Written testimony prepared by Mary A. Fox, PhD, MPH, Assistant Professor
Johns Hopkins Bloomberg School of Public Health

House of Representatives Committee on National Resources
Subcommittee on Energy and Mineral Resources Hearing

"How Should the Federal Government Address the Health and Environmental Risks of Coal Combustion Waste?"

Tuesday, June 10th at 10:00 a.m.

Introduction

I thank you for the opportunity to testify today concerning the health effects of exposure to coal combustion waste. I am Dr. Mary Fox, Assistant Professor in the Department of Health Policy and Management in the Johns Hopkins Bloomberg School of Public Health. I am a risk assessor with doctoral training in toxicology, epidemiology and environmental health policy. I am a core faculty member of the Hopkins Risk Sciences and Public Policy Institute where I teach the methods of quantitative risk assessment. In my research I evaluate the health risks of exposure to multiple chemical mixtures.

My testimony focuses on the health effects associated with exposure to coal combustion waste and assessing the public health risks of such exposures.

Background

According to a recent report from the National Research Council, coal combustion waste includes several waste streams produced at coal-fired facilities, for example, bottom ash and boiler slag from the furnace, and fly ash and flue gas desulfurization material collected by pollution control devices (NRC 2006). The amount produced annually in the US exceeds 120 million tons or enough to fill a million railroad coal cars (NRC 2006). Coal combustion waste has numerous inorganic constituents, many of which are associated with health effects in studies of animal or human exposures. Exposures to human populations may occur depending on methods of coal combustion waste disposal. A summary of health effects information for coal combustion waste constituents following studies of oral (ingestion) exposures is provided below.

From a public health perspective it is interesting to note that the current concerns about coal combustion waste disposal are in part a result of regulatory success at protecting air quality. Two of the waste streams that contribute to the total production of coal combustion waste are from pollution control technologies in place to maintain clean air. Our efforts to minimize air emissions have resulted in a shifting of toxic constituents to another less well-regulated waste stream with potential to release the toxins into other environmental media.

Evaluating potential health risks from exposure to coal combustion waste

Methods of coal combustion waste disposal and potential for human exposure

Several methods of coal combustion waste disposal were identified by the National Research Council committee including placement in lined or unlined landfills, placement in lined or unlined surface impoundments, use in engineered products such as cement, placement or use in coal mines (NRC 2006). If the coal combustion waste is in contact with surface water or groundwater there is potential for the waste to be mobilized into the surrounding environment by leaching or runoff. During transport or placement (dumping) coal combustion waste may be entrained in air. Humans may come into contact or be exposed to coal combustion waste that has been mobilized into the environment from a disposal site. For example, if coal combustion waste leachate is in groundwater it may reach drinking water wells. Coal combustion waste entrained in air may be inhaled, may settle on soil or be transported into buildings through air transfer or on shoes or clothes.

Management of coal combustion waste is a national issue that affects communities around the country where disposal sites are located. Not far from here in Anne Arundel County, Maryland, coal combustion waste has been disposed of in a sand and gravel pit. The county health department has sampled the drinking water wells of nearby residents finding concentrations of aluminum, arsenic, beryllium, cadmium, lead, manganese, and thallium at levels above primary and secondary drinking water standards in some wells (Phillips 2007). It appears that coal combustion waste buried in the former sand and gravel pit is leaching into groundwater.

Health effects information on constituents of coal combustion waste

Health effects information is available for the majority of coal combustion waste constituents. See Table 1. The types and severity of the health effects range from benign and cosmetic effects to changes in organ or system function to cancer. Several coal combustion waste constituents share a common type of toxicity or target organ or system. Three coal combustion waste constituents have neurological effects (aluminum, lead, manganese); three (barium, cadmium, mercury) have effects on the kidney; three have a variety of effects on blood (cobalt, thallium, zinc); two have effects on the gastrointestinal system (beryllium and copper). If exposures to these mixtures occur, there is a greater chance of increased risk to health.

The health effect information for coal combustion waste constituents in Table 1 was gathered from the Centers for Disease Control and Prevention (CDC), the Agency for Toxic Substances and Disease Registry (ATSDR) and the U.S. Environmental Protection Agency Integrated Risk Information System (IRIS). The health effects information listed comes from studies of exposure by ingestion. The listing of coal combustion waste constituents was developed from the National Research Council 2006 report "Managing Coal Combustion Residues in Mines".

Assessing risks to human health

Environmental public health agencies such as the US Environmental Protection Agency routinely use human health risk assessment to evaluate health impacts of exposure to contaminated environmental media such as air and drinking water. Human health risk assessment is a systematic process that combines available data on the contaminant of concern as described in the National Research Council report "Risk Assessment in the Federal Government: Managing the Process" (NRC 1983). The four basic steps of a human health risk assessment are hazard identification, dose-response assessment, exposure assessment and risk characterization. Hazard identification summarizes information on the health effects related to exposure to the contaminant of concern. (As presented in Table 1, hazard information is known for the majority of coal combustion waste constituents.) Dose-response data are developed from research studies and describe the quantitative relationship between exposures and changes in rates of diseases, or other health effects such as organ function changes. Dose-response data are available for the majority of coal combustion waste constituents presented in Table 1. The magnitude, duration and amount of contact the individual or population of concern has with the contaminant of concern will be described in the exposure assessment. The nature of exposure to coal combustion waste will be highly variable depending on conditions at the site of disposal. The risk characterization combines the exposure and dose-response data to evaluate the likelihood of increased health risk.

