ENVIRONMENTAL HEALTH PROJECT

DEFENDING PUBLIC HEALTH SINCE 2012

Environmental Health Medical Toolkit

Our mission is to respond to individuals' and communities' need for access to accurate, timely, and trusted public health information and health services associated with natural gas extraction.

The purpose of this toolkit is to inform health care providers of current information regarding the contribution of shale gas development exposure to disease causation or exacerbation of pre-existing conditions. The goal of the toolkit is to recognize environmental health and exposure history as a systematic risk assessment/ management paradigm in the care of patients. In using the toolkit, clinicians will be able to:

1. **Identify environments of concern and organize potential exposure hazards;**
2. **Distinguish major routes of exposure and target organs of exposure;**
3. **Recognize illnesses related to environmental exposure;**
4. **Identify susceptibility of certain segments of a population to specific exposures.**

Key Concepts

"Environmental health addresses all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviors. It encompasses the assessment and control of those environmental factors that can potentially affect health. It is targeted towards preventing disease and creating health-supportive environments." (World Health Organization Definition)

What Comprises the Environment?

According to the National Institute on Environmental Health Sciences the environment is comprised of:

- **The Natural Environment –** includes physical, chemical and biological things that occur naturally in our surroundings (air, water, food, soil).
- **The Man-Made or Built Environment –** includes physical structures where people live, work and play and the consequences of human alteration to the natural environment such as pollution.
- **The Social Environment –** encompasses lifestyle factors such as diet and exercise, social environmental systems and other societal influences that may affect health.

Environmental Health Issues in Pennsylvania

Historically, Pennsylvania's rich natural resources of timber, coal, and minerals helped to industrialize the state and the nation. At one time or another Pennsylvania led the nation, and many times the world, in the production of iron, steel, coal, and oil. Each of these industries had a direct and visible impact on our environment. Environmental abuses were met with changes in law and policy to restore balance to the use of resources and protect the environment and public health.

Today, according to the Pennsylvania Department of Health (DOH), the field of environmental health examines how different environments affect a person's well-being. The health effects of breathing air or drinking water, for example, are researched in specific locations where there may be cause for concern. DOH environmental health staff members work closely with federal, state, county, local officials and the public to help address environmental health issues and concerns.

Environmental Health Issues in Unconventional Natural Gas Development (UNGD)

The Marcellus Shale, one of more than twenty natural gas shale deposits in the United States, is the largest on-shore natural gas reserve in the world. It lies a mile or more down under two-thirds of Pennsylvania, waiting to be extracted to supply our country's natural gas needs. The extraction is accomplished using high-volume, horizontal, hydraulic fracturing. This includes the drilling and hydraulic fracturing events as well as the ancillary infrastructure required for the entire process.

Stages and Infrastructure

Before drilling a Marcellus Shale natural gas well, seismic testing is done to ascertain the depth of the Marcellus Shale. Based on the depth testing results, approximately a million or more gallons of fresh water are needed for drilling. The water is used to both cool the drill bit, creating a clay slurry, and to remove rock cuttings. The produced water and drill cuttings are stored at the well site in lined pits until hauled away.

Drillers drill both vertical and horizontal wells to access the natural gas. The vertical bores are like conventional natural gas wells that go straight down. Horizontal wells are part of the new technology that is used to retrieve the shale gas.

Once the drilling is finished, the well is ready for hydraulic fracturing. To "frack" a Marcellus Shale gas well, millions of gallons of fresh water are hauled in or withdrawn from a local source, above or below the surface, and chemicals and sand are added to the water. The chemicals are used to make the natural gas flow more efficiently up to the well head. Sand is added to the fracture fluid to prop the fractures in the shale open so the gas can escape from the rock.

During "fracking", millions of gallons of fluid are pumped into the well under pressure to break up the shale. Much of the "fracking" fluid returns to the surface as flowback water, containing both chemicals added for hydraulic fracturing and material occurring naturally in the shale layer. These naturally occurring materials may include radioactive compounds, toxic organic chemicals, or heavy metals such as arsenic, depending upon what is naturally in the rock. The flowback is held in plastic lined pits at the well site until it is trucked away.

Existing pipelines and processing facilities were inadequate to handle the processing and distribution of Marcellus Shale gas. New processing facilities and distribution systems continue to be developed.

Air Emissions/Exposures

Air pollution from shale gas development is a clear, well-defined pathway of exposure that is produced not only from activities in and around the well, but also from the transportation of water, sand, and chemicals to and from well pads and other ancillary processes. Emissions of health damaging air pollutants such as volatile organic compounds and particulate matter occur throughout the life cycle of shale gas development. They have been measured in concentrations elevated enough to contribute to an excess public health burden for nearby populations.[1] In addition, diesel trucks emit diesel particulate matter, a health damaging air pollutant that contributes to cardiovascular and respiratory diseases, atherosclerosis, and premature death.[2]

Water Contamination

Shale gas operations have also been linked to surface and groundwater contamination.[3] Researchers found groundwater near drilling sites contained methane concentrations 17 times higher than wells where drilling was not taking place.

Health Effects

Data suggest that UNGD poses substantial risk to public health. It is believed that the potential consequences of "fracking" begin at the onset of drilling and may last long after the operation has ended.

