Home Environmental Health Risks

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Home environmental health risks and the pollution of indoor residential air are becoming increasingly recognized as sources of injury and exacerbation of illness, particularly in vulnerable populations such as pregnant women, infants, children, the elderly, and those living with a chronic medical condition or disability. Nurses play a key role in prevention, education, and screening activities for patients. Core environmental health knowledge is essential for all nurses regardless of setting or population of practice. This article provides a review of the literature of five common home environmental health risks: lead, carbon monoxide, radon, pesticides, and the broad chemical category of volatile organic compounds. Particular emphasis is placed on the review of articles that address low-dose exposures, such as those most commonly found in the residential environment. Current standards of practice regarding risk minimizations are discussed, and nationally recognized preventative action steps and environmental health resources are presented.

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It has been estimated that Americans spend approximately 90 percent of their time indoors, in homes, daycare agencies, schools, and workplaces. This percentage climbs even higher for sub-populations such as infants and young children, the elderly, and people living with disabilities. Given this high percentage of time most people spend indoors, it is important to recognize that human exposure to pollutants occurs not only outside of buildings but inside them as well, and to work to decrease the increasing number of environmental pollutants found in our homes and pollutants which continue to increase our body burden of chemicals. Chronic, long-term exposure to indoor air pollutants is increasingly being recognized as a threat to health (American Lung Association, 2006; Environmental Protection Agency [EPA], 2006a); and the term "indoor air

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pollution" is gaining increasing public attention with media reports of sick building syndrome, mold, and deaths from carbon monoxide poisoning which can occur in home environments as well as work environments. Pregnant women, infants, children, people with disabilities and chronic medical conditions, and the elderly, are particularly susceptible to environmental health risks and face potential harm from home environmental health exposures. Nurses who work with these patient populations need to be knowledgeable about these risks and be able to assess home environmental health hazards, prioritize patient needs, and provide patients with evidence-based interventions and steps to reduce these exposures in their home environments. In this article, the author will present the challenges of hazards in the home environment and review the literature on five specific home environmental health risks, namely, lead, carbon monoxide, radon, pesticides, and volatile organic compounds. Steps and strategies to minimize home environmental health risks will also be discussed.

Hazards in the Home Environment

Although governmental agencies attend to standards to maintain the quality of outdoor air, maintaining the quality of indoor air in the home and implementing safe indoor air guidelines is the sole responsibility of the home owner and residents of the home. Household activities, such as smoking, frequency and use of air fresheners, cleaning products, and pesticides can affect air pollution levels in residential air. Home cleaning products and pest control practices contribute to volatile organic compound (VOC) levels in the home. In one study, researchers found that 60% of elders, ages sixty to ninety-five, reported using four or more household cleaners every day (Coelho, Steers, Lutzler, & Schriver-Mazzuoli, 2005). The age and condition of the home can also affect the quality of the indoor environment. The Centers for Disease Control and Prevention (CDC) estimates that 70% of homes built before 1980 contain lead-based paint (CDC, 1991). Lead-based paint presents a risk when it is peeling or chipped, or when remodeling activities, such as sanding, are done without proper precautions. Additionally, the types of heating, cooking appliances, and clothes dryers, as well as the venting of these appliances, affect levels of carbon monoxide in the home.

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Home Environmental Risks and Health: A Review of the Literature

Lead paint dust, carbon monoxide, radon, pesticides, and VOCs are five common household pollutants that have the potential to cause humans undesirable health effects even at low dose exposure levels, such as those normally found in the home. This review will present current knowledge about the human health effects of exposure to these five common household hazards. Environmental tobacco smoke is also an important indoor air pollutant, but a discussion of this pollutant is beyond the scope of this article.

Lead

Lead is a heavy metal that was used in many consumer products, such as gasoline and interior and exterior paint, before it was gradually phased out in the late 1970s and 1980s. Despite discontinued use, lead is persistent in the environment and continues to pose a risk to health. Common sources of lead, the harmful effects of lead, and prevention of injury associated with lead poisoning will each be discussed in turn.

Sources of lead. Primary sources of residential lead exposure for children and adults come from lead dust in homes in environmentally polluted urban areas, lead in soil/soot that can be tracked indoors, and lead-paint dust and chips in homes built before 1978. In this era, lead-based paint was commonly used in kitchens and bathrooms, for window and door trim, and on porches. Paint in homes built before 1980 becomes a hazard when it is chipping or peeling and/or when there is remodeling or sanding done which releases lead dust into the air. The route of exposure is through oral ingestion of paint dust or paint chips and/or through inhalation of lead paint during sanding activities.

Dangers related to lead. The current CDC target blood lead level for children under the age of six is 10µg/dl. Children, and also the developing fetus, are especially are susceptible to harm from exposure to lead because of their smaller size and their immature neurological system. Lead is a neurotoxin and affects both the central and peripheral nervous system. Multiple studies have shown a direct effect of lead exposure on IQ, cognition, attention, memory, learning disabilities, aggressive behavior, and delinquency (Breysse et al., 2004; Lanphear et al., 2005; Needleman, McFarland, Ness, Fienberg, & Tobin, 2002; Needleman, Riess, Tobin, Biesecker, & Greenhouse, 1996; Stein, Schettler, Wallinga, & Valenti, 2002). Those with additional neurological impairments, such as seizure disorders and other neurological and psychiatric impairments, may also be at increased risk from exposure (Landrigan, Doyle, & Thomas, 1994).

