfunction. Among our subjects, the presence of debilitating headache was significantly higher in the younger age groups, while older workers complained of less frequent and severe headache (data not shown). This finding would suggest that the more sensitive workers to neurological effects have left the work force. This is another report of significant neurological impairment associated with adult PCB exposure.

This is also the first report finding increased cancer morbidity in transformer workers and further studies are needed of this population. Most notable is the increasing occurrence of cancer with increasing blood PCB level.

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References

1. Ribas-Fitó N, Sala M, Kogevinas M and Sunyer J. *J Epidemiol Community Health* 2001; 55(8): 537-46.
2. Loomis D, Browning SR, Schenck AP, Gregory E and Savitz DA. *Occup Environ Med* 1997; 54(10):720-8.
3. Dahlgren JG, Warshaw RH, Thornton J, Anderson-Mahoney P, Takhar H. *Environmental Research* 2003; 92:92-98
4. Kilburn KH, Hanscom B. *Arch. Environ. Health* 1998; 8(53), 257-263
5. Paepke O, Ball M, Lis A, Scheunert K. *Chemosphere* 1989; 29, 2355-2360
6. Hardell L, Eriksson M, Axelson O, Flesch-Janys D. *Dioxins and Health* 2003; 729 – 764, Schecter & Gasiewicz, Wiley-Interscience
7. Beebe LE, Anver MR, Riggs CW, Fornwald LW, Anderson LM. *Carcinogenesis* 1995; 16 (6) 1345-9
8. Hardell L, Lindström G, van Bavel B, Wedrén H, Melgaard B. *Med Chem* 2006; 2 (6) 607-10
9. Masuda Y. In: *Dioxins and Health*, Schecter & Gasiewicz, Wiley-Interscience, 2003, 855 - 891
10. Guo YL, Hsu C. In: *Dioxins and Health*, Schecter & Gasiewicz, Wiley-Interscience, 2003, 893 – 919

Figure 1 – Types of cancer

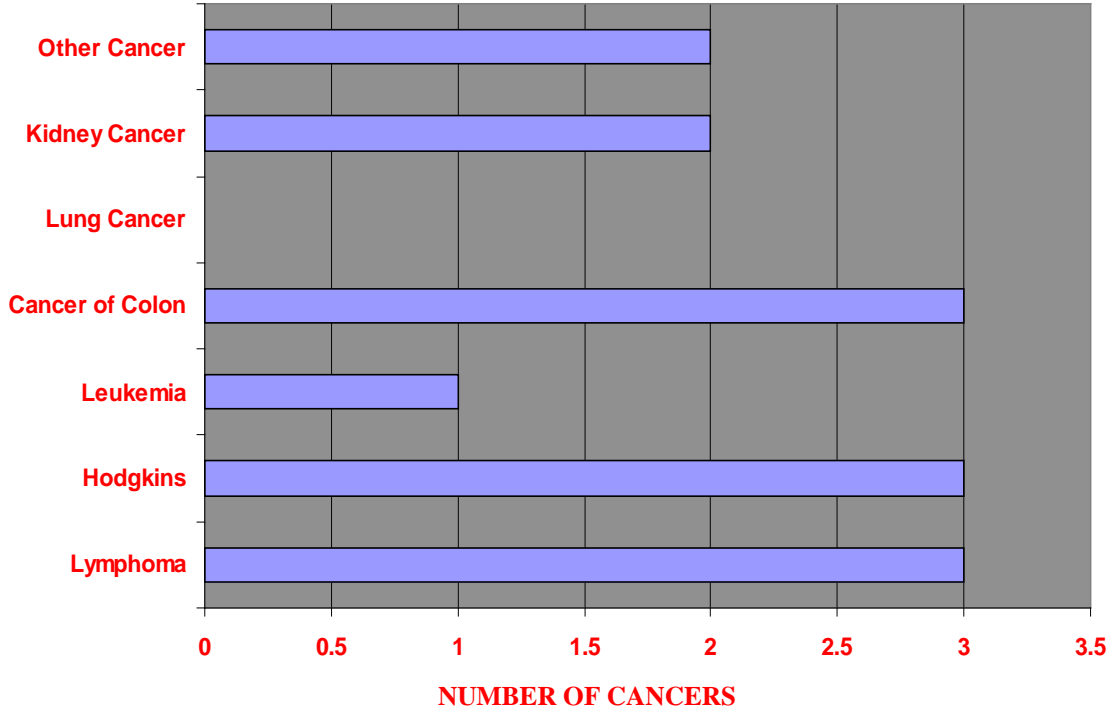


Figure 2 – Increased speed of sway with years in the plant, adjusted for age ($r = 0.38, p < 0.05$) in males only

