Arsenic Backgrounder

Arsenic is a naturally occurring element, widely distributed throughout the Earth's crust. In its pure form its a steel grey, metal-like material. But its not found in nature in its pure form. Its either combined with hydrogen and carbon, in which case its called organic arsenic, or its combined with elements such as oxygen, chlorine or sulphur, in which case its called inorganic arsenic.

Organic arsenic is, with a few exceptions, not harmful to humans, which is a good thing because organic arsenic is found in high levels in certain foods, particularly fish and shellfish. [1]

And there's absolutely no doubt that inorganic arsenic can kill. Inorganic arsenic has been historically used in insecticides, herbicides and rat poison. One website suggested Napoleon died of arsenic poisoning from decaying wallpaper which had been died with an arsenic based pigment.[2] In the 19th century, arsenic was very popular with those who couldn't wait any longer to receive their inheritance. Contemporary uses of arsenic include gallium arsenide semiconductors for use as light-emitting diodes (LEDs) and solar cells, metals manufacturing and wood preservatives.

But inorganic arsenic has been, and continues to be used for beneficial purposes. Fowler's solution, which contains 1% arsenite, was widely used as a tonic in the late 19th century for just about everything that ailed you, despite the fact that overdosing was common. It was removed by the manufacturer from the US marketplace in 1980 after the FDA declared it to be toxic and highly carcinogenic.[3] Arsphenamine, discovered in 1909, was the main treatment for syphilis until it was replaced by penicillin in the 1940s. Arsenic trioxide, marketed as Trisenox, has its origins in traditional Chinese medicine. Recently it has resurfaced as a successful and less harmful (as compared to chemotherapy) leukemia treatment and shows promise in the treatments of other types of cancer, currently undergoing clinical trials for lymphoma, prostate and cervical cancers.[3]

Dr. Eric Uthus, from the Grand Forks Human Nutrition Research Centre, who's made a career from demonstrating that trace elements are necessary for your diet, has research data suggesting that we need exposure to a certain level of arsenic to stay healthy![4] This idea of poisonous substances being harmless or even beneficial in small amounts is not as strange as it seems. A good primer on this subject is a book by Alice M. Ottoboni called "The dose makes the poison: a plain language guide to toxicology" which is available through the Toronto Public Library.

So if a little bit of arsenic is okay, or maybe even necessary, but too much will make you ill, how much is too much? That is a question that is still being debated in the scientific circles. Some thresholds that have been put forward are:

- CEPA lists arsenic as a "non-threshold toxicant" meaning it has been classified as a substance for which there is believed to be some chance of an adverse effect at any level of exposure;[5]
- the Agency for Toxic Substances and Disease Registry put forward an acute (14 days exposure) oral Minimum Risk Level of 0.005 mg As/kg body weight/day and a chronic (365 days exposure) oral Minimum Risk Level of 0.0003 mg As/kg body weight/day;[6]
- the US EPA put forward an oral Lowest Observed Adverse Effect Level of 0.05 mg As/kg body weight/day with a 10x Margin of Error factor.[7]

Arsenic doesn't stick around in your body. Take yourself away from your arsenic exposure source and your body will gradually flush out whatever arsenic it has absorbed.[8] A urine test is the most common method of determining the arsenic levels that a person has been exposed to.

If arsenic is widespread, how much arsenic are we regularly exposed to? Arsenic enters our bodies through inhalation, drinking water and eating food. It is not readily absorbed through skin contact. The Agency for Toxic Substances and Disease Registry provides us with the following facts:

- naturally occurring arsenic levels in water is 1 part per billion (ppb);
- a survey of US drinking water supplies indicated that most drinking water sources (80%) had less than 2 ppb arsenic;
- levels of arsenic in food range from 20 to 140 ppb;
- urban areas generally have arsenic levels in the air ranging from 20 to 30 nanograms/cubic meter; and
- arsenic exposure from all sources (inhalation, eating & drinking) is estimated at 0.05 mg/day of which .0035 mg/day is in the inorganic form.

So if children are already getting a dose of arsenic on a daily basis, how much extra might the playground be contributing and is this extra amount a concern? That's a tough one. First there's no agreed upon threshold level. Second, environmental arsenic levels are reported as amount of arsenic/amount of soil while the human toxicological data is reported as amount of arsenic/kg body weight/exposure time, and linking arsenic levels in soil to actual arsenic exposure involves a host of variables, like how much soil is ingested or the bioavailability of arsenic in soil etc. If we use the assumptions made by the US EPA[7], a 2 year old would have to ingest 50 g of soil per day to reach the threshold level if the arsenic level in the soil was 6 ppm (the City's result) and 6.9 g of soil if the arsenic level in the soil was 43 ppm (Environment Defense Fund's result). On the other hand, if you use the Agency for Toxic Substances' chronic MRL of 0.0003 mg As/kg body weight/day as the threshold limit, then a 2 year old would have to ingest 3.75 g of soil at 6 ppm arsenic or 0.5 g at 43 ppm. How much soil does a child eat? Well someone has studied that too, and reported an estimate of 0.4 g of soil ingested per day.