Community lead exposure also has detrimental health effects on other organ systems including the cardiovascular system. Several studies have examined the effects of community lead exposure on the cardiovascular system. Between 1991 and 1997, Cheng et al. (2001) utilized a sub-sample of the Normative Aging Study to look at the relationship between blood lead, bone lead, and current and future hypertension in 833 men with community levels of lead exposure. Results showed a positive association between baseline, bone-lead levels and systolic blood pressure, while controlling for age, with baseline, bone-lead levels predicting future development of hypertension while controlling for age, body mass, and family history of hypertension (Cheng et al., 2001). No relationship was found between blood-lead levels and blood pressure. Additionally, in a similar, cross-sectional study of 964 urban-dwelling men and women between the ages of 50 years and 70 years, Martin and colleagues (2006) found that tibia lead levels were associated with hypertension.

In adult populations, several studies have assessed the effect of non-occupational, low-levels of lead exposure on cognition, including language, processing speed, eye-hand

coordination, and executive functioning, as well as verbal memory and learning, visual memory, and balance (Kunert et al., 2004; Shih et al., 2006; Weisskopf et al., 2004). In all of these cohort studies, researchers found a significant relationship between cumulative low-level lead exposure, measured by patella and tibia bone lead levels, and changes in cognition and memory, when controlling for other confounding demographic variables, such as age, gender, education, racial and ethnic background, and income. In all three studies, researchers found evidence for an inverse association between cumulative lead exposure and cognitive and memory status.

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Recently, Menke, Muntner, Batuman, Silbergeld, and Guallar (2006) took a more general approach in looking at the effects of blood-lead levels on health using data from 13,946 participants of the National Health and Nutrition Examination Survey (NHANES) III Study to examine the association between blood-lead levels of less than 10 µg/dl and mortality. Participants who had higher blood-lead levels were older, of black or Mexican race, male, less likely to have a high school education, lower income, more likely to consume alcohol, and less likely to exercise. Also postmenopausal women were more likely to have higher blood-lead levels than pre-menopausal women, a finding thought be a result of bone, and thus lead mobilization that occurs after menopause and releases lead into the blood.

Prevention of lead poisoning. Lead poising and elevated lead levels in children and adults require a multifaceted approach including screening and intervention in cases of elevated levels. Table 1, based on the work of the American Academy of Pediatrics (2007), the EPA (2007b), and the New York State Department of Health (2005), and developed by the author, provides a summary of risk reduction interventions.

Table 1. Reducing Risks from Lead in the Home

Actions for Reducing Risk
Test for lead-based paint in dwellings built before 1978
Regularly wipe down floors, windowsills, and other surfaces
Use cold water for drinking and cooking in older homes
Run water for two minutes before use
Remove shoes before entering the home
Be informed, request lead-safe housing
Wash hands of young children frequently
Test for blood lead levels in young children
Avoid sanding, scrapping, or disturbing surfaces painted with lead based paint
Fix or paint over surfaces with peeling or chipping paint

Carbon Monoxide

Carbon monoxide (CO) is a tasteless, colorless, odorless gas which is produced as a bi-product of combustion when any type of fuel is incompletely burned. Any appliance or vehicle that burns gasoline, kerosene, propane, oil, wood, or charcoal creates carbon monoxide and thus a possible risk for human exposure. Sources of CO, as well as the dangers of CO and the prevention of these dangers will be presented in the following paragraphs.

Sources of CO. In homes, sources of CO exposure include gas, oil, or propane furnaces, space heaters, hot water heaters, gas clothes dryers, stoves, and wood burning fireplaces. CO emissions from these sources can create a hazard in indoor environments. Tobacco smoke is also a major source of indoor carbon monoxide exposure. The CDC reported that between 2001-2003 there were 15,000 emergency room visits for confirmed CO poisonings and over 500 people die from accidental CO exposure each year (CDC, 2005b). Many experts have estimated that these numbers represent only a fraction of those being exposed to chronic, low doses each year and have concluded that up to 40,000 people are poisoned in the United States (U.S.) alone each year (Houck & Hampson, 1997). Common causes of death from carbon monoxide poisoning include using appliances, such as gas or charcoal grills, indoors for heating or cooking, or using generators in closed garages and basements during a power outage.

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Dangers related to CO. Although an understanding of CO-related pathology is still developing, experts believe that carbon monoxide causes harm to humans and animals in several ways. One way CO causes harm is by binding to hemoglobin to form carboxyhemoglobin (COHb) molecules and thus displacing oxygen. This mechanism results in impaired oxygenation to all organ systems and creates a condition resembling anemia (Raub, Mathieu-Nolf, Hampson, & Thom, 2000). Several factors influence how an organism or body system will be affected by CO, including the exposure dose, the timing of exposure, and individual differences. The longer and more concentrated the exposure dose, the more devastating the effects of carbon monoxide. Individual differences, such as metabolic rate, level of activity, smoking status, co-morbidities, and age also influence how carbon monoxide will affect the person who has been exposed (Sanchez, 2001). Another way CO harms the body is by causing a change in the myelin protein called myelin basic protein (MBP). This change to the protein is believed to set up an autoimmune reaction which leads to long term neuro-cognitive changes. such as impaired memory and learning (Thom, Bhopale, Fisher, Zhang, & Gimotty, 2004).

Documented health effects of carbon monoxide focus primarily on the neurological and cardiovascular systems. Neurological symptoms such as fatigue, headache, confusion, and dizziness, especially when associated with a particular location, are key signs of a possible CO exposure. At high doses CO exposure results in loss of consciousness, coma, neuropsychiatric and behavioral impairment, and death (Raub, Mathieu-Nolf, Hampson,

& Thom, 2000). In the long term, carbon monoxide poisoning results in neuropsychiatric impairment which often manifests as impaired judgment, poor concentration, memory loss, and impaired cognition (Raub, Mathieu-Nolf, Hampson, & Thom).

Carbon monoxide also acts on the cardiovascular system, causing an exacerbation of cardiac disease from diminished oxygen transport. Hypo-perfusion and decreased oxygenation of cardiac tissue result in EKG changes, arrhythmias, angina, decreased tolerance of exercise, and cardiac arrest (Raub, Mathieu-Nolf, Hampson, & Thom, 2000). The effects of carbon monoxide in outdoor air are especially felt in the summer months when the CO contained in smog results in increases in hospital admissions for cardiovascular morbidity.

Satran (2005) studied the more immediate effects of the CO on the cardiovascular system of 230 adult patients admitted to a regional hospital for treatment of carbon monoxide poisoning. Myocardial injury was assessed in this patient group by looking at biomarkers such as Creatine-Kinase-MB (CK-MB) levels and ECG. Of the study cohort, only 10% had a previous history of cardiovascular disease. Despite this, 37% of the cohort showed signs of myocardial injury after they were exposed to carbon monoxide. Satran and colleagues concluded that cardiovascular effects of carbon monoxide are frequent and warrant a baseline cardiac work-up in all patients admitted to hospitals for carbon monoxide poisoning.

Prevention of CO-related harm. The World Health Organization (WHO) recommends a 9 parts per million (ppm) multi-hour indoor and outdoor air-quality standard as a guideline to protect susceptible and vulnerable populations, such as pregnant women, the elderly, children, and people with respiratory and cardiovascular disease (WHO, 1999). This standard is designed to maintain a blood carboxyhemoglobin level under 2.5%. There are currently no standards in the United States that have been agreed upon for carbon monoxide in indoor air.

Prevention is the most important way of reducing risks from carbon monoxide. Homes and garages that have a source of carbon monoxide need a working carbon monoxide detector on each floor. Nurses can teach their patients the importance of these detectors and how to have preventative maintenance checks done on their home heating system and fireplace or wood burning stove. It is important to ensure that these appliances have a patent venting system in place so that exhaust can reach the outside of the building. This is also important with gas dryers, gas hot water heaters, and gas stoves. Nurses can remind patients to be sure that there is no lint or other material blocking the exhaust vent on a dryer and that gas hot water heaters and stoves are vented to the outside. Nurses also need to teach their patients to not idle their cars in the garage because the carbon monoxide that comes out of the tail pipe often goes into the attached rooms or the rooms above the garage. Additionally, patients need to know that during power outages, they should avoid running unvented kerosene space heaters, gas or charcoal grills, and generators in any part of the home including the basement, car port, garage, and porch. These appliances need to be used far away enough from the house to avoid fumes from

coming inside. Table 2, developed by the author, and based on EPA recommendations (1996, 2005b) provides a list of CO risk reduction actions and interventions.

Table 2. Reducing Risks from Carbon Monoxide in the Home
Actions for Reducing Risk
Install a working carbon monoxide detector on each level of the home
Avoid idling vehicles in the garage
Ensure proper, unobstructed venting of all fuel burning appliances
Do not use generators or outdoors grills indoors
Do not use gas ovens or stoves for heat
Routinely clean and inspect chimney flues
Avoid unvented gas space heaters indoors

Radon

Radon is a naturally occurring, odorless, clear, radioactive gas that comes from the natural decay of uranium in soil.

Sources of radon. Radon gas moves up through the ground and seeps into homes through cracks and holes, water pipes, gas lines, and other open areas. Radon can also seep into well water. Radon poses a risk to health when it builds up in indoor air or water. The EPA has estimated that one in fifteen homes has radon levels above the EPA action level of 4 picocuries per liter of air (pCi/L) (EPA, 2005a).

Dangers related to radon. The EPA estimates that radon causes 21,000 lung cancer deaths per year (EPA, 2003a) The American Cancer Society ranks radon as the second leading cause of lung cancer in people who have never smoked (American Cancer Society, 2006). Multiple studies both in the U.S. and other countries have examined the association between residential radon exposure and risk of cancer death. In 2005, results were published from two large pooling studies, one from the European residential radon studies and one from the North American residential radon studies (Darby et al., 2005; Krewski et al., 2005).

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Prevention of harm from radon. Publication of these U.S. and European studies prompted the U.S. Surgeon General to issue a national health advisory on radon, urging all Americans to test for radon in their residence and to take protective steps if warranted (U.S. Department of Health and Human Services, 2005). The Surgeon General urged that the federal government "lead by example" and take proactive steps to require testing of housing owned or financed by the government. The EPA map of radon zones (EPA, 2005a) provides more detailed information on radon levels in specific geographic locations. Specific action steps and patient teaching for reducing radon risks are listed in Table 3 which was developed by author based on the EPA website (2005a).

Table 3. Reducing Risks from Radon
Actions for Reducing Risk
Test all homes and apartments below the third floor
Take preventative action to reduce radon if levels above 4pCi/L are found
Test private wells for radon in water source

Pesticides

Pesticides are defined as any product designed to prevent, destroy, repel, or mitigate any pest (EPA, 2006d). Pesticide sources and dangers, as well as strategies to prevent harm due to pesticides, will be discussed below.

Sources of pesticides. This large category of products includes those designed to target weeds, fungi, and bacteria, as well as insecticides which are specifically designed to kill insects by targeting the neurological or reproductive systems of the intended target. The Environmental Protection Agency has estimated that 75 % of U.S. households used at least one pesticide product indoors during the past year (EPA, 2006c). Another EPA study has estimated that 80% of most peoples' pesticide exposures occur indoors (EPA, 2006c). Common household pesticides include products used to spray for ants, flies, fleas, and other home pests. Pesticides in the home environment become part of the house dust and settle in carpets and on children's stuffed animals and toys, bedding, and other household textiles. Exposure occurs through dermal absorption, oral ingestion, and inhalation of these pesticide chemicals.

Several studies have been done on the use of residential pesticides. Colt et al. (2004) examined the levels of pesticides in carpet dust and self-reported use of household pesticides. In this sample, 94% of subjects reported that they had treated for insects in or around their home. However, dust samples of the 6% of the participants who denied treating for insects in or around their homes showed that although less frequently detected, pesticides were found in the untreated homes as well. As expected, dust levels of pesticides were higher in the homes that reported treating for insects; and these levels correlated with the number of treatments that had been applied. In another study researchers looked at concentrations of four different pyrethroid pesticides in house dust and airborne particles (Leng et al., 2005). In all cases, pesticides were applied by professional pest control operators. Samples were taken before application, one day after application, six months after application, and twelve months after application. In all households, significant correlations were found between house dust and airborne pesticide particles one day after application. In three out of the four pesticides applied, levels in house dust were still detected after one year.

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Dangers of pesticides. In the United States there are four major categories of chemical insecticides in use today; organophosphates, carbamates, organochlorines, and pyrethroids. The primary documented health effects of all of these classes of pesticides are on the neurological system. Symptoms of moderate organophosphate exposure include headache, dizziness, nausea, papillary constriction, and excessive perspiration and salivation (Kamel &

Hoppin, 2004). More severe exposures can result in muscle weakness, bronchospasms, convulsions, and death. Pyrethroids as a class are also known as respiratory allergens and have been known to trigger asthma symptoms. Acute ingestion or inhalation exposure can result in neurological symptoms such as tremor, salivation, choreoathetosis, and seizures (CDC, 2005a). Dermal exposure can also result in abnormal skin sensations such as burning, rash, and skin irritation.

Despite the abundance of information on the health effects of some specific pesticides, such as the organophosphate pesticides, very little is known about the health effects of residential pesticide used on home residents. Some of the data that is available on the health effects of pesticides is from studies conducted using pesticide application equipment. Kamel and colleagues (2005) examined the association between pesticide use and self-reported neurological symptoms in 18,782 males who worked as private pesticide applicators. They found increased reports of neurological symptoms were associated with cumulative lifetime use of pesticides, particularly insecticides and fumigants, and concluded that chronic moderate pesticide exposure is associated with a wide range of cognitive, sensory, and motor dysfunction symptoms. Rothlein and colleagues (2006) examined the relationship between urine pesticide metabolites, house pesticide dust, and neurobehavioral tests in 92 Hispanic agricultural workers in Oregon. The 45 controls for the study were Hispanic workers living in a town with little agriculture and working in non-agricultural jobs. Controlling for age, years of education, and sex, Rothlein and colleagues found the non-agricultural workers performed better on 12 out of 16 neurobehavioral measurements than did the agricultural workers. When Rothlein and colleagues examined urine pesticide metabolite levels and neurobehavioral functioning, controlling for covariates, they noted that poorer performance on five neurobehavioral tests was associated with higher levels of pesticide metabolites.

Prevention of harm due to pesticides. Nursing interventions to reduce pesticide exposures focus on educating patients about integrated pest management strategies which include the use of preventive strategies and/or a use of the least possible toxic alternatives. An example of an integrated pest management strategy for ants for example, would be to try to remove the food source that is attracting the ants as a first strategy. If this does not work, a second step might to be to use a self-contained, ant bait trap in order to try to control the pests. A third strategy would be to try using a non-toxic product such as boric acid to block the ants from entering the area. These strategies would all be considered preferable to having a pest control company spray after the first ant sighting. Nurses can help their patients by providing them with this type of information and with resources so that they can make informed choices on product usage and less hazardous strategies for pest management. The author has developed Table 4, based on the work of the EPA (2006c) and a group called Beyond Pesticides (2007), which provides helpful information on toxicity of specific pesticides, fact sheets for integrated pest management, and other information on pests and pesticide usage.

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Table 4. Reducing Risks from Pesticides
Actions for Reducing Risk
Use non-chemical methods of pest control when possible
Always use the least toxic product first
Adhere strictly to label instructions when pesticides are used
Keep pesticides out of the reach of children and do not use around children
Promptly remove trash and clean areas that might attract insects or rodents

Volatile Organic Compound Exposure *(Household Products)*

Volatile Organic Compounds (VOCs) are a broad category of chemicals that volatize to become a gas at room temperature. VOC sources, dangers, and prevention will be presented below.

Sources of VOCs. These carbon containing compounds can come from outdoor sources, such as industry, as well as from indoor sources in homes, schools, and workplaces. There are thousands of different VOCs that people can be exposed to on a daily basis. Multiple and common sources of indoor VOC exposure include building materials, paints, lacquers, household cleaning products, air fresheners, disinfectants, personal cosmetics, pesticides, dry-cleaned clothing, and hobby and craft materials. VOCs can also be off-gassed from furniture made from particle board, carpets, and other solids (EPA, 2006b). Volatile organic compound levels in homes are greatly affected by the choices and behaviors in the home. The EPA has estimated that indoor levels of about twelve common VOCs are two to five times higher in homes than they are in outside air, regardless of the location of the home (EPA, 2006b). Common VOCs include benzene, toluene, methylene chloride, formaldehyde, xylene, ethylene glycol, texanol, perchloroethylene, and 1,3-butadiene (Minnesota Department of Health, 2005).

Dangers associated with VOCs. Health effects of VOCs vary depending on the compound of exposure, the amount of air exchange in the indoor environment, and the use pattern. People with respiratory conditions, young children, and the elderly are particularly susceptible to risks from VOCs due to increased time indoors (Bridges, 2005; EPA, 2003b). General, short-term acute health effects of these compounds include respiratory problems, eye and throat irritation, headache, loss of coordination, and dizziness (EPA, 2006b). Long term effects can include cancer, liver damage, kidney damage, and central nervous system damage (EPA, 2006b). Volatile organic compounds have also been known to exacerbate asthma and other respiratory conditions (Rumchev, Spickett, Bulsara, Phillips, & Stick, 2004).

Formaldehyde, a VOC commonly found in residential environments, has known health consequences (Lemus, Abdelghani, Akers, & Horner, 1998). The most common sources of formaldehyde in homes is from pressed board products such as those used for sub-flooring and cabinets, hardwood plywood paneling, and pressed wood furniture (EPA, 2006b). Formaldehyde, in addition to being a respiratory irritant, is known to cause cancer in animals and is a suspected human carcinogen as well (EPA, 2006b). Several studies have looked at the relationship between asthma and formaldehyde exposure in

children. Rumchev, Spickett, Bulsara, Phillips, and Stick (2004) studied participants between the ages of six months and three years who were recruited after they were discharged from an emergency department with asthma as a primary diagnosis and no prior history of asthma. VOC levels were sampled in the homes of these children; other data including risk factors, family history, and environmental exposures were collected via a questionnaire. These researchers reported that children who were exposed to significantly higher levels of VOCs were the ones who were treated emergently for new onset asthma. In another study researchers examined the relationship between home formaldehyde exposure and risk of allergy in children. The results of this study showed that formaldehyde exposure was associated with increased risk of allergic sensitization from common allergens in children (Garrett, Hooper, Hooper, Rayment, & Abramson, 1999).

Prevention measures. Consumer education is key to reducing household VOC exposures. It is important for nurses to provide their patients with resources so that they can make informed decisions about the products that they use in their homes. In almost all cases less hazardous alternatives are readily available and equally effective. The National Library of Medicine (2007a) has a user friendly Household Product Database that can be a helpful resource for nurses and their patients. This database contains the names of all commonly used household cleaning products and household chemicals in an easy to find format. Nurses can show patients how to look up products they use in their homes in order to see a list of chemicals contained in these products and the known health effects of these chemicals. Another resource that nurses can show their patients is the Environmental Working Group (2007) Skin Deep Database. This interactive tool allows nurses and patients to research their health and beauty products such as shampoo, lotion, and toothpaste to find out if chemicals in these products are known carcinogens, reproductive and developmental hazards, allergens and/or other health hazards. This database will also allow a patient to search for alternative, less hazardous products in each product category. Table 5, based by the author on the following references, provides patient teaching steps and resources for nurse and patient education regarding safer alternatives to VOCs (Environmental Working Group; EPA, 2006a, 2006b; National Library of Medicine).

Nurses can show patients how to look up products they use in their homes in order to see a list of chemicals contained in these products and the known health effects of these chemicals.

Table 5. Reducing Risks from Volatile Organic Compounds
Actions for Reducing Risk
Take steps to reduce the amount of household products used daily
Know the risks of commonly used products like cleaners and air fresheners
Choose low toxicity alternatives such as baking soda and vinegar for cleaning
Choose cosmetics wisely
Choose low VOC furniture and flooring if possible
Use low VOC paints for indoor painting
Ventilate home during use of paint, hobbie, and craft materials

Precautionary Steps: Actions to Minimize Home Environmental Hazards

The best approach to decrease environmental health risks in the home environment is to identify the hazards that pose the greatest threat to the residents of the home and teach simple, low-cost prevention strategies to decrease these risks. As is true with most proactive health activities, primary prevention is the simplest, and most economical way of addressing these possible threats to health. It is critical that nurses, who often serve as the primary source of health information for their patients, provide their patients with education and risk reduction strategies that are evidence-based and grounded in science. It is essential that nurses be knowledgeable about home environmental risks and that they have the tools to assess for these risks in their patient populations. Basic environmental health knowledge is essential to all nursing practice.

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In addition, nurses in acute care settings, such as emergency departments or pediatric practices, need to be knowledgeable about signs and symptoms associated with indoor air hazards and how to assess for potential risks in their patients. In this type of setting it is important for nurses to be able to differentiate, for example, between symptoms of a respiratory virus and carbon monoxide poisoning in a five year old child.

Nurses working in long-term care settings, such as nursing homes, assisted living, or schools need to be aware of how the environment can create health risks for their patients. In a nursing home setting, for example, it would be important for a nurse to notice an increase in confusion in her patients after the floors have been mopped or waxed, and advocate for less hazardous cleaning practices.

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For home health nurses, a home, environmental-health assessment is an important component of providing a comprehensive and holistic assessment of health and the living environment. Assessment of the home environment allows the nurse to educate her patients about less hazardous pest control practices, placement of carbon monoxide monitors, or safer cleaning products.

Table 6 provides a summary of the five discussed common household environmental health risks: lead, carbon monoxide, radon, pesticides, and VOCs, along with sources of these exposures, health effects, and evidence-based strategies to minimize risks to health. In addition, there are many other resources and tools currently available to nurses to help them begin to understand the effects of the physical environment on health, build upon a solid knowledge base regarding environmental health, and/or add environmental health tools to their practice.

Table 6. Common Household Risks, Source, Health Risks, and Standards of Practice			
Potential Household Exposure	**Source**	**Health Effects**	**Standards of Practice**
Lead	Dust and chips from interior lead based paint	Neurologic and behavioral effects have been documented in lead-exposed workers with BLLs ranging from 40 to120 µg/dL. These effects include malaise; forgetfulness; irritability; lethargy; impaired concentration; depression and mood changes; increased nervousness; headache; fatigue; impotence; decreased libido; dizziness; weakness; and paresthesia; as well as diminished reaction time, visual motor performance, hand dexterity, IQ scores, and cognitive performance (Agency for Toxic Substances and Disease Registry , 1999).	Maintain integrity of lead based paint to reduce chipping, peeling (EPA, 2007b)
Carbon Monoxide	Incomplete combustion of fossil fuel-heat, appliances, and vehicles	Fetuses, infants, elderly people, and people with anemia or with a history of heart or respiratory disease can be especially susceptible. Headache, fatigue, loss of consciousness, death. Long term effects: cognitive impairment, neuro-psychiatric problems, loss of IQ.	Proper venting of appliances, carbon monoxide detectors (EPA, 2005b)
Radon	Naturally occurring radioactive gas – leaks into homes	EPA estimates about 21,000 deaths per year due to radon. At 2pCi/L lifetime risk of lung cancer in the general population is 12 out of 1,000.	Test all homes for radon to determine risk (EPA, 2005a)
Pesticides	Used for extermination or prevention of insects	Pesticides work either by affecting the neurological system or reproductive system of the target pest and humans.	Integrated pest management, (EPA, 2006c)
Volatile Organic Compounds	Cleaning supplies for home, air fresheners, laundry supplies	Eye, nose, and throat irritation; headaches, loss of coordination, nausea; damage to liver, kidney, and central nervous system. Some organics can cause cancer in animals; some are suspected or known to cause cancer in humans. Key signs or symptoms associated with exposure to VOCs include conjunctival irritation, nose and throat discomfort, headache, allergic skin reaction, dyspnea, declines in serum cholinesterase levels, nausea, emesis, epistaxis, fatigue,	No standards have been set for VOCs in non industrial settings. (EPA, 2006b). Minimize use of products and utilize less hazardous alternatives

		dizziness. (EPA, 2006b)	

Table 7 provides a listing of online, environmental health resources, tools, and patient teaching materials for nurses to incorporate into their everyday practice (American Lung Association, 2006; EPA, 2006a, 2007a; Health Care Without Harm, 2007; National Institute of Environmental Health Science, 2007; National Library of Medicine, 2007a, 2007b; National Safety Council, 1998; Scorecard, 2005; University of Wisconsin, 2007)

Table 7.

Environmental Health Tools and Resources for Nurses	Link
Go on a virtual tour of environmental health exposures in homes, schools, towns and communities at the National Library of Medicine's TOX TOWN	http://toxtown.nlm.nih.gov/
Test your knowledge of home environmental health hazards using the HEALTHY HOME TOOL	www.uwex.edu/healthyhome/tool/
Brush up on the facts with Fact Sheets from the American Lung Association or National Safety Council	www.lungusa.org/site/apps/lk/links.aspx?c=dvLUK9O0E&b=36056 www.nsc.org/ehc/indoor/factshet.htm
Build knowledge of home environmental health risks and health effects of these exposures by reading " Indoor Air Pollution	www.epa.gov/iaq/pubs/hpguide.html
Learn more about specific household products, ingredients, and effects on health at the National Library of Medicine's Household Products Database	http://householdproducts.nlm.nih.gov/products.htm
Read more in-depth about a specific environmental health issues in the Free Online Journal, Environmental Health Perspectives.	www.ehponline.org/docs/2006/114-9/ss.html
Learn who is polluting the air and water in your community, and get	www.scorecard.org/

involved at Scorecard.	
Increase your knowledge of indoor air quality at the EPA Office of Indoor Air Quality.	www.epa.gov/iaq/
Learn about less hazardous cleaning supplies, and safer pesticide practices in the work place at Health Care Without Harm.	www.noharm.org/us

Summary

Individual choices, practices, and activities in homes can create the difference between healthy indoor air and unhealthy indoor air. In this article, the author presented information about hazards identification, health effects, and risk reduction strategies for five common home environmental health hazards: lead, carbon monoxide, radon, pesticides, and volatile organic compounds such as cleaning supplies. It is essential that nurses be aware of these and other common environmental health hazards so that they can incorporate this teaching into nursing care for their patient populations, particularly those with baseline vulnerabilities, such as infants and children, pregnant mothers, the elderly, and people with disabilities. It is also imperative for nurses to have access to evidence-based information, tools, and resources so that they can incorporate environmental health knowledge into everyday practice and plan interventions for their patients and communities that protect health.

Assessment of the home environment allows the nurse to educate her patients about less hazardous pest control practices, placement of carbon monoxide monitors, or safer cleaning products.

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Allison Del Bene Davis is a Clinical Instructor at The University of Maryland, School of Nursing. Her research focuses on the identification of environmental health risks in the homes of people with developmental disabilities and other vulnerable populations and the translation of this science into practices that protect health. She is particularly interested in the characteristics of people with cognitive and developmental disabilities that make them more vulnerable to chemicals and other environmental health risks. Dr. Del Bene Davis is an advocate for equal rights and protection from environmental hazards for people with developmental disabilities. She received her M.S. in community, public, and environmental health nursing, and her PhD from the University of Maryland, Baltimore.

Agency for Toxic Substances and Disease Registry. (1999). Retrieved June 13, 2007 from www.atsdr.cdc.gov/.

American Academy of Pediatrics. (2007). Lead exposure in children: Prevention, detection and management [Electronic Version]. *Pediatrics*, 2005, 1036-1046. Retrieved March 31, 2007.

American Cancer Society. (2006). Causes of lung cancer in nonsmokers. *Journal of the National Cancer Institute, 98*(10), 664.

American Lung Association. (2006). Indoor Air Pollution. Retrieved September 15, 2006, from www.lungusa.org/site/pp.asp?c=dvLUK9O0E&b=315952

Beyond Pesticides. (2007). National coalition against the misuse of pesticides. Retrieved April 27, 2007 from www.beyondpesticides.org/.

Breysse, P., Farr, N., Galke, W., Lanphear, B., Morley, R., & Bergofsky, L. (2004). The relationship between housing and health: Children at risk. *Environmental Health Perspectives, 112*(15), 1583-1588.

Bridges, B. (2005). *Scented products as sources of VOCs: Implications for susceptible populations.* Paper presented at the Air and Waste Management Association, Minneapolis, MN.

CDC. (1991). Preventing lead poisoning in young children. Retrieved September 26, 2006, from www.cdc.gov/nceh/lead/Publications/books/plpyc/contents.htm

CDC. (2005a). *National Report of Human Exposure to Environmental Chemicals* Retrieved. from www.cdc.gov/exposurereport/default.htm.

CDC. (2005b). Study: Unintentional non-fire related carbon monoxide exposures – United States, 2001-2003. . Retrieved 4/14/2005, from www.cdc.gov/od/oc/media/pressrel/fs050120.htm

Cheng, Y., Schwartz, J., Sparrow, D., Aro, A., Weiss, S. T., & Hu, H. (2001). Bone lead and blood lead levels in relation to baseline blood pressure and the prospective development of hypertension: the Normative Aging Study. *American Journal of Epidemiology, 153*(2), 164-171.

Coelho, C., Steers, M., Lutzler, P., & Schriver-Mazzuoli, L. (2005). Indoor air pollution in older people's homes related to some health problems: a survey study. *Indoor Air, 15*, 267-274.

Colt, J. S., Lubin, J., Camann, D., Davis, S., Cerhan, J., Severson, R. K., et al. (2004). Comparison of pesticide levels in carpet dust and self-reported pest treatment practices in four US sites. *Journal Exposure Analysis and Environmental Epidemiology, 14*(1), 74-83.

Darby, S., Hill, D., Auvinen, A., Barros-Dios, J. M., Baysson, H., Bochicchio, F., et al. (2005). Radon in homes and risk of lung cancer: collaborative analysis of individual data from 13 European case-control studies. *British Medical Journal, 330*(7485), 223.

Environmental Working Group, (2007). *Skin deep.* Retrieved April 27, 2007 from www.ewg.org/reports/skindeep/?key=nosign

EPA. (1996). Protect yourself and your family from carbon monoxide in your home. Retrieved January 29, 2007 from www.epa.gov/iaq/pubs/coftsht.html

EPA. (2003a). Assessment of risks from radon in homes. Retrieved September 29, 2006 from www.epa.gov/radon/risk_assessment.html.

EPA. (2003b). *Draft Report on the Environment*. Retrieved April 27, 2007 from www.epa.gov/indicate/roe/index.htm.

EPA. (2005a). *A citizen's guide to radon: The guide for protecting yourself and your family from radon*. Retrieved May 5, 2007 from www.epa.gov/radon/pubs/citguide.html

EPA. (2005b). *Basic information – carbon monoxide*. Retrieved April 4, 2005, from www.epa.gov/iaq/co.html .

EPA. (2006a). *Indoor air pollution: An introduction for health professionals*. Retrieved September 12, 2006, from www.epa.gov/iaq/pubs/hpguide.html.

EPA. (2006b). An Introduction to indoor air quality: Volatile organic compounds. Retrieved October 14, 2006, from www.epa.gov/iaq/voc.html

EPA. (2006c). An introduction to indoor air quality. Pesticides. Retrieved May 5, 2007 from www.epa.gov/iaq/pesticid.html

EPA. (2006d). What is a pesticide ? Retrieved October 4, 2006, from www.mindfully.org/Pesticide/What-Is-A-Pesticide.htm

EPA. (2007a). Indoor air topics. Retrieved April 16, 2007, from www.epa.gov/iaq/

EPA. (2007b). *Pamphlet. Protect your family from lead in your home.* Retrieved January 27, 2007 from www.epa.gov/oppt/lead/pubs/leadprot.htm.

Garrett, M. H., Hooper, M. A., Hooper, B. M., Rayment, P. R., & Abramson, M. J. (1999). Increased risk of allergy in children due to formaldehyde exposure in homes. *Allergy, 54*(4), 330-337.

Health Care Without Harm. (2007). Retrieved April 16, 2007, from www.noharm.org/us

Houck, P. M., & Hampson, N. B. (1997). Epidemic carbon monoxide poisoning following a winter storm. *Journal of Emergency Medicine, 15*(4), 469-473.

Kamel, F., Engel, L. S., Gladen, B. C., Hoppin, J. A., Alavanja, M. C., & Sandler, D. P. (2005). Neurologic symptoms in licensed private pesticide applicators in the agricultural health study. *Environmental Health Perspectives, 113*(7), 877-882.

Kamel, F., & Hoppin, J. A. (2004). Association of pesticide exposure with neurologic dysfunction and disease. *Environmental Health Perspectives, 112*(9), 950-958.

Krewski, D., Lubin, J. H., Zielinski, J. M., Alavanja, M., Catalan, V. S., Field, R. W., et al. (2005). Residential radon and risk of lung cancer: a combined analysis of 7 North American case-control studies. *Epidemiology, 16*(2), 137-145.

Kunert, H. J., Wiesmuller, G. A., Schulze-Robbecke, R., Ebel, H., Muller-Kuppers, M., & Podoll, K. (2004). Working memory deficiencies in adults associated with low-level lead exposure: implications of neuropsychological test results. *International Journal of Hygiene & Environmental Health, 207*(6), 521-530.

