

Incorporating Environmental Health into Nursing Practice: A Case Study on Indoor Air Quality

Glenda Barnes, Barbara Fisher, Julie Postma, Kelly Harnish, Patricia Butterfield, Wade Hill

Nurses play a critical role in reducing exposures to environmental risks. In any practice setting, nurses can improve children's environmental health by providing risk assessments, environmental health education, and referrals to community health nurses and environmental health specialists. By asking patients about environmental exposures and related risk factors, nurses may reduce incorrect diagnoses and issuance of unnecessary tests (Walker, 2005). Environmental assessments also provide an opportunity for discussion about environmental risk reduction education and prevention strategies (Paranzino, Butterfield, Nastoff, & Ranger, 2005). Nurses who conduct home visits are uniquely positioned to provide a thorough environmental home assessment and immediately offer risk reduction measures to families. Evaluating environmental risks also ensures that appropriate referrals are made and resources are obtained from local community agencies.

More than one-quarter of the global disease burden is attributable to environmental exposures, with children bearing a disproportionate amount of risk. Physiologically and behaviorally, children have unique characteristics that make them vulnerable to environmental contaminants. In particular, indoor environmental exposures, such as carbon monoxide, mold, and radon, have an impact on children's health and well being. A case study based on the experiences of nurses working on the Environmental Risk Reduction through Nursing Intervention and Education study is presented to illustrate multiple exposures children may face in the home environment and the role nurses play in prevention and response. Nurses can improve children's environmental health by providing risk assessments, environmental health education, and referrals to community health nurses and environmental health specialists. Resources on indoor air quality and maintaining a healthy home are provided.

This article describes the Environmental Risk Reduction through Nursing Intervention and Education (ERRNIE) study and provides an overview of children's unique vulnerabilities to environmental exposures. A case study illustrates environmental exposures families may face in their homes and the role nurses play in responding to these environmental risks. Nurses in all settings can contribute to protecting children by arming themselves with information and resources, assessing risk, providing risk reduction measures and environmental health education, and referring patients to appropriate professionals and agencies.

Environmental Risk Reduction through Nursing Intervention and Education (ERRNIE)

Although some nurses can gain experience in environmental health through their practice settings (such as in public health departments, schools), others receive limited information about this area of nursing practice. One way the authors' research team, composed of nurse researchers, public health nurses, environmental health specialists, and local research coordinators, has been able to address environmental health risks has been through participation in a

Glenda Barnes, BSN, RN, was a Public Health Nurse, Gallatin City County Health Department, Bozeman, MT, and a Nurse Liaison to the Environmental Risk Reduction through Nursing Intervention and Education Study, Montana State University, College of Nursing, Bozeman, MT, at the time this article was written.

Barbara Fisher, MS, was the Washington Research Coordinator, the Environmental Risk Reduction through Nursing Intervention and Education Study, Washington State University College of Nursing, Spokane, WA, at the time this article was written.

Julie Postma, PhD, RN, is an Assistant Professor at Washington State University College of Nursing, Spokane, WA, and was a Research Associate, the Environmental Risk Reduction through Nursing Intervention and Education Study, Spokane, WA, at the time this article was written.

Kelly Harnish, BS, CHES, was the Montana Research Coordinator, the Environmental Risk Reduction through Nursing Intervention and Education Study, Montana State University College of Nursing, Bozeman, MT, at the time this article was written.

Patricia Butterfield, PhD, RN, FAAN, is Dean of the Washington State University College of Nursing, Spokane, WA, and Principal Investigator, the Environmental Risk Reduction through Nursing Intervention and Education Study, Spokane, WA.

Wade Hill, PhD, PHCNS-BC, is an Associate Professor and Co-Investigator, the Environmental Risk Reduction through Nursing Intervention and Education Study, Montana State University, College of Nursing, Bozeman, MT.

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longitudinal study aimed at testing the impact of public health nursing actions on children's environmental health risks. The ERRNIE study is a four-year study designed to 1) determine the prevalence of multiple environmental exposures (such as well water contaminants, radon, carbon monoxide, moisture/mold, environmental tobacco smoke, lead) among rural children in two western counties in the U.S., 2) deliver and evaluate the effectiveness of public health nurse-delivered environmental risk reduction intervention to rural households, and 3) evaluate the capacity and needs of nurses to integrate environmental health into their practice. To address household environmental risks, the study capitalizes on the existing public health infrastructure serving at-risk populations through programs, such as Women, Infants, and Children (WIC), immunization clinics, public health nurse home visiting programs, and Head Start.

