

LEVELS OF BENZO [A] PYRENE IN ATTIC DUST AND 1-HYDROXYPYRENE IN URINE OF RESIDENTS LIVING NEAR A WOOD TREATMENT PLANT: A PILOT STUDY

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Introduction

A Wood Treatment Plant located in the town of Somerville, Texas preserves railroad ties, poles, pilings, and other timbers with chemicals that have many well-known harmful health effects to both animals and humans. Creosote, the main compound used to preserve railroad ties, contains approximately 85% polycyclic aromatic hydrocarbons (PAHs) by weight¹. It has been shown that individuals exposed occupationally to high levels of airborne PAH demonstrate increased rates of cancer².

PAHs can be absorbed through dermal, oral, and inhalation exposure. In humans, PAHs are activated biologically to metabolites that can initiate mutation and carcinogenesis after being covalently bound to DNA³. Benzo[*a*]pyrene (B[*a*]P) is one of the most potent carcinogens among PAHs⁴. The four ring pyrene occurs in relatively high concentrations in PAH mixtures and is almost exclusively metabolized to 1-hydroxypyrene (1-OHP), which accounts for about 90% of the total urinary excretion of pyrene⁵. Urinary 1-OHP is the major biomarker used for assessment of human exposure to PAH in the work and community environment^{3,5,6,7}. This pilot study examines the levels of 1-OHP in the urine of residents living in close proximity of the railroad tie treating facility compared to control subjects who are not exposed to chemicals from the wood treatment process in order to determine potential PAH exposure.

This pilot study also examined attic dust from 14 residential locations, as it is not practical to use personal air monitoring in a residential study such as this. Attic dust samples have been demonstrated to be a good way to evaluate potential exposure since dust that settles within attics is often preserved from weathering and can provide a "time capsule" of contaminants associated with the dust⁸. However, attic dust is a surrogate for historic inhalation of contaminants, because one should assume that it is more difficult for contaminants to get into the attics as compared to an individual breathing outside or inside their home. These numbers are thus an underestimate of historic exposure.

Materials and Methods

We selected 15 random volunteers from the town of Somerville who lived close to the plant. Each volunteer provided us with a urine sample in a sterile container. The sample was shipped to Quebec Laboratory and analyzed for 1-hydroxypyrene. We also collected 15 controls from volunteers in Houston; however, three of the samples were too dilute and were not included in the data, giving a total of 12 control values.

Indoor attic dust sampling was performed in November of 2006 at fourteen random homes located within a two-mile radius of the Wood Treatment Plant. Samples were collected using a method adapted from the method described as High Volume Simplified Small Surface Sampler (HVS4) in general accordance with American Society for Testing and Materials (ASTM) method D5438, "Standard Practice for Collection of Floor Dust for Chemical Analysis." Attic dust samples were shipped to Severn Trent Laboratories (STL), Inc. in Sacramento, California for chemical analysis. PAHs were evaluated using USEPA Method 8270C using GC/MS SIM. Samples were analyzed for levels of B(a)P Equivalents.

Results

The carcinogenic potency of a PAH can be expressed as its BaP-equivalent concentration (BaP_{eq}), which is calculated from the toxic equivalent factor (TEF) of the PAH relative to the carcinogenic potency of BaP. TEFs can be estimated in several ways, which have been reviewed by Nisbet and LaGoy⁹.

Indoor sampling found the level of B(a)P Equivalents in 17 samples. The minimum was 0.98 mg/kg and the maximum was 707.48 mg/kg with a mean of 112.19mg/kg and a median of 15.91mg/kg (Table 1).

Furthermore, the mean 1-OHP level in urine for the exposed (n=14) is 3.099 µg/g and for controls (n=12) is 0.297 µg/g (Figure 1).

Discussion

In this study we measured the levels of 1-OHP in urine as a biomarker of potential PAH exposure from a nearby Wood Treatment Plant that utilizes creosote, a known source of PAHs. While many studies have been done on occupational levels of 1-OHP and PAH exposure, few have been done on PAH exposure in residents near an industry utilizing PAH. One study that has been done on residential exposure found that urinary 1-OHP is a sensitive and specific indicator for recent neighborhood exposures to ambient PAH from nearby steel mill plants¹⁰.

In a study of coke oven workers, aluminum smelter pot-room workers, road pavers, and occupationally non-exposed persons in Sweden, it is suggested that urinary 1-hydroxypyrene can be used as reliable biological exposure index for PAH exposure¹¹. Van Schooten et al found a good correlation between PAH exposure and the concentration of urinary 1-OHP in aluminum workers¹². The results of the Omland et al study suggest that 1-OHP is a sensitive biomarker for low-dose PAH exposure¹³. The results of a study done by Merlo et al demonstrate that pyrene and B(a)P are appropriate indicators for mixtures of PAH¹⁴.

The presence of B(a)P levels in a random sampling of homes in the town suggests that many of the residents are exposed to high levels of PAH due to ongoing chemical releases from the Wood Treatment Plant. The occurrence of 1-OHP, a known metabolite of PAH, further confirms potential exposure. Our results thus far suggest that precautions should be taken by industrial plants in residential areas to minimize releases and prevent high levels of exposure and thus increases risk of cancer and disease among members of the town.

References

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Table 1: B(a)P Sample Results from 14 Homes

Descriptive Statistics	BaP Eq. (mg/kg)
Number of Samples	17
Minimum	0.98
Maximum	707.64
Mean	112.19
Median	15.91

Figure 1: Urinary Levels of 1-OHP in Controls vs. Exposed

