Arsenic Levels at CCA Pressure Treated Wooden Playgrounds in Western New York

Nancy R. Smith, M.S.
Western New York Program Coordinator, New York Coalition for Alternatives to Pesticides

Joseph A. Gardella, Ph.D.
Professor of Chemistry and Associate Dean for External Affairs, University at Buffalo

Sylvia Quick, M.A.
Intern, New York Coalition for Alternatives to Pesticides, Student, Department of Social and Preventive Medicine, University at Buffalo.

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Introduction

Many wooden play structures common to school and municipal playgrounds have been treated with chromated copper arsenate (CCA), a pesticide designed to protect wood from pests and decay. CCA contains arsenic, chromium and copper and is commonly used to pressure treat wood for outdoor decks, fences and picnic tables. Arsenic has a tendency to leach from wooden structures into the environment [1,2] and there are concerns about its impact on human health and the environment.

In the fall of 2002, the New York Coalition for Alternatives to Pesticides (NYCAP) and the Erie County Environmental Management Council surveyed all of the school districts and municipalities in Erie County to locate playgrounds containing CCA wooden play structures. With a 100% response rate from the survey, 26 playgrounds were located containing CCA wood. The issue of arsenic leaching from CCA wood has been studied in various areas and under diverse conditions [1-4]. This study measures arsenic levels on and near children's play structures at three of the playgrounds in Erie County.

Background Information

Humans may be exposed either by direct contact with CCA treated wood, by contact with the soil below or by breathing in wood dust. Although not readily absorbed through unbroken skin, the chemicals in CCA may be ingested if contaminated hands or objects are put into the mouth, placing children at increased risk for exposure.

The chemicals in CCA produce a number of health effects in humans. The World Health Organization, the Department of Health and Human Services and the Environmental Protection Agency have determined that arsenic is a human carcinogen [5-7]. Studies have shown that arsenic can increase the risk of lung cancer, skin cancer, bladder cancer, liver cancer and prostate cancer. The Agency for Toxic Substances and Disease Registry states that short term exposures to elevated levels of arsenic can result in stomach ache, nausea, vomiting and diarrhea (in the case of oral exposure), sore throat and lung irritation (in the case of inhalation), fatigue, abnormal heart rhythm and impaired nerve function causing numbness and tingling in hands and feet. Long term exposure to even low levels of arsenic can lead to skin problems and to circulatory and nervous system damage[4]. Because their bodies are growing and developing, children may be particularly susceptible to the effects of these compounds[8,9].

Arsenic levels in humans can be evaluated by testing samples of urine, blood, hair or nail clippings[10]. Urine and/or blood samples are appropriate for short term exposure (within 3 days) and hair and/or nail clippings are appropriate for evaluating chronic exposure [11]. A recent review of studies on the bioavailability of arsenic recommended against setting a single value for arsenic risk assessment because so many factors impact an individual's response to arsenic [12]. An individual's ability to metabolize and eliminate arsenic and therefore the individual's risk of toxicity and carcinogenesis from arsenic exposure may be influenced by factors such as genetic susceptibility, exposure to other environmental toxins and nutritional deficiencies[13].

Arsenic is fairly soluble and can leach out of wood that has been treated with CCA. Leaching rate is highly variable and depends on several factors including the integrity of the wood and the environmental conditions to which the wood is exposed[14]. Although research is incomplete, sealing or painting CCA-treated structures with penetrating semitransparent oil-based stains every 6 months to a year may decrease further leaching [15].

The New York State Department of Environmental Conservation has established a Technical and Administrative Guidance Memorandum (TAGM) that is designed as guidance for the determination of cleanup levels at Hazardous Waste Sites. The New York State Department of Environmental Conservation recommended soil cleanup level for arsenic is 7.5 parts per million (ppm) or the site background level[16].

In recognition of the hazard posed by CCA-treated wood, the wood treatment industry recently entered into an

agreement with the EPA to phase-out the production of CCA-treated wood for residential uses. This phase-out does not take effect until January 1, 2004 and it does not require the testing, removal or sealing of existing play structures that may continue to present a significant risk to children. On September 17, 2002, New York State amended New York State Environmental Conservation Law 37-0109 to include a section which prohibits the use of wood pressure-treated with CCA for new public playground equipment and requires proper maintenance of existing playground equipment and the underlying ground cover to decrease exposure to CCA[17]. Additional provisions were added to 37-0109 on August 5, 2003 which include similar requirements for publicly owned picnic tables.

Methodology

Three Erie County sites were chosen for testing: one in a rural setting, one in a suburban setting and one in an urban setting. The sites were: Marilla Elementary School in the Iroquois Central School District, Maple East Elementary School in the Williamsville Central School District and the Massachusetts Avenue Project in Buffalo. The testing protocol included 9 samples at each site including soil, ground cover material, surface wipe and quality control samples. Sample collection and assessment were conducted by Ecology & Environment, Inc.