Nurses in this study work with families to reduce risks to a variety of biologic and chemical risks. Prior to each home visit, the nurse reviews test results from the family's home (well water contaminants, radon, carbon monoxide, moisture) and children (salivary cotinine, blood lead) to build an action plan for the home visit. The nurses conduct four home visits, with each visit focusing on different risks in the home and steps the family can take to reduce their children's risk to the agents of concern. In contrast to many public health programs that focus on either a single agent (radon) or a single disease (asthma), this study addresses exposures to multiple environmental toxins that children may realistically encounter within the home.

The study is conceptually based on the World Health Organization's Multiple Exposure-Multiple Effect (MEME) model; this framework serves as a guide for the nursing assessment and intervention process. The MEME model suggests that environmental exposures occur distally and proximally within social, demographic, and economic contexts (Briggs, 2003). The most distal exposures are those from the ambient environment, such as mining operations, which can deposit contaminants into ground water or release toxic fumes into the air. The most proximal exposures are in the home environment, such as appliances that leak high levels of carbon monoxide or damp home materials that harbor molds. The ERRNIE study focuses on exposures to chil-

ren within the home. By testing for multiple exposures within the home and providing risk reduction information guided by findings of actual and potential risks, the ERRNIE study anticipates being able to influence families to adopt risk-reduction behaviors. By working in the most proximal environment where environmental exposures occur, the intervention has greater specificity in addressing risks tailored to each family's needs.

Background and Significance

More than one-quarter of the global disease burden is attributable to environmental exposures, with children bearing a disproportional amount of risk (Smith, Corvalan, & Kjellström 1999). Although children in North America are less likely to be exposed to agents that pose an immediate threat to their survival, these exposures may pose risks to health later in life. For example, Landrigan, Schechter, Lipton, Fahs, and Schwartz (2002) estimated the contribution of environmental pollutants to the incidence, prevalence, mortality, and costs of four pediatric diseases in American children. They calculated the environmentally attributable fraction (the percentage of a disease category that would be eliminated if environmental risk factors were reduced to their lowest feasible levels) as 100% for lead poisoning, 30% for asthma, 5% for cancer, and 10% for neurobehavioral disorders. Total costs to society (direct medical costs and indirect societal costs, such as lost work days) were estimated to range from 48.8 billion to 64.8 billion dollars. These estimates highlight the significance of environmental exposures as contributing factors in children's disease processes (Landrigan et al., 2002).

Children's Unique Vulnerabilities

Physiologically and behaviorally, children have unique characteristics that make them particularly vulnerable to environmental contaminants. Environmental exposures occur through a number of routes, including inhalation, ingestion, and transdermal absorption. Relative to their size, children breathe more air, eat more food, and drink more water than adults. They may also breast feed, which exposes them to higher concentrations of some toxicants

(such as polychlorinated biphenyls or PCBs) than would typically be ingested. For example, Lorber and Phillips (2002) found that "over a lifetime, breastfeeding is predicted to result in an accumulated exposure [of polychlorinated biphenyls - PCBs] that is 3% to 18% higher than that of a formula-fed infant, depending on the duration of breastfeeding" (p. A325). Behaviorally, children spend more time on the floor and are explorers, placing multiple inedible objects in their mouths. For these reasons, they are disproportionately exposed to environmental toxins compared to adults.

Risk is not just a function of exposure; it is also influenced by the ability of the body to detoxify toxins. Physiologically, children are more susceptible to the harmful effects of environmental toxins than adults because the systems used to detoxify contaminants are still maturing. Likewise, developing organs such as the brain have "critical periods" of vulnerability to toxicants during gestational development. Although poorly understood, gene-environment interactions contribute to individual vulnerability in developmental responses to environmental exposures (Faustman, Silbernagel, Fenske, Burbacher, & Ponce, 2000).

Environmental quality in the home has a significant impact on children's health and well being (Wu & Takaro, 2007). For example, reports by the Institute of Medicine (IOM) suggest that indoor air pollutants may lead to the development and/or exacerbation of a variety of diseases and symptoms, including allergies, asthma, infection, hypersensitivity pneumonitis, inhalation fevers, mucosal irritation, central nervous system effects, psychologic effects, dermatitis, and some forms of cancer (IOM, 2000, 2004). According to two North American surveys, children aged 11 to 17 years spend between 61% and 67% of their time indoors at home. Children younger than 11 years of age spend about 70% of their time indoors at home (Leech, Nelson, Burnett, Aaron, & Raizenne, 2002). In keeping with the importance of children's exposures in home environments, a case study based on nurse experiences in the ERRNIE study will be used to illustrate multiple exposures families may face and the role that nurses in multiple practice settings play in response. Because preliminary study data demonstrated that radon and moisture are the most prevalent abnormal exposures among

the families in the study (Butterfield et al., 2007), and because carbon monoxide is the most acute and deadly exposure addressed, these three exposures will be highlighted in the case study.