At first glance it would appear that the play structure is safe for children. BUT, bear in mind that many estimates and assumptions went into the above calculations. In 2001 the US EPA proposed a study to investigate children's arsenic exposure from pressure treated wood play structures. That study should provide a more accurate picture of what's going on. Until then, based on the existing data, I would draw the following conclusions:

- should children be kept away from the park playstructure – I don't believe so. The benefits of physical activity outweighs the risk of arsenic exposure;
- should the play structure be torn down and replaced – the above data doesn't suggest an immediate threat so I would say no. But the next time the structure needs replacing, it should be replaced with another material;
- should the play structure be painted and the sand replaced – yes, if you can further lower the children's exposure for the cost of some sweat equity and paint then it makes sense to do so. I believe the sand is replaced on a regular basis already;
- should we continue to monitor the situation. Absolutely. As more studies are completed and data becomes available, the issue should be re-visited and new decisions made based on the best available data.

The above is my opinion based on the research I have done. I urge each parent to spend a bit of time doing their own research so that you can arrive at a conclusion that you're comfortable with. Some good places to start are:

Agency for Toxic Substances and Disease Registry, Public Health Statement for Arsenic
http://www.atsdr.cdc.gov/toxprofiles/phs2.html

Survey of Total and Inorganic Arsenic in Food: Results of 199 Total Diet Study – provides tables listing measured arsenic levels in different types of food
http://www.foodstandards.gov.uk/multimedia/pdfs/2002-46ar.PDF

Effects of Arsenic on Human Health – The Arsenic Website Project – provides photographs of people suffering from illnesses due to arsenic exposure
http://phys4.harvard.edu/%7Ewilson/arsenic_project_health_effects.html

Sample Calculation of Arsenic Exposure

Assumptions used:
LOAEL = 0.05 mg As/kg bw/day
Margin of error = 10x
2 year old child body weight = 15 kg
bioavailability = 25%

How much soil would a 2 year old have to eat to reach the threshold?

[0.05 mg As/kg bw/day x 10 (error factor) x 15 kg body weight x 4 (bioavailablity factor)] / 6 mg As/kg soil = 0.05 kg soil = 50 g of soil

References

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2. Arsenic, King of Poisons, Gets and Image Makeover, by Jeremy Smith, Science-Reuters website, viewed at http://phys4.harvard.edu/%7Ewilson/Image_Makeover1.htm on May 28, 2003.
3. List of Drug Products That Have Been Withdrawn or Removed From the Market for Reasons of Safety or Effectiveness, Department of Health and Human Services, U.S. Food and Drug Administration, 21 CFR Part 216, Docket No. 98N-0655 viewed at http://www.fda.gov/ohrms/dockets/98fr/100898b.txt on May 28, 2003.
4. Arsenic Bad, Good or Both?, Eric Uthus, Grand Forks Human Nutrition Research Center, viewed at http://www.gfhnrc.ars.usda.gov/News/nws9710a.htm May 28, 2003.
5. Canadian Environmental Protection Act (CEPA) Priority Substances List Assessment Report; Arsenic and its Compounds, Government of Canada, Environment Canada, Health Canada, 1993,

ISBN 0-662-20488, viewed at http://www.hc-sc.gc.ca/hecs-sesc/exsd/cepa/arsenic_and_compounds_intro.pdf May 28, 2003.

6. Toxicological Profile for Arsenic, Agency for Toxic Substances and Disease Registry, CAS #7440-38-2, September 2000, pp 164-165, viewed at http://www.atsdr.cdc.gov/toxprofiles/tp2-c5.pdf on May 28, 2003.
7. A Set of Scientific Issues Being Considered by the Environmental Protection Agency Regarding: Preliminary Evaluation of the Non-dietary Hazard and Exposure to children from Contact with Chromate Copper Arsenate (CCA)-treated Wood Playground Structures and CCA-contaminated Soil, FIFRA Scientific Advisory Panel Meeting, October 2001, viewed at http://www.epa.gov/oscpmont/sap/2001/october/ccawood.pdf on May 28, 2003.
8. Public Health Statement, Agency for Toxic Substances and Disease Registry, viewed at http://www.atsdr.cdc.gov/toxprofiles/tp2-c1.pdf on May 28, 2003.