Core samples of soil and ground cover (wood or pea gravel mulch) materials were taken under and nearby (2 inches away from) the play structures. Of the three sites, two had wood chip ground cover and one had a pea gravel ground cover. Two samples of ground cover material were tested from each site; one from under a vertical structure and one from under a horizontal structure. A control sample was taken 20 feet away from each of the playgrounds to evaluate background soil arsenic levels. The wipe test simulated a child's hand on the wood itself using a 100 cm2 template to control the areas sampled by the test. Two wipe samples were taken at each site.

Soil samples: The sample was mixed thoroughly with a wooden tongue depressor to achieve homogeneity. 0.5g to 1.0 g of wet sample was weighed to the nearest 0.01-g and transferred to a labeled Digitube. Approximately 10 mL of ASTM Type II water was added. 5 mL of 1:1 nitric acid was added and the tube covered with a ribbed Digibloc watch glass. The tube was placed in Digibloc and the sample heated to 95 +/- 5 Degrees C. The sample was refluxed for 10-15 minutes without boiling. The sample was allowed to cool. Then 2.5 mL of concentrated nitric acid was added. The watch glass was replaced, sample placed in a Digibloc at 95 +/- 5 Degrees C and allowed to reflux for 30 minutes to ensure complete oxidation. With the ribbed watch glass on, the solution was allowed to evaporate to approximately 5 mL without boiling. The sample was cooled and the inside walls of Digitube rinsed with approximately 2 mL of ASTM Type II water. 1 mL of 30% hydrogen peroxide was added. The sample was covered with a ribbed watch glass and placed in Digitube to start the peroxide reaction. 30% hydrogen peroxide in 1-mL aliquots with gentle warming was added until effervescence was minimal or unchanged. The sample was covered with a ribbed watch glass. Heating of the acid-peroxide digestate continued until the volume was reduced to approximately 5 mL or heated at 95 +/- 5 Degrees C without boiling for 2 hours. 5.0 mL of concentrated hydrochloric acid was added. The solution was covered with a ribbed watch glass and refluxed an additional 15 minutes at 95 +/- 5 Degrees C, then cooled. The sample was diluted with ASTM Type II water to a final volume of 50 mL. As measures of quality control, a blank and laboratory control sample were prepared with the soil samples. Spike solutions were also added to samples designated as matrix spike/spike duplicates.

Wipe preparation
The entire wipe was transferred to a Digitube and the same procedure used for soil preparation was followed.

Method 6010B Analytical Procedure
The digested sample was aspirated to the spray chamber where it passed through a nebulizer and was converted into an aerosol and carried to the plasma by argon flow. Once in the plasma, the atoms and ions in the sample were excited to emit light at characteristic wavelength by a radio frequency and the inductively coupled plasma. For arsenic the wavelength is 188.98 nm.

The spectra were dispersed by a grating spectrometer and the intensities of the line spectra monitored at the wavelength by a photosensitive solid-state detector. Emitted light energy was converted to electrical signals, digitized and collected by the computer. The instrument was calibrated with a solution containing a known amount

of the target element. The sample data was compared to the calibration data by the instrument software resulting in a quantitative result. Yttrium was used as an internal standard to monitor drift of the instrument and to indicate potential problems with sample introduction.

Sample Analysis
Samples were digested and analyzed within hold time. Arsenic results were adjusted for soil moisture content.

Calibrations
All initial and continuing calibrations were acceptable.

Quality Control
All calibration and preparation blank analyses were acceptable.

Results and Findings

In the soil samples, all twelve of the test locations had higher levels of arsenic than the respective control samples. (Table 1) The New York State Department of Environmental Conservation recommended soil cleanup level for arsenic is 7.5 parts per million (ppm) or site background level. All of the soil test sites had arsenic levels greater than this recommended soil cleanup level (see Appendix 1 for complete results).

Table 1
Arsenic Levels in Soil Tests (reported in ppm)

Sampling Site	Control Sample	Test Site Highest Levels	Test Site Average Levels
Buffalo	8	283	125
Elma	10	60	46
Williamsville	4	42	20

The wipe sample results ranged from 8 to 44 micrograms per 100 cm2 (Table 2). Each of the test sites showed that arsenic could be dislodged from the wood in the wipe test, which suggests that arsenic could be dislodged from the wood onto children's hands. While the wipe test provided a single swipe of one surface, children would likely be wiping their hands across multiple surfaces, multiple times. As children frequently put their hands in the mouths, there is the potential for children to ingest significant amounts of arsenic via this route.

Table 2
Arsenic Levels from Wipe Tests (reported in micrograms per 100 cm2)

Site	Wipe 1	Wipe 2
Buffalo	44	6
Elma	23	17
Williamsville	8	36

Buffalo and Williamsville used wood chip mulch; Elma used pea gravel. Arsenic was detected in 5 of the 6 samples (See Table 3). One of the pea gravel samples from the Elma playground was unique in that it was the only sample that did not detect arsenic.