Landrigan, P. J., Doyle, G. G., & Thomas, R. D. (1994). Environmental neurotoxic illness: Research for prevention. *Environmental Health Perspectives, 102*(Supp 2), 117-120.

Lanphear, B. P., Hornung, R., Khoury, J., Yolton, K., Baghurst, P., Bellinger, D. C., et al. (2005). Low-level Environmental lead exposure and children's intellectual function: an international pooled analysis. *Environmental Health Perspectives, 113*(7), 894-899.

Lemus, R., Abdelghani, A. A., Akers, T. G., & Horner, W. E. (1998). Potential health risks from exposure to indoor formaldehyde. *Review of Environmental Health, 13*(1-2), 91-98.

Leng, G., Berger-Preiss, E., Levsen, K., Ranft, U., Sugiri, D., Hadnagy, W., et al. (2005). Pyrethroids used indoor-ambient monitoring of pyrethroids following a pest control operation. *International Journal of Hygiene & Environmental Health, 208*(3), 193-199.

Martin, D., Glass, T. A., Bandeen-Roche, K., Todd, A. C., Shi, W., & Schwartz, B. S. (2006). Association of blood lead and tibia lead with blood pressure and hypertension in a community sample of older adults. *American Journal of Epidemiology, 163*(5), 467-478.

Menke, A., Muntner, P., Batuman, V., Silbergeld, E. K., & Guallar, E. (2006). Blood lead below 0.48 micromol/L (10 microg/dL) and mortality among US adults. *Circulation, 114*(13), 1388-1394.

Minnesota Department of Health. (2005, September). *Volatile organic compounds (VOCs) in your home.* Retrieved October 14, 2006, from www.health.state.mn.us/divs/eh/indoorair/voc/.

National Institute of Environmental Health Science. (2007). *Environmental Health Perspectives.* Retrieved April 12, 2007, from www.ehponline.org/

National Library of Medicine. (2007a). *Household products database.* Retrieved January 29, 2007, from http://householdproducts.nlm.nih.gov/products.htm

National Library of Medicine. (2007b). *Tox town*. Retrieved April 12, 2007, from http://toxtown.nlm.nih.gov/

National Safety Council. (1998). Indoor air quality fact sheets. Retrieved April 16, 2007, from www.nsc.org/e.c/indoor/factshet.htm

Needleman, H. L., McFarland, C., Ness, R. B., Fienberg, S. E., & Tobin, M. J. (2002). Bone lead levels in adjudicated delinquents. A case control study. *Neurotoxicology and Teratology, 24*(6), 711-717.

Needleman, H. L., Riess, J. A., Tobin, M. J., Biesecker, G. E., & Greenhouse, J. B. (1996). Bone lead levels and delinquent behavior. *Jama, 275*(5), 363-369.

NY State Department of Health. (2005). Lead exposure in adults: A guide for health care providers. Retrieved March 31, 2007 from www.health.state.ny.us/environmental/lead/hlthcare.htm.

Raub, J. A., Mathieu-Nolf, M., Hampson, N. B., & Thom, S. R. (2000). Carbon monoxide poisoning--a public health Perspectives. *Toxicology, 145*(1), 1-14.

Rothlein, J., Rohlman, D., Lasarev, M., Phillips, J., Muniz, J., & McCauley, L. (2006). Organophosphate pesticide exposure and neurobehavioral performance in agricultural and non-agricultural Hispanic workers. *Environmental Health Perspectives, 114*(5), 691-696.

Rumchev, K., Spickett, J., Bulsara, M., Phillips, M., & Stick, S. (2004). Association of domestic exposure to volatile organic compounds with asthma in young children. *Thorax, 59*(9), 746-751.

Sanchez, R., Fosarelli, P., Felt, B., Greene, M., Lacovara, J., Hackett, F. (2001). Carbon monoxide poisoning due to automobile exposure: Disparity between carboxyhemoglobin levels an symptoms of victims. *Pediatrics, 82*(4), 663-666.

Satran, D., Henry, C. R., Adkinson, C., Nicholson, C. I., Bracha, Y., & Henry, T. D. (2005). Cardiovascular manifestations of moderate to severe carbon monoxide poisoning. *Journal of the American College of Cardiology, 45*(9), 1513-1516.

Scorecard. (2005). *The pollution information site.* Retrieved April 16, 2007, from www.scorecard.org/

Shih, R. A., Glass, T. A., Bandeen-Roche, K., Carlson, M. C., Bolla, K. I., Todd, A. C., et al. (2006). Environmental lead exposure and cognitive function in community-dwelling older adults. *Neurology*.

Stein, J., Schettler, T., Wallinga, D., & Valenti, M. (2002). In harm's way: toxic threats to child development. *Journal of Developmental Behavior in Pediatrics, 23*(1 Suppl), S13-22.

Thom, S. R., Bhopale, V. M., Fisher, D., Zhang, J., & Gimotty, P. (2004). Delayed neuropathology after carbon monoxide poisoning is immune-mediated. *Proceedings of the National Academy of Science U S A, 101*(37), 13660-13665.

University of Wisconsin. (2007). Help yourself to a healthy home. Retrieved April 16, 2007, from www.uwex.edu/healthyhome/tool/.

U.S. Department of Health and Human Services, H. (2005). *Surgeon General releases National health advisory on radon*. Washington DC.

Weisskopf, M. G., Wright, R. O., Schwartz, J., Spiro, A., 3rd, Sparrow, D., Aro, A., et al. (2004). Cumulative lead exposure and prospective change in cognition among elderly men: the VA Normative Aging Study. *American Journal of Epidemiology, 160*(12), 1184-1193.

WHO (Ed.). (1999). *International Program on Chemical Safety, Environmental Health Criteria 213, Carbon Monoxide*. Geneva.

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