Case Study on Indoor Air Quality

Assessment

Mrs. Jones presents at a community health clinic with her two children, ages 18 months and 4 years old. Her complaints to the clinic nurse are that both her children have not been as active as usual, have been coughing a lot lately, and have had runny noses for "quite some time." The 4-year-old child has been complaining of an upset stomach. Neither child has any history of chronic illnesses, and both demonstrate normal development for their age. Mrs. Jones reports her family just moved into an older rented home a couple of months ago, and the children have not been as healthy as before their move.

After the children are assessed by the pediatric nurse practitioner, she and the clinic nurse generate a referral for the Jones family to the local public health department. They explain to Mrs. Jones that a home visiting community health nurse can schedule an appointment with her to complete an environment health assessment in her home. The referral includes:

- Physical assessment findings for both children that included normal GI, normal oximeter readings, increased respiratory rates in both children, rhinitis in the youngest, and non-productive cough in the oldest.
- Mrs. Jones' and her 4-year-old son's subjective information.
- Metabolic profiles drawn for both children, results of which are pending.
- Negative results for both children's rapid strep tests.
- A request for an environmental assessment in the home.
- A request for a report back to the clinic within five working days.

Lucy, one of the home visiting nurses, schedules an appointment with Mrs. Jones for the following week. Armed with her beloved "Green Book" (American Academy of Pediatrics [AAP] *Pediatric Environmental Health*), Lucy greets Mrs. Jones at her door. When Lucy first enters the home, she recognizes the faint scent of rotten eggs. Knowing that the local

fuel company is required to add a "smell" to natural gas to help homeowners identify gas leaks, she asks Mrs. Jones how each family member is feeling, for fear of a carbon monoxide (CO) leak. Mrs. Jones reports "no changes in the children," but that she has noticed she has had a headache since the clinic visit. Lucy asks if any of the home appliances are fueled by gas. Mrs. Jones states her furnace and water heater use natural gas. Lucy assesses whether a carbon monoxide detector is installed in their home. Mrs. Jones reports she has a carbon monoxide detector but has not installed it because she does not know where it should be placed. Lucy asks Mrs. Jones if she has an attached garage to the home. Mrs. Jones states, "Yes, and when it is cold, like today, I open the garage door first while the car warms up."

Due to the acute and potentially deadly nature of CO, Lucy and Mrs. Jones immediately call the local fire department to have CO readings taken near each gas appliance and in the ambient air. The fire department staff comes immediately, performs the testing, and informs Mrs. Jones that her furnace is leaking gas and to turn it off until proper maintenance is completed. She complies, and doors and windows are opened to ventilate the home. Subsequent CO readings are taken until the level is zero. Lucy instructs her to place her CO detector on a wall 10 inches below the ceiling in front of the children's rooms and shares with Mrs. Jones that CO fumes could also be drafted into their home if she continues to warm her car up in the garage, even with the garage door open. With the current crisis abated, they continue the home visit.

As they walk-through the home, Lucy hears and then locates a leaky faucet that is dripping into the sink in the children's bathroom. She wonders if water might be dripping under the sink as well. Upon opening the safety latches to the cabinet, both Mrs. Jones and Lucy identify leaky plumbing with a resultant damp wall that has visible mold growing along the cabinet floor. Mrs. Jones states she has not looked under the sink since she moved in and has been hoping that her landlord would repair the leaking faucet soon.

When Mrs. Jones and her children take the nurse to the basement to show her where the children sleep, she notices the cement floor has several unsealed cracks in it. The nurse asks Mrs. Jones if she has tested her home for radon or if she has had any

discussions with her new neighbors about radon. Mrs. Jones states she has not had her home tested but that a neighbor recently mentioned having a radon ventilation system placed in her basement. Mrs. Jones could not state what radon was or why some homes are tested for it.

Mrs. Jones thanks Lucy and welcomes her to sit at her kitchen table to summarize their findings. Together they develop an action plan to address some of the suspected potential triggers that may be contributing to her headache and her children's symptoms.

