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EDITORIAL

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A network of Pediatric Environmental Health Specialty Units (PEHSUs): Filling a critical gap in the health care system

Sieć Pediatrycznych Specjalistycznych Poradni Medycyny Środowiskowej (PEHSU): wypełnienie istotnej luki w systemie opieki zdrowotnej

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Abstract

A network of pediatric environmental health specialty units (PEHSUs) in the United States was formed in 1998 out of a recognized need for clinical expertise in children's environmental health. Documented trends in a rise of pediatric diseases caused or exacerbated by environmental conditions, coupled with the failure of medical schools and residency programs to cover these issues in a significant way, leaves health care providers, parents, communities, and governments at a loss for this specialized knowledge. The PEHSUs fill this gap by providing: 1) medical education, 2) general outreach and communications, and 3) consultative services to communities and health care professionals. This paper presents examples of key situations where PEHSU involvement was instrumental in improved patient outcomes or advancing clinical expertise in children's environmental health. Challenges and opportunities for future directions for the program are also discussed.

Key words: Children, Environmental Health, Medical Education, Environmental Exposure, Public Health, Pediatrics, Program Development

Streszczenie

Sieć Pediatrycznych Specjalistycznych Poradni Medycyny Środowiskowej (PEHSU) w Stanach Zjednoczonych została utworzona w 1998 roku w wyniku uznania konieczności przeprowadzania ekspertyz w zakresie zdrowia środowiskowego dzieci. Udokumentowane trendy wzrostu chorób dzieci wywołanych lub zaostrzonych

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przez czynniki środowiskowe i nakładający się równocześnie niedostatek programów nauczania z tego zakresu w szkołach medycznych lub w czasie rezydentury spowodowały brak tej specjalistycznej wiedzy wśród pracowników opieki zdrowotnej, rodziców, społeczności i władz. PEHSU wypełniają ten brak wykonując: 1) edukację medyczną, 2) promocję zdrowia środowiskowego 3) porady konsultacyjne dla społeczności i dla pracowników ochrony zdrowia. W niniejszej pracy przedstawiono najważniejsze przykłady, kiedy udział PEHSU był instrumentem dla polepszenia stanu zdrowia albo postępu ekspertyzy klinicznej w zakresie zdrowia środowiskowego.

Słowa kluczowe: dzieci, zdrowie środowiskowe, kształcenie medyczne, ekspozycja środowiskowa, zdrowie publiczne, pediatria, programowanie.

Introduction

Children are uniquely vulnerable to the health effects of environmental contaminants. Key physiological and behavioral differences such as increased metabolic rates, organ growth and development, and hand-to-mouth behavior play important roles in augmenting environmental exposures and their impacts [1, 2]. Over the past 30 years in the United States, epidemiological trends indicate that childhood diseases such as asthma, neurodevelopmental disorders, childhood cancers, birth defects, and obesity have been steadily increasing in prevalence and incidence [2–4]. A significant portion of these chronic childhood conditions are likely caused or exacerbated by toxic environmental exposures [3–7]. The World Health Organization estimates that globally, 24% of disease burden (life-years lost) is attributable to environmental factors and that a disproportionate burden falls on children [8].

During the 1980s and 1990s, the Agency for Toxic Substances and Disease Registry (ATSDR) and United States Environmental Protection Agency (US EPA) were responsible for investigation and remediation of outbreaks of environmental contamination with the potent agricultural pesticide methyl parathion. These included widespread episodes of contamination of indoor settings, such as day care centers and houses, in which children were present. Children's symptoms likely to have been the result of exposure were rarely identified on physician visits [9]. Though the federal agencies working on this issue were able to refer adults to established clinics with specialists in Occupational and Environmental Medicine, no such expertise existed for younger patients. In recognition of these challenges, the first Pediatric Environmental Health Specialty Units (PEHSUs) were formed in 1998 and ultimately a network of 12 PEHSU affiliated clinics has developed across the United States plus sister clinics in Canada and Mexico [10]. The mission of the PEHSU program is to provide education and consultation for health care providers, public health professionals, and others about the topic of children's environmental health. The program is supported through two federal agencies: ATSDR and US EPA, and operates through a cooperative agreement with the nonprofit Association of Occupational and Environmental Health Clinics (AOEC) [10].

All PEHSUs are affiliated with major universities with clinical training programs. The PEHSU organizational model exists as a partnership between departments of Pediatrics and Occupational Environmental Medicine in collaboration with medical toxicology (for example, the poison control center system). Each PEHSU includes one or more board-certified occupational and environmental health physicians and board-certified pediatricians on staff. Ancillary personnel vary but may include experts in industrial hygiene, developmental pediatrics, nurse specialists, child psychiatry, and others.

Filling the gaps: The need for PEHSUs in the health care system

Various professional institutions including the National Academy of Sciences' Institute of Medicine (IOM) have expressed increasing concern over the inability of the complex U.S. medical system to address questions of environmental health [11]. At the same time, there is a growing recognition among parents and the media of environmental contributions to children's health and well being. Survey results convey that the U.S. public believes that the environment plays an important role in a number of health problems, and that parents would like more information from their pediatricians on environmental health topics [12, 13]. Greater access to environmental health information via the Internet, and the potential for misinformation, heighten the need for providers to be informed about emerging environmental issues.

As a trusted source of information and often the first person to be alerted to health concerns of potential environmental origin, clinicians can play a vital role in diagnosing, treating, preventing and communicating environmental threats to children's health. However, there is a lack of corresponding education and training in U.S. medical schools and residency programs to adequately prepare physicians to face these challenges [14, 15]. Roughly 75% of medical schools have some environmental medicine content; however the average instruction is only 7 hours over the span of 4 years in medical school [16]. Surveys of practicing pediatricians have

found that over half have seen cases that they suspected to be of environmental origin, but only one-fifth have ever received training in taking an environmental history [17, 18]. While pediatricians strongly believe in the importance of environmental exposures to children's health, they report a lack of confidence in their ability to advise and treat their patients with concerns about these exposures [2, 17].

This lack of confidence should not be surprising since both childhood exposures and their health impacts are compounded by many broader environmental determinants. These include psychosocial conditions, the physical or "built" environment, and economic conditions that require the coordination of multiple stakeholders to assess and redress the impacts. `

PEHSU Goals and Services

PEHSUs were established to serve a variety of functions including consulting in the diagnosis and treatment of diseases of environmental origin, strengthening prevention capacity through education, and improving pracitioner access to expertise in environmental medicine [2, 10]. Furthermore, PEHSUs are a resource for local and federal agencies, an avenue for clinicians to develop sub-specialty knowledge, and provide a core of clinically focused publications and factsheets.

PEHSU Role in Medical Education

To address the knowledge gap among providers discussed above, one of the primary goals of the PEHSUs is to educate practicing clinicians and clinical trainees in academic and community-based settings [10]. PEHSU outreach to educate medical personnel occurs through speaking at grand rounds and medical conferences, lecturing to medical and nursing students, or through formal continuing education opportunities [19]. For example, in 2011, approximately 10,700 health professionals (including 6,300 physicians) were eligible to receive continuing education credits through didactic events conducted by PEHSU staff [20].

Many PEHSU physicians and staff have contributed to hundreds of medical and public health journals, chapters, and books to raise awareness of environmental health issues relevant to clinical and research communities [19]. For example, PEHSU staff have published papers on specific chemical exposures such as lindane, arsenic, mercury, uranium, perchlorate, and endocrine disrupting chemicals [21–27]; the need for medical training in environmental health [15]; the special vulnerabilities of children and those with developmental disabilities [28–30]; and environmental justice [31] among others.

The PEHSUs provide opportunities for trainees to have exposure to environmental health training including lectures and clinical rotations. New media tools such as webinars and online courses are increasingly being used to educate clinical populations (see Table I for a list of highlighted courses). For example, the "Pediatric Environmental Health Toolkit" (developed by the University of California San Francisco (UCSF) PEHSU and the non-governmental organization – Physicians for Social Respon-sibility) has been used as a teaching tool in medical, public health, and nursing schools [32]. In 2011 alone, 479 practitioners completed the online toolkit training (housed on the Centers for Disease Control and Prevention website at: http://www.atsdr.cdc.gov/emes/health_professionals/pediatrics.html) for continuing education credits. The UCSF PEHSU has worked with a consortium of pediatric residencies in California, at their request, to develop curriculum. One module of this curriculum provides the preparation and resources for an instructor to take residents on a "community walk" to learn how features of the neighborhood and community impact children's health. The goal is to have residents recognize key features like physical design, access to health resources, proximity to and levels of pollution, and social structure. The community module and other resources can be found at: http://coeh.berkeley.edu/ucpehsu/.

Outreach and Communications

Beyond supplementing clinical training, the PEHSUs materials are used by a broad range of government, healthcare and advocacy organizations. These include public health officials, school districts, county-level and state-level governments, the American Academy of Pediatrics, and federal agencies.

While research is not the primary focus of the PEHSU program, collaborations are being developed between the PEHSUs and government-funded Children's Environmental Health and Disease Prevention Research Centers on areas of emerging research. The Children's Centers conduct scientific research to promote understanding of how environmental factors impact children's health, and translate basic research findings into health-protective interventions. These institutions are emphasizing the need for their research to reach a broader audience, and the PEHSUs offer expertise in research translation to the medical community and also interpretation of research to public audiences. In the western United States, the PEHSUs in Seattle and San Francisco are working with the region's Children's Environmental Health Research Centers to develop a consortium to coordinate data sharing, inform policy leaders, and enhance research translation efforts.

The expertise cultivated in Pediatric Environmental Health by the PEHSUs provides an important clinical perspective to consultations with local, state, and federal health agencies. In this way, clinical practitioners can serve on scientific and other government advisory committees such as US EPA's Science Advisory Board and lend their unique perspectives. The expertise is also useful when governmental agencies seek consultations with the PEHSU, particularly in situations of community-wide exposures or environmental justice concerns. Here, the role of the PEHSUs as a resource for clinicians establishes an avenue for communicating with the public. When faced with major environmental hazards, communication from public health authorities may be tense since many communities have a distrust of government agencies [33]. Though PEHSU clinics receive federal funding, PEHSU physicians are based in reputable academic institutions and are not employed directly by government. In this way, PEHSU staff are in a unique position to serve as independent and respected medical and environmental resources in the community setting [19]. This type of PEHSU support was observed in Anniston, Alabama, the location of a US EPA Superfund Site (a designated area of high risks to human health and the environment) contaminated with polychlorinated biphenyls (PCBs) and lead. The Southeast PEHSU provided technical support and information to community residents and conducted medical education sessions for local pediatricians about potential health effects resulting from exposure to environmental toxins. The PEHSU also met with local elected representatives, community groups, school officials, and community leaders to facilitate dialogue and connect families to available resources [31]. These collaborative efforts resulted in the development of a local model early education screening and intervention program for the community.

Communications to the lay public are an important component of promoting children's environmental health. Community engagement can come in the form of community meetings, school-related activities, and publications. For example, guidance documents and factsheets for emerging issues such as children affected by hurricanes and wildfires were developed by the PEHSUs and endorsed by the American Academy of Pediatrics (AAP) for use by communities and clinicians alike (see Table II for a listing of all current PEHSU factsheets) [19]. More recently, the growing number of natural gas drilling wells in the eastern United States has sparked public concern over the potential health effects of this practice. Anecdotal reports have described the apprehension of physicians to diagnose, test, or give advice to symptomatic patients living near natural gas extraction wells [34]. This is understandable given the scientific uncertainty concerning connections between hydraulic fracturing (commonly called "fracking") and adverse health effects. However, clinicians confronted with these questions need to make assessments and decisions in the face of uncertainty. To assist these types of emerging situations, the PEHSUs can respond by supplying factsheets for both health providers and the general public. In the case of natural gas extraction, factsheets were released in August 2011 describing potential health concerns and recommendations for working with communities and increasing awareness of the potential hazards (see Supplemental Factsheet I following this article entitled, "Information on Natural Gas Extraction and Hydraulic Fracturing for Health Professionals"). The PEHSU response provides summary information for health professionals quickly, often long before governmental agencies produce a guidance document.

Consultation

Clinical information and expert consultation are also a core component of the PEHSU program. The diverse team of PEHSU health professionals can be accessed through a toll-free number by anyone: physicians, parents, nurses, school officials, media representatives, and public health professionals. In 2011, the PEHSUs responded to 1225 calls [20]. The calls span a range of environmental health issues (see Table III for the most recent call topics across the U.S.). Typically, the PEHSUs will receive a spike in calls if a particular topic has garnered significant media attention. For example, in 2012 the PEHSUs saw an increased number of calls related to arsenic after the publication of a paper reporting arsenic contamination in brown rice syrup-sweetened formula [35]. Through this mechanism, the PEHSUs are available to: answer general questions about environmental health, recommend diagnostic tests and interpret results for clinicians on specific cases of environmental exposures, assist with planning and execution of environmental assessments, and recommend additional resources for concerns about environmental hazards [19].

PEHSUs do not employ physicians full-time, and there is limited funding to accomplish the three stated goals of consultation, education and referral. Because of these limited resources, collaboration to enhance the collective efforts of the PEHSUs and federal, state and local governments, non-governmental organizations, educational institutions, and/or international organizations is extremely important. The following two case studies represent a sample of the PEHSUs accomplishments in these different collaborations, and highlight the potential

impact of having an accessible network of informed environmental health clinicians.

Additional Examples of PEHSU Activities

The PEHSU network across the U.S. has collaborated with a variety of stakeholders on emerging environmental concerns, capacity building and training, and raising awareness of children's unique vulnerabilities. Below, we have highlighted key examples of PEHSUs working collaboratively with partners to address emerging health issues in the U.S. and internationally.

Mercury in Imported Face Creams: An Example of Stakeholder Collaboration

In March 2010, when results from a biomonitoring study revealed a mother and three young children in the San Francisco area with elevated blood mercury levels, the local health department was contacted and they arranged for a clinic visit with the family. The pediatrician who evaluated the family contacted the UCSF PEHSU for additional evaluation and clinical recommendations on the case [36].

The UCSF PEHSU was able to determine that the family was exposed to inorganic mercury and contacted the regional office of the US EPA whose Emergency Response Team was able to confirm significantly elevated levels of mercury vapor in the home during a site evaluation. The PEHSU worked with California State Department of Public Health to develop an appropriate questionnaire, which ultimately identified the source as an unlabeled container of face cream from Mexico. Public health investigations identified similar cases, including several women who had used the contaminated creams while pregnant and nursing [37]. The PEHSU worked with the state health department in California to develop alerts to public health authorities and clinicians about this possible novel cause of mercury toxicity. As well, PEHSU helped the state health department develop radio public service announcements to warn the public about the hazards of unlabeled skin-lightening creams or products that contain mercury [36, 37]. A presentation on this breaking issue at the annual meeting of PEHSU staff and federal agency representatives alerted both the clinician network as well as the agencies to this emerging issue. Subsequently, other cases have been identified in California and elsewhere.

Developing Pediatric Environmental Health Capacity in Global Health Settings

Children's hazardous exposures are often magnified in developing and transitional countries [5]. While the PEHSU network makes gains in North America, the limitations and gaps in capacity to identify and respond to these issues in less resourced settings remain immense. In response, the PEHSU program has developed several global partnerships with professional colleagues beyond North America.

For example, in 2008 The University of Washington (UW) PEHSU initiated capacity building activities aimed at improving children's environmental health in Southeast Asia. This ongoing effort began with PEHSU staff formal presentations at regional scientific and pediatric medical conferences. Informal meetings with governmental and non-governmental public health and pediatric health professionals were also held. In these venues, the PEHSU model and core training content was discussed.

During trainings delivered to over 250 staff at medical sites in Vietnam, information was collected on the status of pediatric clinician training, beliefs and attitudes regarding Pediatric Environmental Health [38]. This provided the foundation and impetus for a new children's environmental health research training initiative that identified five early career professionals from Cambodia, Thailand, and Vietnam. These trainees participated in a week-long children's environmental health "boot camp" both in 2010 and 2011. U.S.-based faculty in epidemiology, occupational and environmental health and medicine, and pediatric environmental health and medicine led these workshops. Content encompassed research proposal development and design, UW-sanctioned training on human subjects research ethics as well as core content on the environmental health topics identified by the trainees for a mentored research experience. Competitive review of trainee proposals provides opportunity for the project to fund modest research studies led by the trainees. Two studies are in progress. The first is assessing childhood lead exposure in a heavily contaminated rural village that has a long history of lead battery recycling and a second involves evaluating the role of indoor environmental conditions on asthma control in a cohort of urban and rural children. The World Health Organization's children's environmental health modules provided a basis for some of the core children's environmental health content delivered (http://www.who.int/ceh/capacity/trainpackage/en/index.html).

Using a mentored research approach, the UW PEHSU hopes to continue to contribute to regions outside the North American network through career development of professional colleagues in pediatric environmental health. In addition, the approach can provide useful data to define environmental health concerns of importance in the developing world and initiate infrastructural capacity to reduce hazards. Leveraging the North American network

with funding mechanisms and organizations focused on global health and development provides an opportunity to enrich the North American focus of the original network. In the UW example, the PEHSU's Southeast Asia work was largely due to a partnership and funding opportunities through the former Fogarty International Centers for Training in Environmental and Occupational Health. The Fogarty Center at UW and the Project Vietnam Foundation also provided key links to establishing professional contacts in the region.

Future Directions

The entire PEHSU system of 12 program sites in the United States operates with a core funding of only about 1.8 million U.S. dollars/year including management and overhead expenses. The amount of activity and advancement of pediatric environmental health accomplished with this very limited funding is a hopeful sign that similar clinics can be run in other countries without prohibitive monetary investment. At the same time, the level of funding of PEHSUs in the U.S. has resulted in the majority of PEHSU clinical activity being targeted to the geographic regions closest to the federal regional clinic sites. In an attempt to further the reach of PEHSU activity to a larger audience, the PEHSUs have increasingly worked to develop fact sheets, online educational materials (including online opportunities for continuing education credits), journal articles, and the like (see Tables I and II). To expand clinical services and educational programs in children's environmental health beyond the New York City area, the Mount Sinai PEHSU has worked with the New York State legislature and Department of Health to build a statewide network of Centers of Excellence in Children's Environmental Health (CECEHs). This network currently consists of six Centers of Excellence.

International Efforts

Internationally, various groups have adapted the PEHSU concept [10, 39]. The organization of their activities and the goals vary from country to country. For example, the Republic of Korea has set up a network of multiple sites implemented by the Ministry of the Environment to focus on research and preventive management of pediatric environmental health issues [40]. Similarly, Argentina has also developed a network of PEHSUs. A network established in Spain follows the PEHSU model, but focuses their attention on the impact of the environment on childhood cancer [41]. Other stated objectives of the Valencia PEHSU include providing individualized information to pediatricians on environmental factors affecting children's health, educating pediatricians about the connections between health and the environment, and increasing research, assistance and expertise in this emerging field [42]. This program formed out of an increased recognition from organizations like World Health Organization (WHO) and the European Union that special attention should be focused on pediatric environmental health to reduce the burden of disease worldwide [43, 44]. In a recent article, Ortega-García and colleagues highlight the need for PEHSUs due to a lack of awareness of pediatricians in Europe to issues in environmental medicine, and health care structures that are inadequately equipped to manage environmentally–related health concerns [45]. Another paper evaluates the pressing needs of Eastern Central Europe, where the authors point out a deficiency in pediatric institutions addressing environmental matters and a corresponding lack of environmental societies that focus efforts on children [46]. At the same time, these countries face air and water quality issues, and emerging threats to children's health including: obesity, traffic accidents, and alcohol and tobacco use.

One key component of the efforts of the international PEHSUs has been practitioner education and training. In 2005, the PEHSU in Mexico established a distance-learning course that had participation from 17 Latin American countries in its first year and trained 520 health professionals in topics in children's environmental health [47].

Integrating OB/GYN Practitioners

Frequently the questions that come to PEHSUs involve exposures of pregnant women and concerns about the potential effects on the fetus. While the Occupational/Environmental physicians and Pediatricians staffing the clinics are comfortable handling these concerns, it is clear that there is a need to develop a similar cadre of clinicians within the Obstetrics and Gynecology community [48, 49]. The PEHSU system is now working with various partners in the hope of adding Obstetrician/Gynecologists as regular members of PEHSU teams. For example, the UCSF PEHSU collaborates with the UCSF Program for Reproductive Health and the Environment (www.prhe.ucsf.edu/), whose mission includes educating the public about potential prenatal exposures.

Current Challenges

An additional concern is the need to develop the next generation of Pediatric Environmental Health specialists. There are few established fellowship

opportunities for clinicians to get advanced training in Pediatric Environmental Health. For those considering a career in this field there are a very limited number of academic positions available. This is in part related to the lack of recognition of Pediatric Environmental Health as a sub-specialty as well as an undefined career path for this multidisciplinary field of study. With limited funding, few young physicians are being trained in the field, and with an uncertain career path, opportunities for expansion of the field are being missed. The current leaders of the PEHSU clinics come from a set of diverse backgrounds including general academic pediatrics, occupational environmental medicine, medical toxicology, and epidemiology.

Despite the many challenges and limitations of the current PEHSU system, a cohesive network of collaborators in pediatric environmental health can bring tremendous opportunity to fill this largely unmet need in medicine and public health. Promising undertakings, such as forming global alliances and including a prenatal focus into the work of the PEHSUs, can expand the conversation on children's environmental health with increased regional and technical experience. Drawing on current expertise and building capacity for the future, PEHSUs can exercise their invaluable perspectives in improving the health and welfare of children around the world.

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Table I. PEHSU-developed online health provider training tools

Selected Examples of Online Training Tools developed by PEHSU
"OP Pesticides and Child Health: A primer for healthcare providers" http://depts.washington.edu/opchild/
"Pediatric Environmental Health and Air Pollution" http://www.eh.uc.edu/cares/learn/physicians.html
"Pediatric Environmental Health Toolkit" http://www.atsdr.cdc.gov/emes/health_professionals/pediatrics.html
Nursing Education Courses *"Bed Bugs: Implications and Recommendations in Nursing Practice"* *"Asthma Triggers: Best Practices for Identification and Management in the School Setting"* *"Asthma Primer for School Nurses: New Guidelines and Intervention Techniques for Asthma"* *"Children and Disasters: New Guidelines and Recommendations in Nursing Practice"* http://www.swcpeh.org/providers_ceupres.asp

Table II. Current PEHSU factsheets. Available for download at: http://aoec.org/pehsu/facts.html

PEHSU Fact Sheets
Chelation Therapy – Guidance for the General Public (May 2012)
Advisory about Chinese Drywall (April 2011)
Recommendations Regarding Return of Children to Areas Impacted by Flooding and/or Hurricanes (August 2011)
Advisory about Gulf Oil Spill, for health professionals (August 2010) Advisory about Gulf Oil Spill, for patients (August 2010) Advisory about Gulf Oil Spill, for health professionals, Vietnamese (August 2010) Advisory about Gulf Oil Spill, for patients, Vietnamese (August 2010)
Information on Natural Gas Extraction and Hydraulic Fracturing for Health Professionals (August 2011) Information on Natural Gas Extraction and Hydraulic Fracturing Information for Parents and Community Members (August 2011)
Advisory about Melamine, for health professionals (October 2009) Advisory about Melamine, for health professionals (Chinese) (November 2009)
Advisory about PBDE, for health professionals (May 2010)
Advisory about Phthalates and BPA, for patients (October 2009) Advisory about Phthalates and BPA, for patients (Spanish) (June 2008) Advisory about Phthalates and BPA, for health professionals (October 2009) Advisory about Phthalates and BPA, for health professionals (Spanish) (June, 2008)
Information on Health Risks of Wildfires for Children – Acute Phase Guidance for Health Professionals (August 2011) Information on Health Risks of Wildfires for Children Guidance for Parents and Community Members – Acute phase (August 2011) Information on Health Risks of Wildfires for Children – Aftermath Guidance for Health Professionals (August 2011) Information on Health Risks of Wildfires for Children – Aftermath Guidance for Parents and Community Members (August 2011)

Table III. Environmental health issues to which PEHSU responded; based on preliminary data aggregated across the U.S. Source: PEHSU Annual Report FY11 (October 1, 2010–September 30, 2011) [20]

Initial Contacts by Substance – 2011		
Substance	*Number of Calls*	*Percentage of Total*
Lead	371	30.00
Fungus/Mold	129	10.23
Pesticides	55	4.44
Phthalates & BPA	58	4.36
Mercury	53	4.44
Electromagnetic Field	5	0.42
Indoor Air Contaminants	49	4.02
Arsenic	31	2.35
Metals	8	0.67
Hazardous Waste	12	0.84
Soil Toxins	9	0.75
Water Toxins	11	0.90
Gases/Fumes	37	3.10
Artificial Turf	5	0.40
Unknown	46	3.90
Other	346	29.10
Total	**1225**	**100.00**

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Supplemental Factsheet I.
Example of PEHSU Factsheet for Health Professionals (August 2011)

PEHSU
Pediatric Environmental Health Specialty Units

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

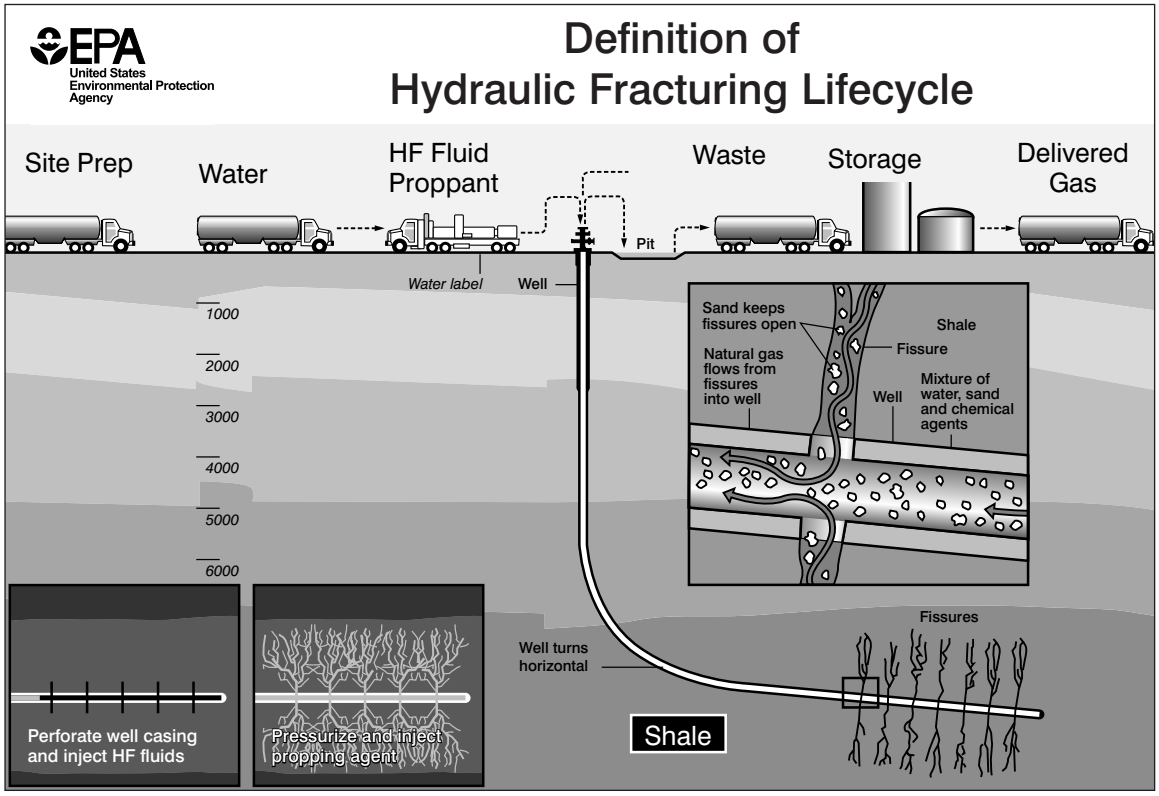
PEHSU Information on Natural Gas Extraction and Hydraulic Fracturing for Health Professionals

The Pediatric Environmental Health Specialty Units (PEHSU) Network encourage families, pediatricians, and communities to work together to ensure that children are protected from exposure to environmental hazards.

Background

Natural gas extraction from shale is a complex process which includes: 1) building access roads, centralized water and flowback holding ponds and of the site itself ; 2) construction of pipe lines and compressor stations; 3) drilling ; 4) hydraulic fracturing; 5) capturing the natural gas; 6) and disposal (or recycling) of, flowback water and drill cuttings.

Hydraulic fracturing, also known as hydrofracking or fracking, uses a combination of water, sand, and chemicals injected into the ground under high pressure to release natural gas. The HF process is also used in some parts of the country for extracting oil. This process has become much more common in the US over the last decade. It was first used for natural gas in Colorado, Wyoming, and Texas. The practice has recently spread into other states, including West Virginia, Pennsylvania, and New York. The figure below is a diagram of the process:



Health Issues

Questions regarding the possible health effects of Natural gas extraction/Hydraulic fracturing (NGE/HF) have been raised about water and air quality. To ensure that children's health is part of the ongoing evaluation of possible human health effects of NGE/HF, the Pediatric Environmental Health Specialty Unit (PEHSU) network, which consists of experts throughout the country dedicated to preventing adverse pediatric health outcomes from environmental causes, developed this fact sheet. A distinct challenge in discussing these possible health effects is the lack of research regarding the human health effects of NGE/HF. Most of the research to date focuses on ecosystem health. Because many questions remain unanswered, the PEHSU network recommends a precautionary approach to toxicants in general and to the NGE/HF process specifically.

Water Contamination

One of the potential routes of exposure to toxics from the NGE/HF process is the contamination of drinking water, including public water supplies and private wells. This can occur when geologic fractures extend into groundwater or from leaks from the natural gas well if it passes through the water table. In addition, drilling fluid, chemical spills, and disposal pit leaks may contaminate surface water supplies. A study conducted in New York and Pennsylvania found that methane contamination of private drinking water wells was associated with proximity to active natural gas drilling. (Osborne SG, et al., 2011). While many of the chemicals used in the drilling and fracking process are proprietary, the list includes benzene, toluene, ethyl benzene, xylene, ethylene glycol, glutaraldehyde and other biocides, hydrochloric acid, and hydrogen treated light petroleum distillates. These substances have a wide spectrum of potential toxic effects on humans ranging from cancer to adverse effects on the reproductive, neurological, and endocrine systems (ATSDR, Colborn T, et al, U.S. EPA 2009).

Air Pollution

Sources of air pollution around a drilling facility include diesel exhaust from the use of machinery and heavy trucks, and fugitive emissions from the drilling and NGE/HF processes. These air pollutants are associated with a spectrum of adverse health outcomes in humans. Increases in particulate matter air pollution, for example, have been linked to respiratory illnesses, wheezing in infants, cardiovascular events, and premature death (Laden F, et al, Lewtas J, Ryan PH, et al, Sacks JD, et al). Since each fracturing event at each well requires up to 2,400 industrial truck trips, residents near the site and along the truck routes may be exposed to increased levels of these air pollutants (New York State DECDMR, 2009).

Volatile organic compounds can escape capture from the wells and combine with nitrogen oxides to produce ground-level ozone (CDPHE 2008, CDPHE 2010). Due to its inflammatory effects on the respiratory tract, ground-level ozone has been linked to asthma exacerbations and respiratory deaths. Elevated ozone levels have been found in rural areas of Wyoming, partially attributed to natural gas drilling in these locations. (Wyoming Department of Environmental Quality, 2010). In an air sampling study from 2005 to 2007 conducted in Colorado, researchers found that air benzene concentrations approached or exceeded health-based standards at sites associated with oil or gas drilling (Garfield County PHD, 2007). Benzene exposure during pregnancy has been associated with neural tube defects (Lupo PJ, et al), decreased birth parameters (Slama R, et al., 2009), and childhood leukemia (Whitworth KW, et al., 2008).

Noise Pollution

Noise pollution from the drilling process and resulting truck traffic has not been optimally evaluated, but since drilling sites have been located in close proximity to housing in many locations, noise from these industrial sources might impact sleep, and that has been associated with negative effects on learning and other aspects of daily living (Stansfeld SA, et al., 2003, WHO 2011).

Special Susceptibility of Children

Children are more vulnerable to environmental hazards. They eat, drink, and breathe more than adults on a pound for pound basis. Research has also shown that children are not able to metabolize some toxicants as well as adults due to immature detoxification processes. Moreover, the fetus and young child are in a critical period of development when toxic exposures can have profound negative effects.

Recommendations

In light of the lack of research investigating the potential adverse human health effects from gas and oil well operations located in close proximity to human habitation, as well as considering the unique vulnerability of children, the PEHSU network recommends the following:

- Continuing the surveillance of water quality, noise levels, and air pollution in areas where NGE/HF sites are located near communities.
- Monitoring the health impacts of persons living in the area, preferably with cohort studies.
- Increasing the awareness of community healthcare providers about the possible health consequences of exposures from the NGE/HF processes, including occupational exposures to workers and the issue of take-home toxics (e.g., clothing and boots contaminated with drilling muds).
- Disclosure of all chemicals used in the drilling and NGE/HF and product dewatering to ensure that acute exposures are handled appropriately and to ensure that surveillance programs are optimized.
- Given the short half-lives of volatile organic compounds and the fact that many of the NGE/HF chemicals have not been disclosed, biologic testing should not be pursued unless there has been a known, direct exposure.
- In addition to the annual testing for coliforms and nitrates recommended by the U.S. EPA and the American Academy of Pediatrics (AAP), the AAP guidance recommends that families with

private drinking water wells in NGE/HF areas should consider testing the wells before drilling begins and on a regular basis thereafter for chloride, sodium, barium, strontium, and VOCs in consultation with their local or state health department.

- As invaluable resources for their local, state, and regional communities, health professionals should advocate for human health effects to be a part of the discussion regarding NGE/HF.

For further information, please contact your regional Pediatric Environmental Health Specialty Unit, available at www.pehsu.net.

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