Table 3
Arsenic Levels in Ground Cover Materials (reported in parts per million)

Site	Ground Cover Material under Vertical Structure	Ground Cover Material under Horizontal Structure
Buffalo	10	25

Elma	13	none detected
Williamsville	34	13

The playground at the Massachusetts Avenue Project in Buffalo was built in 1994 and has been sealed two and one half times. The Elma playground was built in 1989. It was sealed each year except in 2002. The Williamsville playground was built in 1992. It was sealed in 2001 and half of the playground was sealed again in 2002.

Conclusions

All soil test sites at the 3 Erie County playgrounds had arsenic levels higher than the New York State Department of Environmental Conservation recommended soil cleanup level of 7.5 parts per million. The highest soil arsenic levels, found at the Massachusetts Avenue Project, were 40 times higher than the recommended clean up level. At each playground, the arsenic levels at the soil test sites within the play set area were higher than levels at the control sites, which were 20 feet away from the play set area. These results are not unique. Similar findings have been reported at playgrounds in Rochester, Ithaca and Albany New York[3,4,18]. In Rochester, several playgrounds have been removed and the soil and buffering materials at others has been replaced. The City of Albany removed all of its wooden play structures after testing was conducted. Dozens of playgrounds have been removed from public playgrounds in Florida.

Arsenic levels were elevated not only in the soil samples, but also in wipe samples taken directly from the surface of the wood. This suggests that there is a risk of exposure from handling CCA-treated surfaces. This risk likely exists not only for playground equipment, but also for other common and frequently handled outdoor CCA-treated structures such as home decking, picnic tables and sand boxes.

One of the pea gravel ground cover samples tested negative for arsenic while all of the wood chip ground cover materials tested positive. It is possible that the wood chip ground cover was made partly of CCA-treated wood. It is also possible that arsenic leaching from the CCA wooden play structure adhered more tightly to the wooden ground cover than the pea gravel. This area may warrant additional research.

Test Site Recommendations:

1. Since all three test sites had soil arsenic levels significantly higher than NYS DEC cleanup guidelines, NYCAP recommends closing the playgrounds immediately and removing the CCA-treated play structures, the contaminated ground cover and the contaminated soil.

2. If there are delays in acquiring funding for play structure removal, NYCAP recommends sealing the play structure every 6 months in conjunction with removal of the contaminated ground cover and soil, monthly testing of arsenic levels on the surface, ground cover and soil and posting signs encouraging playground visitors to wash hands after playing on the playground.

General Recommendations:

1. Do not build with CCA-treated wood where children live and play.

2. Evaluate existing CCA-treated structures that are routinely used by children for arsenic levels. NYCAP can provide a list of laboratories that conduct arsenic testing.

3. If test results reveal arsenic levels in excess of NYS DEC cleanup recommendations, the CCA-treated structure and the surrounding ground cover and soil should be removed.

4. If replacement is not immediately possible, then the ground cover and soil should be replaced. Sealing or painting the CCA-treated structure every 6 months may decrease further leaching.

5. Have children wash hands after playing on CCA-treated playground equipment or handling other CCA-treated wood, especially before eating.

6. Do not pressure-wash or sand CCA-treated wood.

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For more information about NYCAP, contact our office or visit our web site

New York Coalition for Alternatives to Pesticides (NYCAP)
P.O. Box 533
East Aurora, NY 14052
Phone: (716) 652-6230 E mail: wny@altpest.org
Web site: www.altpest.org

Additional Resources:

www.cpsc.gov/phth/cca.html

www.epa.gov/pesticides/factsheets/chemicals/cca_qa.htm

www.atsdr.cdc.gov/toxprofiles/tp2.html

www.beyondpesticide.org

www.ewg.org/issues/home.php?i=7

http://assembly.state.ny.us/leg/?cl=37&a=153

http://www.dec.state.ny.us/website/dshm/sldwaste/cca.htm

http://www.cleanwateraction.org/pdf/fact_cca.pdf

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Appendix 1

Arsenic Levels in Soil Tests (reported in parts per million)

Test Site	Sample location *	Arsenic Level
Marilla	Control	10
	Horizontal 1	60
	Horizontal 2	33
	Vertical 1	34
	Vertical 2	57
Buffalo	Control	8
	Horizontal 1	48
	Horizontal 2	283
	Vertical 1	97
	Vertical 2	74
Williamsville	Control	4
	Horizontal 1	8
	Horizontal 2	11
	Vertical 1	20
	Vertical 2	42

* Control samples were taken 20 feet outside of the playground area. The two horizontal samples were taken underneath the midpoint of large horizontal structures. The two vertical samples were taken two inches away from large vertical structures.