Human health risk assessment methods are available to evaluate multiple chemical exposures (EPA 2000). Coal combustion waste is a complex mixture of constituents. Risk assessment methods for multiple chemical exposures will be essential to evaluating health risks of exposure to coal combustion waste.

Three of the four common coal combustion waste management practices (landfill, surface impoundment, use in or reclamation of mines) result in localized disposal. Communities surrounding such disposal sites are typically small. Proximity to the coal combustion waste disposal site will likely spur interest in evaluating community health. Unfortunately, systematic health effects research in any one small community will have limited statistical power to detect changes in health outcomes.

Reducing risks to human health

Risks to human health are increased if people are exposed to coal combustion waste. The tremendous volume of this waste generated and disposed of each year in communities throughout the country represents an enormous public health challenge. People are exposed if coal combustion waste is dispersed into the broader environment by runoff, leaching or entrainment in air. Dispersal of coal combustion waste into the broader environment will be reduced or eliminated by disposal practices that contain the waste away from contact with ambient air, surface water and groundwater. Human health risks are reduced or eliminated if human exposure is reduced or eliminated.

Conclusions

Coal combustion waste is a mixture of well-recognized substances. The approach to evaluating exposures to coal combustion waste should acknowledge potential interactions among the constituents in the body. Methods are available to assess health risks from exposure to mixtures of chemical substances, however, current regulatory strategies were not designed to control such mixture exposures. Coal combustion waste disposal practices must be improved to ensure population exposures are controlled through appropriate long-term containment and management.

Main points:

- Large volumes of coal combustion waste are produced and disposed of in the U.S. every year.
- Coal combustion waste is a complex mixture that can become mobilized in the environment, depending on disposal methods used.
- People are exposed through multiple means including inhalation, direct contact, and ingestion. Exposures may occur indoors and outdoors.
- Current approaches to evaluating health risks are limited and may underestimate the true risks to exposed communities.
- Health effects of exposure will be underestimated unless the potential cumulative impacts of the multiple toxic components of the mixture are considered together.
- Prevention of exposure through better management of the waste is ultimately the most sound public health approach.

Thank you very much for this opportunity to address the Subcommittee.

References

Agency for Toxic Substances and Disease Registry 2007. Minimum Risk Levels. Available at: http://www.atsdr.cdc.gov/mrls/index.html [accessed May 23, 2008].

Centers for Disease Control and Prevention 2005. Preventing Lead Poisoning in Young Children. Atlanta: CDC.

Environmental Protection Agency 2000. Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures. EPA/630/R-00/002. Risk Assessment Forum, Washington, DC.

Environmental Protection Agency 2008. Integrated Risk Information System. Available at: http://cfpub.epa.gov/ncea/iris/index.cfm [accessed May 23, 2008].

National Research Council Committee on the Institutional Means for Assessment of Risks to Public Health. Risk Assessment in the Federal Government: Managing the Process. Washington: National Academy Press, 1983.

National Research Council Committee on Mine Placement of Coal Combustion Wastes. Managing Coal Combustion Residues in Mines. Washington: The National Academies Press, 2006.

Phillips, F. 2007. Impacts of Fly Ash on Groundwater in Anne Arundel County, Maryland. Available at: www.mde.state.md.us/assets/document/watersupply/2007symposium/r0345Phillips_Frances.pdf [accessed May 23, 2008].

Table 1. Health effects of coal combustion waste (CCW) constituents

CCW Constituent	Health Effect(s) of Concern (Exposure by Ingestion)	Information Source
Aluminum	Neurological	ATSDR 2007
Antimony	Longevity, changes in blood glucose and cholesterol	EPA IRIS
Arsenic	Cancer, hyperpigmentation, keratosis of skin	EPA IRIS
Barium	Nephropathy	EPA IRIS
Beryllium	Gastrointestinal	EPA IRIS
Boron	Decreased fetal weight	EPA IRIS
Cadmium	Significant proteinuria	EPA IRIS
Chromium (III)	No effects observed	EPA IRIS
Chromium (VI)	No effects observed	EPA IRIS
Cobalt	Blood	ATSDR 2007
Copper	Gastrointestinal	ATSDR 2007
Fluorine	Cosmetic fluorosis of teeth	EPA IRIS
Iron	NA	NA
Lead	Neurological	CDC 2005
Manganese	Neurological	EPA IRIS
Mercury	Kidney	ATSDR 2007
Molybdenum	Increased uric acid levels	EPA IRIS
Nickel	Decreased body and organ weight	EPA IRIS
Potassium	NA	NA
Selenium	Selenosis – hair and nail loss	EPA IRIS
Silver	Argyria - benign skin pigmentation	EPA IRIS
Strontium	Bone growth and mineralization	EPA IRIS
Thallium	Change in blood chemistry	EPA IRIS
Vanadium	Decreased hair cystine	EPA IRIS
Zinc	Decreased red blood cell copper and enzyme activity	EPA IRIS

Abbreviations: ATSDR, Agency for Toxic Substances and Disease Registry; CCW, coal combustion waste; EPA, Environmental Protection Agency; IRIS, Integrated Risk Information System; NA, not available.