PAH's: the New Asbestos

PAH's (polycyclic aromatic hydrocarbons) are likely to be some of the most potent carcinogens (chemicals that cause cancer) known to science. They are found in smoke from burning wood and fossil fuels; in water when coal is fracked, and in run off from bushfire areas and open cut coal mining. They are the major carcinogens in cigarette smoke.

With a potencies up to 1,000 times greater than asbestos for causing cancer when inhaled, PAHs pose a huge threat to public health. This is being overlooked largely because few of these chemicals have been studied, or have "health risks" estimated. Commercial water and air testing (VOC assays) often do not include these chemicals.

PAH levels are increasing worldwide in air and watercourses, and are considered by many scientists to be the major enviromental carcinogen causing tracheal, lung, oesophageal, liver and bladder cancer.

PAH's are very stable and will remain in the environment for a long time increasing cancer in our children and grandchildren.

PAH's from coal and gas mining are linked to increasing cancer in USA and Australia.

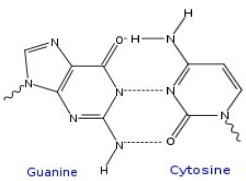
The most potent carcinogens from solubilised coal are PAH's, and scientists have warned of the elevated risk of cancer from PAH's in UNCG (Unconventional Gas) Mining areas in USA. It takes 10 to 15 yrs from exposure to PAH's to the onset of cancer in adults, and 4-5 years in children. A recent study (*Finkel M L, Shale gas development and cancer incidence in southwest Pennsylvania. Public Health 2016 Dec;141:198-206.)* has shown increases bladder cancer in UNCG mining areas in the USA**.** Other studies have been clouded by industry funded publications.

In a recent Australian study, 5 to 9 year olds in a CSG mining area and in a coal mining area in Queensland had 2 times the hospitalization rate for neoplasms (cancer) compared to those in a control area (no mining). [*Angela K Werner et al, All-age hospitalization rates in coal seam gas areas in Queensland, Australia, 19985-2011. BMC Public Health volume16, Article number:125 (2016)]* [(1)]**. These results indicate that carcinogens from coal (PAHs) are likely to be the cause, rather than fracking chemicals (see below). This needs further study, and follow up data is available.**

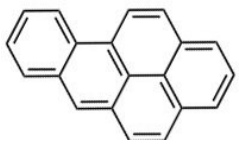
How PAHs cause Cancer.

PAH's (polycyclic aromatic hydrocarbons) are found in coal, all fossil fuels, (the main compounds in coal tar) and in bushfire and cigarette smoke. PAH's are flat multi-ring structures that mimic DNA base pairs.

G-C DNA Base Pair



Benzo-α-pyrene



PAH's slip in between the base pairs in DNA (intercalation) and react with the DNA causing mutations. Cancer is caused by a series of DNA mutations that change an ordinary cell in our body to a cancer cell which then replicates out of control to form tumours.

PAH's are likely to be some of the most potent carcinogens known. Only a handful have been studied. These have been shown to cause cancer in laboratory animals, but not in humans. ***For most PAH's there are no "safe levels" defined, so they are largely overlooked in public health considerations.***

Some scientists consider that because activated PAHs covalently react with DNA to form stable adducts, the process is not concentration dependant, so there are no safe levels for these chemicals in water or air. A single molecule is capable of causing a mutation, and cancer.

PAHs compared to Asbestos

Based on values of Relative Inhalation Carcinogenic Potency from *World Health Organization Air Guidence for Europe,* comparable values are given below:

	Air Inhalation relative risk
Benzene	**1**
Asbestos	**29**
Benzo(a)pyrene (PAH)	**14,500**

Fracking chemicals compared to solubilized coal chemicals.

Total PAH levels of 190 ng/l and Benzyo(a)pyrene (5.4ng/l) were found in produced water samples from coalbed natural gas (CBNG) wells in the Powder River Basin, WY, sampled in 2001 and 2002 - *W. H. Orem, C. A. Tatu, H. E. Lerch, C. A. Rice, T. T. Bartos, A. L. Bates, S. Tewalt, M. D. Corum, Organic compounds in produced waters from coalbed natural gas wells in the Powder River Basin, Wyoming, USA. Appl. Geochem. 2007, 22, 2240-2256.*

Using these figures, the concentration of benzene is 30 times higher than the PAH, Benzyo(a)pyrene:
Benzene 0.16µg/l
Benzo(a)pyrene .0054µg/l

Taking into account the relative potencies in causing cancer, Inhalation carcinogenic potency (WHO air guidence for Europe):

PAH – benzo(a)pyrene	8.7×10^{-2}	unit risk/(µg/cu. m.)
Benzene	6×10^{-6}	" "

(PAH:Benzene 14,500:1) and the concentrations in the produce water (1:30), ***the cancer risk from PAH in this produce water would be 500 times higher than that from benzene. So the cancer risks for chemicals released by solubulizing coal are likely to be far greater than the risks from fracking chemicals.***

VOC air and water testing.

Coal and fossil fuels contain hundreds of Volatile Organic Compounds (VOC's) that can be assayed in a single gas cromatogram. Curent commercial air and water tests only list the results for top 5 or 10 compounds. PAH's that usually occur in the top 30 to 200 compounds are not listed in these assay results.

Where specific PAH assays are carried out, the assays are not sensitive enough to measure levels that can cause cancer. The Australian safe drinking water level for Benzyo(a)pyrene is 10 ng/l. US EPA safe level for community water supplies is 0.2 ng/l. Many scientists believe the safe levels should be much lower than this and the Australian safe level needs to be reduced. Typical water testing limits of quantification (*LOQ*) values for PAHs range from 18µg/l to 10 ng/l. So even if PAH's are there at levels causing a health risk, they can be below current test detection levels, or are not listed in test results.

Specific high-sensitivity PAH assays are needed to check PAH levels in drinking water and air.

PAH's in bushfire smoke

When inhaled, PAH's can have a higher carcinogenic potency than asbestos. (Inhalation potency of PAH's range from the same as asbestos to 1,000 more potent). The potential health risk from PAH's could be much greater than asbestos. PAH levels in the recent bushfire smoke over large areas of Australia, and in high popluation areas like Sydney, need to be estimated.

In bushfire areas, PAH's in smoke tend to bind to particulate matter, end up in the soil, and can be solubilized in run off when it rains. So, as well as smoke, the PAH levels in drinking water in fire areas need to be taken into account to estimate cancer risks.

PAH's in bushfire smoke and in drinking water from fire areas, need to be studied to assess their potential to increase cancer. They need to be taken into account in assessing the health impacts of bushfires and climate change.

Conclusion

By reducing PAHs in air and water we can prevent future cancer cases. The long term monetry costs of cancer treatment are huge, but the human cost of cancer is much greater.

Effie Ablett

The author's publications include papers in Nature, the Lancet, New England Journal of Medicine, Mutation Research, Neurology, Oncogene, Biochemical Pharmacology and Plant Science. Invited speaker at the *Dibble Cancer Research Centre, UDMS, London, and the International Congress for In Vitro Biology, Portland, OR, USA. Over 30 years working as a molecular biologist in Cancer Research at University of Qld and Qld Institute of Medical Research, studying the effects of chemical carcinogens on cultured human cells.*

For further information please email: