Preserving Health in the Marcellus Region

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Abstract

Community health nurses (CHNs) have an opportunity and responsibility to address potential environmental health issues related to shale drilling, even in the face of scientific uncertainty. Potential health impacts to air and water quality related to shale drilling are addressed within the context of the CHNs role of educator, case finder, advocate and researcher.

Since 2005, an estimated 5,500 unconventional natural gas wells have been drilled in Pennsylvania's Marcellus Shale (Pennsylvania Department of Environmental Protection [PA DEP], n.d.), resulting in tremendous controversy throughout the state regarding impacts to human health and the environment. Although there are numerous anecdotal reports of illnesses in humans and animals living in drilling areas, there is a notable lack of peer-reviewed research on the impacts. Research efforts are underway to study these issues, including a proposed retrospective study of hospital and clinic data by Geisinger Health System's Weis Center for Research (Begos, 2012). However, CHNs have the opportunity and the responsibility to help address potential environmental health issues related to shale drilling, even in the face of scientific uncertainty. This responsibility is highlighted by the American Nurses Association's (ANA) (2003, p. 2) adoption of the Precautionary Principle, which states that "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."

CHN practice includes the promotion and preservation of health, and the prevention of disease, as well as assisting people in their response to illness (Maurer & Smith, 2009). In Pennsylvania's Marcellus Shale regions, CHNs must assume the critical nursing roles of educator, case finder, advocate and researcher when addressing the health needs in shale drilling communities. Unfortunately, CHNs practicing within these regions may feel unprepared to take on these roles related to unconventional gas extraction. The following discusses these CHN roles in the context of environmental health impacts of shale drilling on air and water quality.

Educator

CHNs are ideally situated to educate clients and communities about potential air and water quality issues related to Marcellus Shale drilling. Air emissions from shale drilling and gas processing include nitrous oxide, particulate matter (PM), sulfur dioxide, methane and volatile organic compounds (VOCs) (Ground Water Protection Council, 2009). Consequently, air quality impacts in shale drilling areas may include increases in ground-level ozone, PM and VOCs from diesel exhaust and gases that escape during the drilling process (Riedl & Diaz-Sanchez, 2005; U.S. Department of Energy, 2011; Witter, 2010). The presence of ground-level ozone is associated with reduced lung function and exacerbations of asthma and emphysema (Chang, Wu, Lee, Lin, Yu & Chen, 2011; U.S. EPA, 2012), while elevated PM is responsible for increased incidences of asthma (Peden, 2002; Tzivian, 2011), as well as car-
diovascular disease (Zanobetti, Baccarelli & Schwartz, 2011), chronic obstructive pulmonary disease (Grigg, 2009), and cancer (Turner, Krewski, Pope, Chen, Gapstur & Thun, 2011). People with preexisting pulmonary disease have a greater risk from effects of air pollution; children are also at greater risk due to their more rapid breathing rate, and developing lungs and immune systems (Suwanwaiphatthana, Ruangdej & Turner-Henson, 2010). When exposed to air pollutants, pregnant women have increased personal health risks as well as an increased risk of pre-term labor and delivering a low birth weight infant (Hackley, Feinstein & Dixon, 2007; Wilhelm, Ghosh, Cockburn, Jerrett & Ritz, 2012).

While there is certainly a need to more fully monitor and understand local impacts on air quality from drilling operations, CHNs can provide education about potential air quality issues. Shale drilling in PA occurs primarily in rural areas and many residents may not be aware of air pollution effects, which most often pose problems in urban environments. The PA Department of Environmental Protection (PA DEP) website (Table 1) provides ambient or outdoor air quality reports for certain pollutants from 38 monitored sites located throughout the state. While these monitored sites may not reflect the ambient air quality of local areas, communities can be educated on how to use the information to monitor trends in their region.

CHNs can encourage self-monitoring by teaching awareness of poor air quality symptoms such as feeling tired or short of breath, which are alleviated when away from the drilling area. Since these symptoms are also indicative of serious illness or disease, residents should be advised to seek medical help for differential diagnoses. For those with asthma, self-monitoring would include use of peak flow meters as recommended (Schantz, 2009).

Another consideration for the CHN is to teach communities that ground-level ozone develops from a chemical interaction between sunlight, nitrogen oxides and VOCs emitted during extraction processes (Riedl & Diaz-Sanchez, 2005; Witter, 2010). Consequently, air quality may be worse on sunny days. Community members with pre-existing pulmonary disease may need to limit outdoor activity on days of poor air quality to reduce the risk of exacerbations (American Lung Association, n.d.). Additionally, children and pregnant women without respiratory disease may need to limit outdoor activity to prevent exposure to air pollutants that can lead to respiratory problems such as asthma (Suwanwaiphatthana et al., 2010). CHNs can work with community members in developing strategies to reduce exposure on days of poor air quality, keeping in mind that indoor air quality can also present pollution hazards such as methane, carbon monoxide and radon. The Southwest Pennsylvania Environmental Health Project (SWPA-EHP)
A primary health hazard is methane migration from active drilling sites to ground water aquifers. In Pennsylvania, Osborn et al. (2011) found the average methane level was 17 times higher for drinking-water wells within a kilometer (approximately 0.6 miles) of drilling sites, compared to the average level for wells in non-drilling sites. High methane in drinking water supplies presents an explosion and asphyxiation hazard in confined spaces when it evaporates (Jackson, Rainey Pearson, Osborn, Warner & Vengosh, 2011). Although the EPA does not currently regulate methane in drinking water, there is a notable lack of research on the health effects of long-term exposure to methane in drinking water. This is troubling considering the potential for extensive methane contamination of ground water by active drilling operations (Jackson et al., 2011).

Methane is only one of the many chemicals of concern. High concentrations of contaminants such as benzene, xylenes, purgeable hydrocarbons, and gasoline and diesel by-products were detected in shallow ground water near drilling sites in Pavillion, WY (DiGiulio, Wilkin & Miller, 2011). Collectively, these chemicals present risks for neurotoxicity, reproductive problems, birth defects and cancer, among others (Agency for Toxic Substances and Disease Registry, 2007a, 2007b, 1999). The EPA determined the most likely cause of the ground water contamination was leaky pits that are used to store drilling wastewater (DiGiulio et al., 2011).

Table 2. Selected strategies to keep indoor air healthy

<table>
<thead>
<tr>
<th>Strategy</th>
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<tbody>
<tr>
<td>Take shoes off before entering the home</td>
</tr>
<tr>
<td>Test home for radon - remediation if above 4 pCi/L</td>
</tr>
<tr>
<td>Have working smoke and carbon monoxide detectors</td>
</tr>
<tr>
<td>Have furnace serviced annually by a professional</td>
</tr>
<tr>
<td>No tobacco smoking in the home</td>
</tr>
<tr>
<td>Reduce mold by fixing leaking pipes and eliminating areas of moisture</td>
</tr>
<tr>
<td>Use non-toxic cleaning products</td>
</tr>
<tr>
<td>Avoid formaldehyde containing products (i.e., furniture &amp; upholstery)</td>
</tr>
<tr>
<td>Dust frequently</td>
</tr>
<tr>
<td>Manage insects and pest with integrated pest management</td>
</tr>
</tbody>
</table>

(n.d.), a nonprofit environmental health organization supporting communities impacted by shale drilling, has a list of common-sense recommendations to reduce harmful indoor pollution (Table 2).

In addition to air quality, CHNs can educate communities about water quality issues specific to shale drilling areas. There are already a host of documented instances in which a community's drinking water has been contaminated, requiring shale drilling companies to provide alternative sources of water for everyday use (Osborn, Vengosh, Warner & Jackson, 2011; PA DEP, 2010). Private wells are of particular concern since these are not regulated by the EPA or the PA DEP. A primary health hazard is methane migration from active drilling sites to ground water aquifers. In Pennsylvania, Osborn et al. (2011) found the average methane level was 17 times higher for drinking-water wells within a kilometer (approximately 0.6 miles) of drilling sites, compared to the average level for wells in non-drilling sites. High methane in drinking water supplies presents an explosion and asphyxiation hazard in confined spaces when it evaporates (Jackson, Rainey Pearson, Osborn, Warner & Vengosh, 2011). Although the EPA does not currently regulate methane in drinking water, there is a notable lack of research on the health effects of long-term exposure to methane in drinking water. This is troubling considering the potential for extensive methane contamination of ground water by active drilling operations (Jackson et al., 2011).

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Surface water contamination has also occurred in shale drilling areas, with releases of treated shale drilling wastewater into major rivers, and accidental spills of wastewater and different types of fluids used in drilling operations. Pollution of rivers and streams primarily affects public water systems (PWSs) that use these to supply communities with drinking water. Although PWSs are regulated at both federal and state levels, standards are currently lacking for some problem chemical constituents such as bromide. Bromide interacts with chlorine, a disinfectant commonly used by PWSs, to produce brominated trihalomethanes (THMs). In 2010, elevated levels of THMs were noted in PWSs using the Allegheny River and various tributaries for drinking water (States et al., 2011). Subsequent research linked these increases with elevated levels of bromide in the river, which were most likely from discharges of treated shale drilling wastewater (States, Cyprych, Stoner, Wydra, Casson & Monnell, 2011). Studies indicate that THMs increase the risk of birth defects, including anencephalus, ventricular septal defect and cleft palate (Hwang, Jaakkola & Guo, 2008; Klotz & Pyrch, 1999).

CHNs have the responsibility to educate communities about health issues related to water quality and the specific problems that can occur related to shale drilling. CHNs can provide resources for community members to learn about potential problems and actions they can take to protect water supplies (Table 1). For those on PWSs, this may entail providing education on the meaning of water quality reports, and information on accessing the PA DEP website for specific PWS monitoring requirements and reports (Table 1). For private well owners, CHNs can provide resources for water testing regarding frequency, state-certified laboratories that perform testing and water quality parameters suggested for private wells in shale drilling areas (Table 1). Since private wells are not regulated, owners are responsible for all water quality testing. Research shows that private well owners in Pennsylvania are often unaware of water quality issues and recommended annual testing regimes (Clemens, Swistock & Sharpe, 2009), indicating the need for CHNs to provide this type of information in drilling and non-drilling areas.

Under the Pennsylvania Oil and Gas Act 13 of 2012, Section 3218, PWSs and private well owners must report contamination of water supplies by shale drill-
ing within one year of drilling companies completing their operations. As noted in the resources in Table 1, this will require testing on a more frequent basis for contaminants such as methane, which are not typically included in water quality tests. Although private well owners should test their water annually, testing recommendations for shale drilling areas in Marcellus regions are at 3 months, 6 months, and 12 months with each gas well drilled (New York State Department of Environmental Conservation, 2011); testing should also be performed with noted physical changes in water quality. CHNs must emphasize the need for water testing, since contamination may exist but not be apparent through changes in water appearance and odor. Although the law states that contaminated water wells within 2,500 feet of drilling operations are presumed to have been polluted by shale drilling, water quality testing is highly recommended before shale drilling begins, to establish a baseline of water quality for that well. The PA DEP has initiated a system for homeowners to sign up for electronic notification of shale drilling permits obtained in their area, and has instructed homeowners to notify their regional PA DEP office for water contamination issues (Table 1).

Case Finder

CHN practice includes public health principles of case finding, screening and surveillance (Truglio-Londrigan & Lewenson, 2011). Case finding occurs when CHNs identify community members who are experiencing symptoms that might be associated with exposure to contaminated air or water from shale drilling (Maurer & Smith, 2009). An important tool for the CHN’s work in surveillance and case finding is a thorough assessment that includes environmental exposures. The Alliance of Nurses for Healthy Environments website (EnviRN.org) offers two simple tools, one for the home and the other for the community, that could easily be integrated into an assessment or intake interview to determine community members exposure risk (Table 3). Additionally, it is important for CHNs to determine the proximity of individuals, families or communities to shale drilling sites, the source of drinking water (municipal, private well or purchased bottled water), and water for cooking and bathing. CHNs must also assess any unusual symptoms and changes in health that may relate to air and water contamination.

In Pennsylvania’s shale drilling areas, there have been anecdotal reports of some people experiencing metallic tastes in their mouths, headaches, nose bleeds, nausea, fainting (National Public Radio [NPR], 2012), stomach pains and fatigue (Griswold, 2011). In other areas of the U.S. where shale drilling is taking place there have been anecdotal reports of odors of rotten eggs, nail polish and sulfur, and people experiencing symptoms of headaches, burning eyes, rashes, high blood pressure, fatigue and memory loss (Griswold, 2011). CHNs should attempt to reduce the risk by recommending that affected persons leave the area when possible, arrange for evaluation by a health care provider and report the exposure. CHNs should record the described symptoms and predisposing factors or potential causes of the symptoms. Furthermore, according to the Pennsylvania Oil and Gas Act 13 of 2012, health care professionals such as CHNs may request the names of proprietary chemicals used in drilling operations, for purposes of diagnosis or treatment of a health problem related to shale drilling. By obtaining the chemical components used in drilling operations, the CHN may identify exposures.

It is also important that the CHN notify the PA Department of Health (DOH) when there are suspected health problems that might be related to shale drilling. Reporting suspected problems will assure that the PA DOH is aware of problems in the state and will alert DOH officials to further investigate health issues that may be associated with shale drilling as part of their state-wide surveillance responsibilities. The PA DOH number is 877-PA-HEALTH (877-724-3258). CHNs can participate in screening by encouraging community

| Table 3. Professional resources for environmental health in community health nursing |
| Alliance of Nurses for Health Environments (ANHE) | http://enviRN.org |
| | Research Workgroup http://envirn.org/pg/groups/4105/anhe-research-work-group/ |
| PA State Nurses Association | http://psna.org/ |
| | Environmental Health Committee http://psna.org/take-action/environmental-health/ |
| | Contact us at GreenRNs@panurses.org |
members who are experiencing symptoms of toxicity to be tested for exposures, and by collecting samples of urine or blood, when ordered, for laboratory analysis for potential contaminants.

**Advocate**

CHNs in shale drilling communities can engage in advocacy on the local, state and national levels. Advocacy includes representing the health interests of communities by educating policymakers through letters, phone calls and face-to-face meetings, as well as serving on regulatory boards. CHNs should keep in mind the importance of involving all stakeholders including community members and leaders, health care providers, and representatives from the oil and natural gas industry.

One area that requires advocacy at the local level is air quality. Air quality monitoring is often lacking in rural areas where shale drilling is predominately taking place. The need for this type of continued monitoring was recommended in the Governor's Marcellus Shale Advisory Commission Report (2011). CHNs in shale drilling communities should work with the PA DEP, local governments, and oil and gas companies to place air quality monitors at appropriate sites, to accurately monitor and evaluate trends. Air quality monitoring should include testing for gases typically emitted in shale drilling processes. This would enable community members to make informed choices regarding outdoor activities and determine if additional health protective measures are warranted. The PA DEP (2011) announced that the agency would collect the state's air emissions from shale drilling and natural gas processing as part of its 2012 report to the EPA. These reports will provide more information on potential air quality impacts and guide CHNs in advocacy efforts.

At the state level, CHNs can serve as members of state boards and commissions to represent the community health perspective within the shale drilling region. The current lack of representation of health care professionals in shale drilling policy making was noted by the composition of the 31-member Marcellus Shale advisory commission, formed in 2011. Although the Commission was comprised representatives from academia, environmental organizations, government and industry, there was no representation from the public health sector (Goldstein, Kriesky & Pavliakova, 2012). No doubt, CHNs working in shale drilling communities would have provided valuable insight to the Commission on the health impacts communities are potentially experiencing. CHNs can still make their voices heard by speaking to state organizations and legislators to advocate for safe water and clean air in shale drilling communities. CHNs bring a unique perspective to the policy arena of the potential environmental impacts on the health of communities.

Another air quality issue related to shale drilling is the emission of methane, a potent greenhouse gas that contributes to climate change. Released within the first days to weeks with the back flow of fluids (U.S. Environmental Protection Agency [EPA], 2010), methane emissions from shale drilling have been noted to be 22 percent to 45 percent greater than for conventional gas extraction (Howarth, Santoro & Ingraffea, 2011). Methane also leaks from natural gas pipelines during transport to consumers. Public health threats related to climate change, which is partly a function of continued greenhouse gas releases, are forecast to be one of the most important global health concerns for the 21st century. CHNs, as well as nurses in other health care settings, should educate local, state and national policymakers of the impact greenhouse gases have on the health of communities. On the national level, nurses should advocate for and support the Clean Air Act and legislation that reduces greenhouse gas emissions. Professional organizations such as the Pennsylvania State Nurses Association (PSNA) and Alliance of Nurses for Healthy Environments (ANHE) have participated in advocacy related to shale drilling and related issues of air quality and climate change. These organizations can offer assistance, guidance and support in advocacy efforts (Table 3).

**Researcher**

Many practicing nurses may not consider themselves researchers, but, in fact, nurses consistently collect and analyze data in their practice. CHNs need to consider how their work translates into developing evidence-based strategies that protect the health of communities. In shale drilling areas, CHNs can use individual and community assessment data to develop educational programs that reduce or prevent the risk of environmental exposures, such as air and water contamination, and engage in further research by studying the effectiveness of the educational programs. One way to evaluate the health impact of educational or policy changes is by measuring health care provider or emergency department (ED) visits before and after the change is initiated. For example, CHNs could collaborate with other health care professionals and specialists to compare air quality measures to changes in asthma-related ED visits. Of course, any formal research study that includes human health data or human participants must have the appropriate informed consent and Institutional Review Board approval. Ongoing assessment and evaluation of community members'
health can determine effectiveness of interventions, and is an accepted method of public health research (Smith, 2010).

Additionally, CHNs should make use of opportunities to communicate assessment and evaluation data through presentations and publication. Since shale drilling is relatively new in Pennsylvania, CHNs must share community-nursing strategies that have been effective through professional presentations or publications. By formally sharing their research and successful strategies with others, CHNs are able to extend their efforts to promote and preserve health to other communities, thus extending their advocacy for community health.

ANHE has an active research workgroup and provides a list of members’ research interests and experience on their website. Additionally, Penn State University and the University of Pittsburgh, School of Public Health are both actively engaged in Marcellus Shale research. As reported earlier, Geisinger Health System’s Weis Center for Research announced they would be using their vast electronic medical record system to investigate longitudinal health effects in the Marcellus region (Begos, 2012). CHNs may seek opportunities to work with these or other investigators to facilitate data collection and analysis, and develop interventions to reduce environmental risks.

Conclusion

Working to protect communities from potential environmental risks in shale drilling areas may seem an overwhelming task. However, CHNs have the skills to educate community members and policymakers about risk and protective actions, monitor for cases of illness, advocate for policies that promote health, and develop evidence-based risk reduction strategies to support healthy communities. CHNs should not feel alone in this process but should collaborate with other community stakeholders and official state agencies. By relying on existing knowledge of environmental risks of shale drilling within the context of the precautionary principle, the nurse may participate in reducing health risks, and thus, promote and preserve community health.

References


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**Questions**

1. Outdoor air quality reports can be found at the following website:
   a. ☐ Department of Energy
   b. ☐ Environmental Protection Agency
   c. ☐ Alliance of Nurses for Health Environments
   d. ☐ Health and Human Services

2. Diesel truck emissions affect air quality by increasing:
   a. ☐ Carbon dioxide
   b. ☐ Nitrous oxide
   c. ☐ Particulate matter
   d. ☐ Sulfur Dioxide

3. To reduce ground-level ozone exposure, the nurse should teach community members to limit time outdoors on days that are:
   a. ☐ Sunny
   b. ☐ Windy
   c. ☐ Cloudy
   d. ☐ Rainy

4. A nurse can participate in case finding by:
   a. ☐ Reducing risk of water exposure
   b. ☐ Teaching community members about air quality monitoring
   c. ☐ Speaking to legislators about policies that support health
   d. ☐ Identifying individuals who are experiencing health symptoms

5. In active natural gas drilling areas, private drinking water wells should be tested:
   a. ☐ Only prior to drilling the gas well
   b. ☐ Prior to each drilling of the gas well and at 3, 6 and 12 months
   c. ☐ Prior to each drilling of the gas well and at 3, 6, and 12 months. If no problems then renew annual testing
   d. ☐ Prior to each drilling the gas well and once drilling is complete

6. The risk of water contamination is related to:
   a. ☐ Proximity to shale drilling operations
   b. ☐ Methane migration from shale drilling operations
   c. ☐ Formation of THM with chlorinated water
   d. ☐ All of the above

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**Objectives**

Upon completion of this CE, please rate your achievements of the following objective questions (1 - lowest, 5 - highest).

Objective 1: The reader will be able to identify resources to reduce environmental hazards.

1 2 3 4 5

Objective 2: The reader will be able to discuss the community health nurse's role in the Marcellus Share region of PA.

1 2 3 4 5
7. What contaminate has been found in private well water in Pennsylvania's shale drilling areas?
   a. Ozone
   b. Methane
   c. VOCs
   d. Hydrogen

8. The CHN could advocate for a community's health by
   a. Identifying air exposures
   b. Community surveillance of private wells
   c. Serving on regulatory boards
   d. Purchasing natural gas

9. The CHN could participate in research by:
   a. Serving on a regulatory board
   b. Assessing and evaluating a nursing intervention
   c. Writing a letter to a legislator
   d. Teaching community members to stay indoors on sunny days

10. An organization with advocacy experience and an advocacy resource for the CHN is:
    a. PA Department of Health
    b. PA Department of Environmental Protection
    c. PA Department of Education
    d. PA State Nurses Association

11. Indoor air can be improved by:
    a. Not wearing shoes in the home
    b. Remediating for radon if level is above 4 pCi/L
    c. Fixing leaks and eliminating areas of moisture
    d. All of the above

12. Who is responsible for testing the water quality of private drinking water wells?
    a. The gas drilling companies
    b. The owner of the private drinking water well
    c. The local municipality
    d. The PA Department of Environmental Protection

11. How long did this article take you to read?
    a. 20-40 minutes
    b. 40-50 minutes
    c. 50-60 minutes
    d. > 60 minutes

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    a. 10-20 minutes
    b. 20-30 minutes
    c. 30-40 minutes
    d. > 40 minutes

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