- Toxic chemicals are used in UNGD and are present in generated wastes and byproducts.
- Individuals can be exposed to these toxins through a number of environmental pathways, including air pollution and water contamination.
- Individuals may be exposed to other social and biological stressors associated with related heavy industrial activities, such as noise and light pollution.
- It is likely that some of the somatic health symptoms reported by residents in gas producing areas have a psychological basis, given that increased levels of anxiety, tension, irritability and depression have all been identified in these residents. Nevertheless, a pilot study of health problems associated with natural gas

development suggests that the occurrence of these problems is not insignificant and is worthy of further study.[4]

• Many of the toxic chemicals used and produced by UNGD have well-known adverse health effects. For instance, benzene is a known carcinogen, toluene is a neurotoxin, and hydrogen sulfide irritates the lungs and can cause asthma. Research is mounting on the emissions of UNGD at all stages and on health effects experienced by nearby residents.

• In a randomized study, the authors determined that individuals living within one kilometer of UNGD wells experienced greater numbers of dermatological and upper respiratory symptoms than those living further away.[5] These findings are consistent with previously published community surveys.[6,7]

Summary of Provider Responsibilities

• When seeing patients in your practice, inquire regarding potential environmental and occupational exposures.

• Consider the possible contribution of environmental exposures when formulating a differential diagnosis for patient symptoms.

• Exposures from UNGD are unlikely to result in new diseases; rather it will increase the occurrence and severity of recognized illnesses.

• Be familiar with resources to consult.

• Recognize variations in response to exposures in vulnerable populations such as elderly, children, individuals with pre-existing disease, and pregnant women, among others.

Best Practices for Health Providers

Guidance for an Environmental Health and Exposure History

Although most environmental diseases either manifest as common medical problems or have nonspecific symptoms, environmental factors rarely enter into the clinician's differential diagnosis. As a result, health providers may miss the opportunity to make correct diagnoses that might influence the course of disease in some affected individuals (by stopping exposure) and that might prevent disease in others (by avoiding exposure).[8]

Incorporating an environmental health and exposure history is helpful to clinicians in recognizing potentially hazardous chemicals and pollutants in the environment. As the literature about shale gas development increases, one of the recommendations for health professionals working in shale country is to incorporate questions about shale development activities into patient evaluation. In a practical sense, an extensive environmental health and exposure history is beyond the scope of the practitioner. However, asking a few screening questions will alert the clinician to a possible environmental cause.

Examples of screening questions include:

• Do you or anyone in your family live, work, or attend school in proximity to an industrial plant, dump site, or natural gas drilling site?

• Have you experienced any changes in the water quality such as color, taste, or smell?

• Are you currently exposed to metals, dust or fibers, chemicals, fumes, loud noise or vibration?

• Have you ever changed your residence because of a health problem?

• Do you or anyone in your family work in the natural gas industry?

Included in this toolkit for your use is an Environmental Health and Exposure History form available from the Agency for Toxic Substances and Disease Registry. You may also access this information at www.atsdr.cdc.gov.

Questions about exposure to shale gas development have not previously been included as part of patient intake questionnaires, but doing so can provide clues to explaining symptoms whose possible etiology might otherwise be missed by the health provider or patient. Collecting such information can also help provide research data on the prevalence of shale gas-related health symptoms among those living or working in areas of shale gas operations.

Biomonitoring

A question frequently asked of clinicians is whether individuals living or working close to UNGD, such as well pads, compressor stations, or production facilities should undergo blood or urine testing (biomonitoring) to determine if they have harmful chemicals in their body as a result of exposures from these operations.

Some of the chemicals associated with UNGD activity are cleared rapidly from the body, have other sources of exposure in the environment, or may not have a measurable metabolite that is specific to the chemical of concern. Consequently, results of blood or urine tests are often misleading. A "positive" result may not actually be related to a hazardous exposure or may have resulted from an exposure unrelated to UNGD activity. A "negative" result may occur, even if there has been an exposure, if the testing takes place too long after the exposure occurred and the hazardous chemical has already been cleared from the body, causing false reassurance.

Finally, a result may actually indicate an exposure to a chemical originating from UNGD activity, but there may be no information available to interpret if the results indicate that the exposure poses a health risk to the individual. As a result of their limitations, biomonitoring tests are not usually recommended for individuals who may have had environmental exposures to chemicals originating from UNGD activity.

Resources

- *Environmental Health Project (EHP): 724-260-5504 www.environmentalhealthproject.org*
- *US Environmental Protection Agency (EPA): www.epa.gov*
- *Department of Environmental Protection Regional Resources in Pennsylvania (DEP): www.portal.state.pa.us*
- *Penn State Extension: www.extension.psu.edu*
- *Agency for Toxic Substances and Disease Registry (ATSDR): www.atsdr.cdc.gov*
- *Pennsylvania Department of Health: www.health.pa.gov*
- *National Institute on Environmental Health Sciences: www.niehs.nih.gov*
- *World Health Organization: www.searo.who.int/topics/environmental_health/en/*

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[4] *Penn Medicine. 2013. Penn pilot study finds that group of Bradford County, PA residents concerned about health effects of hydraulic fracturing. Retrieved from http://uphs.upenn.edu/new/News_Releases/2013/04/fracking/*

[5] *Rabinowitz PM, Skizovskiy IB, Lamers V, et al. 2014. Proximity to natural gas wells and reported health status: Results of a household survey in Washington County, Pennsylvania. Environmental Health Perspectives 123:21-6.*

[6] *Steinzor N, Subra W, Sumi L, 2013. Investigating links between shale gas development and health impacts through a community survey project in Pennsylvania. New Solutions 23: 55-83.*

[7] *Ferrar KJ, Kriesky J, Christen CL, et al. 2013. Assessment and longitudinal analysis of health impacts and stressors perceived to result from unconventional shale gas development in the Marcellus Shale region. International Journal of Occupational and Environmental Health 19:104-112.*

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