Action Plan

Carbon monoxide. Now that the fire department has tested the CO levels, located the faulty furnace, and ventilated the home until CO levels were zero, Lucy takes the time to explain to Mrs. Jones that when a gas-fueled appliance, furnace, or even a wood fireplace is not functioning correctly, complete combustion may not occur, so excess CO develops. When breathed in, CO robs the body of oxygen. The initial symptoms of CO poisoning are similar to the flu, but without the fever. Symptoms may also include headaches, tiredness, shortness of breath, nausea, and dizziness. Lucy reiterates that if a CO leak is suspected, to go outside immediately and call the business that supplies gas to the home or the local fire department, just as they had done. Mrs. Jones and Lucy reviewed the symptoms of the family. Together they questioned if the CO leak from the furnace might have explained the children's increased fatigue, her son's upset stomach, and her headache.

Mold. Lucy tells Mrs. Jones that her children's runny noses and coughs could be a result of breathing in mold spores. She explains that children and adults can be exposed to mold by breathing in spores growing on floors, walls, and other hard surfaces; inhaling mold in dust or from blowing humidifiers, air conditioners, and forced-air heating systems; and ingesting mold by transferring it from hands to mouth. Lucy explains that exposure to mold can cause runny noses, headaches, fatigue, sore throats, coughing, wheezing, breathlessness, chest tightness, and allergy symptoms. Mrs. Jones states she will have her husband repair the leaking faucet in the bathroom. Lucy advises Mrs. Jones that she can kill the mold using a 10% bleach-to-water solution to clean the surface. Mrs. Jones is reminded to wear gloves and a face

Table 1.
Summary of Indoor Air Quality Case Study

| Contaminants of Concern | Potentially Related Symptoms | Assessment Findings | Action Plan | Education | Follow Up |
|-------------------------|--------------------------------------|--|--|---|--|
| Carbon monoxide (CO) | Fatigue Upset stomach Headache | Furnace leak | Fire department tested CO levels Ventilate Furnace repair | Sources and health effects of CO Importance of CO detector | Furnace repaired CO detector placed Behavior change |
| Mold | Runny noses Cough Headache | Faucet leak and poor plumbing with resultant mold growth | Fix faucet Clean mold growth with 1:10 bleach: water solution | Sources and health effects of mold Resources for professional assistance | Faucet fixed Mold cleaned up |
| Radon | None | Home in radon zone Unsealed cracks in concrete floor | Place 2-day radon kit | Sources and health effects of radon Referral information | Possible long-term kit needed Remediation Move children's bedrooms |

mask, and to never vacuum mold because that could spread the spores and facilitate mold growth. She encourages Mrs. Jones by telling her the symptoms her children are experiencing may improve when the mold is removed. Lucy also encourages Mrs. Jones to call the local environmental health department to ask for resources should she identify more extensive mold growth in her home. Contact information is given for the environmental health department in the event that Mrs. Jones needs to have mold growth professionally assessed and removed.

Radon. Lucy explains that radon exposure is greater in basements. Because she sees there are some cracks in the floor where her children sleep, it would be wise to assess the basement for radon gas. She explains that radon gas is naturally occurring, odorless, and tasteless. It is formed from the radioactive decay of uranium, which is found in small amounts in most rocks and soil, but more so in the part of the country where they live. It is found in low levels in outdoor air and can be found in higher levels indoors. There is an increased risk for lung cancer with continued exposure, but no symptoms are associated with acute exposure. Lucy helps the family place a two-day radon test kit in their basement, instructing Mrs. Jones to write an end date on the enclosed information sheet when she mails it after 48 hours. Lucy adds that if the radon gas level is identified as greater than 4 picocuries per liter (pCi/L), she will recommend a long-term (90-day) radon test for

confirmation, refer Mrs. Jones to the local health department, and suggest the children not sleep in the basement until remediation is complete.

Lucy gives several resources to Mrs. Jones to refer to and share with her husband while they follow through with the shared action plan. These include the following publications: a) *Protect Your Family and Yourself from Carbon Monoxide Poisoning* (Environmental Protection Agency [EPA], 2005), b) *A Brief Guide to Mold, Moisture, and Your Home* (EPA, 2002), c) *A Citizen's Guide to Radon: The Guide to Protecting Yourself and Your Family from Radon* (EPA, 2007a), d) *Buying a New Home: How to Protect Your Family from Radon* (EPA, 1998), e) *A Radon Guide for Tenants* (EPA, 1996), and f) *The Inside Story: A Guide to Indoor Air Quality* (EPA, 2007b).

A follow-up home visit is scheduled for the following week. Lucy sends a letter to the referring pediatric nurse practitioner and calls the referring clinic nurse with information about the Jones' home assessment findings, which include the CO leak from the furnace, the mold growth in the bathroom due to the leaky faucet, and the unsealed cracks in the basement floor. She shares with the nurses that the fire department was called and education was provided to Mrs. Jones regarding recognizing CO poisoning, placing a CO detector, preventing and cleaning up mold growth, testing for radon, and the potential need to move the children from the basement until the radon issue is resolved (see Table 1). Lucy offers to provide the same handouts

and resources that she gave to the family to the clinic.

Follow Up

At the follow-up home visit, Lucy learns that the landlord had contacted a professional furnace repairman to inspect the heating system. After the furnace had been repaired, the CO readings were reportedly 0 ppm in all areas tested. The CO detector had been placed 10 inches below the ceiling on the wall outside the children's bedroom. Mrs. Jones reports she is no longer warming her car up in the garage. Lucy's husband fixed the leaky faucet, and the mold had been removed from under the sink with the recommended bleach solution. The 48-hour radon test result came back at 12.6 pCi/L. When hearing this, Mrs. Jones proudly shared that she had moved the children upstairs to sleep as a precautionary measure. After checking to see if the family had informed the landlord of the result, Lucy referred the family to the health department who could help them make an appointment with a radon expert about sealing and/or venting the basement. Mrs. Jones was happy to report that the children's cough and runny noses had resolved, her son no longer complains of an upset stomach, they are "as active as ever," and she no longer has a headache.

Discussion

Using her assessment and observational skills, the case study nurse identified three potential environmental exposures the children were

or might be exposed to: carbon monoxide, mold, and radon gas.

Carbon Monoxide

CO is an odorless, colorless gas that forms from incomplete carbon combustion. Any fuel-burning appliance that is inadequately vented or maintained can be a source of CO. Upon entering the home, the nurse smelled the scent of rotten eggs, indicating that the likely source of CO exposure was from a gas leak somewhere in the home. Because propane and natural gas are both odorless and tasteless, mercaptain is added before distribution to give the gases a distinct unpleasant smell (such as rotten eggs) so that a leak can be detected. It is important to note, however, that the presence of CO will not be indicated by an odor if the source of CO is incomplete combustion from a wood or pellet-burning stove/fireplace or kerosene heater.

The home visiting nurse assisted Mrs. Jones in properly placing a CO detector outside her children's bedrooms. A CO detector that meets the Underwriters Laboratory Standard 2034 may be used as a method for detecting CO in an indoor environment. However, CO detector performance varies, and no detector is 100% reliable. Having a CO detector is not a solution, but rather, a back-up to properly using, maintaining, servicing, and ventilating CO producing appliances (AAP Committee on Environmental Health, 2003a).

Health implications. Carbon monoxide is dangerous because of its attraction to hemoglobin in the bloodstream (Rosenthal, 2006). When inhaled, CO replaces oxygen required by cells to function. CO rapidly accumulates in the blood, causing symptoms similar to the flu, such as headaches, dizzy spells, fatigue, nausea, confusion, and irritability. As levels increase, vomiting, loss of consciousness, and eventually brain damage or death can result.

Assessment. A simple set of questions asked in either a clinical or home setting can help a nurse determine if CO poisoning is a potential risk (AAP Committee on Environmental Health, 2003b; EPA, 1994). The following are some examples:

- Do you have any gas appliances in your home (such as a range, furnace, hot water heater, dryer)? If so, are they vented to the outside and have they been serviced according to the manufacturer's recommendations to keep them in good working condition?

- Have you ever smelled a rotten egg scent in the home (possibly indicating a gas leak)?
- Does your home have an attached garage or workshop? Do you warm your car up in the garage or any attached dwelling?
- Do you ever use a propane or kerosene heater, generator, oven, or a camp stove inside the home? Do you ever use your gas oven or range as a heating source?
- Do you ever burn charcoal indoors in a hibachi, grill, or fireplace?
- Are family members complaining of nausea, fatigue, watery eyes, headache, coughing, or other flu-like symptoms?
- Do you have a CO detector? Is it installed? Where? Are batteries charging the monitor?

Mold

Molds are ubiquitous in the outdoor environment and can enter the home through doorways, windows, and heating and ventilation systems. Molds flourish in indoor environments that contain excess moisture (Centers for Disease Control and Prevention [CDC] & U.S. Department of Housing and Urban Development [USDHUD], 2006). Excessive indoor moisture can be produced by inadequate heating; poor air circulation; moisture permeating basements, walls, and floors; venting clothes dryers indoors; and poor ventilation when bathing or boiling water. Leaky roofs, walls, or windows create mold-friendly conditions, as do potted plants and stagnant water in appliances (dehumidifiers, dishwashers, refrigerator drip pans). Older, substandard housing can be particularly prone to mold problems because of inadequate maintenance (inadequate insulation, lack of air conditioning, poor heating) (CDC & USDHUD, 2006). New "airtight" homes can also be a problem if they are poorly ventilated.

Health implications. Children may be exposed to mold by inhaling contaminated air or by touching surfaces where mold spores are deposited. Exposure to mold may affect the mucous membranes of the eyes, nose, throat, and respiratory tract, and symptoms may be more prevalent among individuals suffering from allergies and asthma (EPA, 2002). Symptoms of reaction to mold include rhinitis, sneezing, eye irritation, and coughing and wheezing (EPA, 2002). A few uncommon molds produce potent mycotoxins that may produce a more toxic effect, especially to infants.

Because of the potential severity of diseases associated with mycotoxin exposure in infants, the AAP recommends that infants under 1 year of age not be exposed at all to chronically moldy, water-damaged environments (AAP Committee on Environmental Health, 1998).

Assessment. The nurse in the case study discovered that a leaky faucet and poor plumbing in the children's bathroom had created an environment for mold growth, and mold was present inside the cabinet. A musty smell or visual observation can help identify areas where mold growth exists. Where access is limited or impractical, or in the case of a clinical setting, the following risk assessment questions may assist in identifying if moisture is an issue in the household (AAP Committee on Environmental Health, 2003b).

- Is there a musty smell detected anywhere in the home? Any visual observation of water damage or stains or mold growing on surfaces inside the home?
- Has the home had any water damage inside or out? Any history of flooding or leaking plumbing or faucets?
- Are windows sealed? Does condensation form on the inside of windows?
- Is the home adequately insulated and heated?
- Are bathroom and kitchen fans used when bathing and cooking? Are they vented to the outside? Is the clothes dryer vented to the outside?
- If the family uses a humidifier, is it cleaned regularly and appropriately?

Radon

Radon is a colorless, odorless gas that occurs naturally in soil and rock, and is a decay product of uranium (EPA, 2007a). Some areas of the United States have higher levels of naturally occurring radon gas than others, and homes built in these areas are at greater risk of high levels of indoor radon (EPA, 2008). Radon gas can enter homes through cracks in the foundations or through porous building materials, and homes with basements are at greater risk of having higher levels of radon.

Health implications. Radon does not have any short-term, acute health effects; rather, radon is a known carcinogen, and long-term exposure leads to lung cancer. Radon is the second-leading cause of lung cancer after smoking, and the leading cause of

Table 2.
Indoor Air Quality Resources

| Name | Source | Description |
|--|--|---|
| Agency for Toxic Substances and Disease Registry (ATSDR):Case Studies in Environmental Medicine | http://www.atsdr.cdc.gov/csem/csem.html | The Case Studies in Environmental Medicine (CSEM) is a series of self-instructional publications designed to increase the primary care provider's knowledge of hazardous substances in the environment and to aid in the evaluation of potentially exposed patients. Continuing nursing education credit is offered in support of this series. |
| Centers for Disease Control and Prevention: Environmental Health | http://www.cdc.gov/Environmental/ | This site has links to national statistics, guidelines, and publications on specific environmental health exposures. |
| Healthy Child Healthy World's: Health ehouse | http://www.checnet.org/healthehouse/virtualhouse/index.asp | This virtual house is filled with everyday household items. Within each room, items (carpet, computer) can be clicked on (using the mouse) to find detailed information about health hazards and how children may come into contact with chemicals contained in the products. Detection, mitigation, and alternative products are suggested, alongside links to organizations and articles. |
| National Center for Healthy Housing's Pediatric Environmental Home Assessment: Tools for Public Health and Visiting Nurses | http://www.healthyhomestraining.org/Nurse/PEHA_Start.htm | A training module that includes a nursing assessment form and care plan to make it easier to identify potential hazards in the home and actions needed to address those hazards. |
| <i>Pediatric Environmental Health</i> , 2nd Edition | The American Academy of Pediatrics Committee on Environmental Health. (2003). <i>Pediatric environmental health</i> (2nd ed.). Elk Grove Village, IL: American Academy of Pediatrics. | This handbook presents summaries of the evidence about environmental hazards to children, and provides guidance to health care professionals about how to diagnose, treat, and prevent childhood illnesses linked to environmental exposures. |
| Physician's for Social Responsibility: Pediatric Environmental Health Toolkit | http://www.psr.org/site/PageServer?pagename=pediatric_toolkit | The Toolkit is a combination of easy-to-use reference guides for health providers and user-friendly health education materials on preventing exposures to toxic chemicals and other substances that affect infant and child health. |
| Pediatric Environmental Health Specialty Units (PEHSU) | http://www.aoec.org/PEHSU.htm | PEHSU staff are available for free consultation about potential pediatric environmental health concerns affecting both the child and the family. |
| United States Environmental Protection Agency | http://www.epa.gov/iaq/ http://www.epa.gov/iaq/co.html http://www.epa.gov/mold/index.html http://www.epa.gov/radon/index.html | These agent-specific Web sites provide information on indoor air quality, carbon monoxide, mold, and radon. |
| United States Environmental Protection Agency | http://www.epa.gov/iaq/pubs/hpguide.html | The health professional should use this booklet as a tool in diagnosing an individual's signs and symptoms that could be related to an indoor air pollution problem. |

lung cancer in non-smokers (EPA, 2007a). Because of synergistic effects, individuals who smoke and are exposed to radon are at even greater risk to lung cancer.

Assessment. In the case study, the nurse noted that the home had a basement and was located in a geographical area identified by the EPA as having a high potential for indoor radon. Because testing is the only way to know if a family is at risk from radon (EPA, 2007a), the nurse helped Mrs. Jones place a two-day testing kit that will be used to determine if a longer-term testing kit is required. All homes should be tested for radon by either the occupant or by a professional. Radon detection kits are available at most hardware stores or county health departments for a small fee. Short-term tests (2 to 90 days) are best if quick results are needed; however, because radon levels vary from day to day and season to season, long-term tests (more than 3 months) yield better information on average year-round exposure (AAP Committee on Environmental Health, 2003c). Generally, a homeowner initially screens the home for radon with a two-day, charcoal canister kit set at the lowest occupied level in the home. If the test results exceed 4 pCi/L, retesting is recommended with a kit that will measure average radon levels over a 3 to 12-month period.

The following risk assessment questions may assist in identifying if long-term exposure to radon is an issue in the household.

- Do you live in an area with high uranium/radon levels, and thus, potential for high indoor radon?
- Does your home have a basement? Are there any cracks in the basement floors or wall? Are any bedrooms located in the basement? Do family members spend a lot of time in the basement?
- If the household is located in an area with potentially high indoor radon levels, does anyone in the household smoke?
- Has your home ever been tested for radon?

Conclusion

In summary, the case study on indoor air quality illustrates how nurses from different practice settings can work together to protect children's health. The pediatric nurse practitioner recognized the need for an environmental assessment of the home, and the visiting nurse used her knowledge and sensory skills to assess

the home environment. Although the link between environmental exposures and health effects can be insidious, it is possible that Mrs. Jones' headache, her son's upset stomach, and the children's fatigue were related to the CO leak. The children's runny noses and coughs may have been related to the mold growth in the bathroom. It is unlikely that anyone experienced symptoms in relation to radon exposure, as radon poses no immediate health effects. Rather, lung cancer is a long-term health effect that can be prevented through precautionary action. An action plan was developed by the family and the home visiting nurse, and then shared with the clinic nurses to support the family with consistency. A follow-up home visit appointment was scheduled to evaluate and reassess the action plan.

Nurses are uniquely positioned to interact with concerned parents in a variety of settings. In the privacy of the family home or in the clinic office, nurses can assess for health effects potentially linked to environmental exposures. Table 2 presents a list of resources that can be used to educate nurses and clients on indoor air quality. Nurses who practice in various settings can collaborate to share their assessment findings with diagnosticians to reflect a more complete picture for a growing child. Because nursing competencies include assessment skills and care plan development that supports children who experience environmental risks and exposures, nurses are charged to practice on their behalf and advocate for their wellbeing (IOM, 1995). As a practice that has endured many changing faces over the years, nursing's contemporary role in environmental health is to protect our children from environmental risks. ■

References

- American Academy of Pediatrics (AAP) Committee on Environmental Health (1998). Toxic effects of indoor molds. *Pediatrics*, 101(4, Pt. 1), 712-714.
- American Academy of Pediatrics (AAP) Committee on Environmental Health. (2003a). Carbon monoxide. In R. Etzel (Ed.), *Pediatric environmental health* (2nd ed., pp. 113-124). Elk Grove Village, IL: American Academy of Pediatrics.
- American Academy of Pediatrics (AAP) Committee on Environmental Health. (2003b). How to do a home history of environmental hazards. In R. Etzel (Ed.), *Pediatric environmental health* (2nd ed., pp. 47-50). Elk Grove Village, IL: American Academy of Pediatrics.
- American Academy of Pediatrics (AAP) Committee on Environmental Health. (2003c). Ionizing radiation (including radon). In R. Etzel (Ed.), *Pediatric environmental health* (2nd ed., pp. 215-233). Elk Grove Village, IL: American Academy of Pediatrics.
- Briggs, D. (2003). *Making a difference: Indicators to improve children's environmental health*. Geneva: World Health Organization.
- Butterfield, P., Hill, W., Postma, J., Butterfield, P., Odom-Maryon, T., Swanson, B., et al. (2007). *Rural low-income children's exposure to environmental health risks: Prevalence estimates for biologic and chemical agents*. Presented at the American Academy of Nursing's 34th Annual Meeting and Conference, November 2007, Washington, D.C.
- Centers for Disease Control and Prevention (CDC), & U.S. Department of Housing and Urban Development (USDHUD). (2006). *Healthy housing reference manual*. Atlanta: U.S. Department of Health and Human Services.
- Environmental Protection Agency (EPA). (1994). *Indoor air pollution: An introduction for health professionals*. Retrieved from <http://www.epa.gov/iaq/pubs/hpguide.html>
- Environmental Protection Agency (EPA). (1996). *A radon guide for tenants*. Retrieved from <http://www.epa.gov/radon/pubs/tenants.html>
- Environmental Protection Agency (EPA). (1998). *Buying a new home: How to protect your family from radon*. Retrieved from <http://www.epa.gov/radon/pubs/rmc-tri.html>
- Environmental Protection Agency (EPA). (2002). *A brief guide to mold, moisture, and your home*. Retrieved from <http://www.epa.gov/mold/moldbasics.html>
- Environmental Protection Agency (EPA). (2005). *Protect your family and yourself from carbon monoxide poisoning*. Retrieved from <http://www.epa.gov/iaq/pubs/coftsht.html>
- Environmental Protection Agency (EPA). (2007a). *A citizen's guide to radon: The guide to protecting yourself and your family from radon*. Retrieved from <http://www.epa.gov/radon/pubs/citguide.html#contacts>
- Environmental Protection Agency (EPA). (2007b). *The inside story: A guide to indoor air quality*. Retrieved from <http://www.epa.gov/iaq/pubs/insidest.html>
- Environmental Protection Agency (EPA). (2008). *EPA map of radon zones*. Retrieved from <http://www.epa.gov/radon/zonemap.html>
- Faustman, E.M., Silbernagel, S.M., Fenske, R.A., Burbacher, T.M., & Ponce, R.A. (2000). Mechanisms underlying children's susceptibility to environmental toxicants. *Environmental Health Perspectives*, 108(Suppl. 1), 13-21.

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- Institute of Medicine (IOM). (1995). *Nursing, health and the environment*. Washington, DC: National Academy Press.
- Institute of Medicine (IOM). (2000). *Cleaning the air: Asthma and indoor air exposures*. Washington DC: National Academy Press.
- Institute of Medicine (IOM). (2004). *Damp indoor spaces and health*. Washington DC: National Academy Press.
- Landrigan, P.J., Schechter, C.B., Lipton, J.M., Fahs, M.C., & Schwartz, J. (2002). Environmental pollutants and disease in American children: Estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities. *Environmental Health Perspectives*, 110(7), 721-728.
- Leech, J.A., Nelson, W.C., Burnett, R.T., Aaron, S., & Raizenne, M.E. (2002). It's about time: A comparison of Canadian and American time-activity patterns. *Journal of Exposure Analysis and Environmental Epidemiology*, 12(6), 427-432.
- Lorber, M., & Phillips, L. (2002). Infant exposure to dioxin-like compounds in breast milk. *Environmental Health Perspectives*, 10(6), A325-A332.
- Paranzino, G., Butterfield, P., Nastoff, T., & Ranger, C. (2005). I PRE-PARE: Development and clinical utility of an environmental exposure history pneumonic. *American Association of Occupational Health Nurses Journal*, 53(1), 37-42.
- Rosenthal, L. D. (2006). Carbon monoxide poisoning. Immediate diagnosis and treatment are crucial to avoid complications. *American Journal of Nursing*, 106(3), 40-46.
- Smith, K.R., Corvalan, C.F., & Kjellstrom, T. (1999). How much global ill health is attributable to environmental factors? *Epidemiology*, 10(5), 573-584.
- Walker, B., Jr. (2005). Pediatric environmental health. *Journal of the National Medical Association*, 97(2), 262-269.
- Wu, F., & Takaro, T. K. (2007). Childhood asthma and environmental interventions. *Environmental Health Perspectives*, 115(6), 971-975.