

prevention). Increased risks associated with breast and colon cancer was determined through this longitudinal study. Further nurses conduct research in many areas of environmental health. Some of this research directly relates to exposure to carcinogens such as hydraulic fracturing (McDermott-Levy et al, 2016), pesticides (Runkle et al, 2013) and water (ONeal et al, 2013).

### Advocacy and Policy

A final area where nursing practice can advance risk reduction for carcinogens is through policy and advocacy work. First, nurses must be knowledgeable about regulations, policies and legislation that relates to toxic chemical exposures. Advocacy can occur in the workplace setting where nurses advocate for the use of safer products. Advocacy can occur at the local level in their own communities to reduce risk in areas such as the elimination of crumb rubber and pesticide application to playing fields where children can be exposure to carcinogens. This can occur at the federal level to identify areas where public comment can be made or by participation with alliances, coalitions and advocacy groups that target hazardous chemicals such as Safer Chemicals, Healthy Families, Clean and Healthy New York, Connecticut Clean Water Action, Children's Environmental Health Network, and Health Care without Harm. These and many other organizations dedicated to reducing toxic exposures have nurses as directors or in leadership positions. In particular the Cancer Free Economy (CFE) part of the Garfield Foundation promotes networks and funds programs to specifically address the carcinogens prevalent in our everyday lives. Their work to build networks includes nurses and funds initiatives to engage the public for advocacy. The CFE goal is to create a cancer free economy or one that is healthy by shifting the current culture based upon risk reduction to that of an upstream preventive approach.

### TOXIC SUBSTANCES CONTROL ACT (TSCA)

Beginning in 1970 with the establishment of the Environmental Protection Agency (EPA), the US government began taking steps to control sources of hazardous exposures in the environment through the Clean Air Act, the Clean Water Act and the Toxic Substances Control Act. (TSCA). In 1976 Congress approved TSCA to evaluate chemicals for their safety for human health. At that time, all existing chemicals were not required to be evaluated and were considered to be safe. That allowed those chemicals to have a "grandfather clause" to consider their safe use. All new chemicals were then subject to regulation by the Environmental Protection Agency (EPA). For almost 40 years EPA was unable to enact strong regulatory action on chemical hazards due to the limitations of the 1976 ruling. Building upon work began in 2004 by those concerned about the need to improve TSCA, Senators Frank Lautenberg and David Vitter introduced the Chemical Safety Improvement Act in 2013. During the time that the bill faced challenges until 2015 when in December 2015 a revised version garnered 60 co-sponsors and was passed in the Senate by an unanimous vote. Prior to that, the House of



Mom's Clean Air Force advocating for stronger clean air policy with a stroller brigade. This photo by an unknown author is licensed under CC BY-SA-NC.

Representatives had passed a similar bill that was less comprehensive. While the two bills had to be reconciled

to enact the legislation that was passed and signed into law in June 2016, it greatly improves TSCA of 40 years earlier. Despite the death of Senator Lautenberg in 2013 his work was recognized through the naming the legislation Frank R. Lautenberg Chemical Safety for the 21st Century Act. This act mandates stronger reviews of chemicals, strengthens the protection of vulnerable populations such as pregnant women and children and requires EPA to prioritize persistent and bioaccumulative chemicals while enhancing the agency's authority to test new and existing chemicals. Safer Chemicals, Healthy Families provides a readable summary of the law on their website.

## CONCLUSION

If nurses are to practice to meet the standards put forth in the ANA Scope and Standards of Practice (2015) they must be knowledgeable about carcinogens and incorporate that knowledge into their professional practice. Further, to fulfill that professional role, nurses should use evidence from research and advance nursing knowledge of hazardous carcinogenic chemicals. They must also become advocates to reduce and eliminate carcinogens for cancer prevention and a healthier world.

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As the most trusted profession, nurses have a responsibility to instruct and advocate for not only proper medication use but also for proper disposal to keep our families, children, and communities safe. Nurses have opportunities daily to educate patients and their families about the medications they are taking including proper dosage, timing, effect(s), side effects, and interactions. These instructions must also include proper disposal of each medication as a part of their interactions with patients and their families. Every professional in the healthcare continuum should include this information, including the prescriber, pharmacists, and nurses. Despite this, researchers found that only 67.9% of pharmacists provided education only once a month to their customers and less than 16% of the pharmacists were able to select all the appropriate medication disposal recommendations (Tai, Hata, Wu, Frausto, and Law, 2016). A review of the literature did not reveal any research regarding nurses and providing appropriate disposal recommendations or patient education.

In 2002, the U.S. Geological Survey published a study of the ground and surface waters tested from 30 U.S. states. The findings revealed that there were low levels of pharmaceuticals such as antibiotics, contraceptives, hormones, and steroids in 80% of the water samples (Earth Talk, n.d). In 2009 waterways in rural Central Pennsylvania were found to be contaminated with caffeine, antibiotics, ibuprofen, and diphenhydramine. These findings were attributed to run off from municipal effluents and animal feeding operations (Loper, Crawford, Otto, Manning, Meyer, & Furlong, (2007). The concentrations of pharmaceuticals in the water remains low; however, there is no evidence to identify the human health impacts of long-term exposure of the pharmaceutical agents, their metabolites, and the health impacts of combined exposures to contaminated water and other contaminants.

Pharmaceuticals enter the environment in several ways. First, human consumption of medications leads to excretion of pharmaceutical waste and metabolites into sewage that can be released into aquifers or surface water. In fact, 30-90% of medication is excreted unchanged after ingestion (Pharmaceutical Technology, 2017). While this is unintentional contamination, there is also the purposeful flushing of unused or expired medications. Contamination also occurs as part of pharmaceutical manufacturing and waste disposal. There is also the excretion of pharmaceuticals by animal sources, due to use of medications (generally steroids and antibiotics) in livestock production (BeckerMendz-Quigley & Phillips, 2010).

As our population ages there are increases in chronic illnesses with subsequent increases in prescription medication use that leads to a greater likelihood of pharmaceutical waste in the environment. It is estimated that hospitals and long-term care facilities contribute up to 65% of the unused pharmaceuticals into wastewater facilities (Becker, Mendez-Quigley & Phillips, 2010). The article Managing Pharmaceutical Waste: What Pharmacists Should Know (Smith, 2002) is very helpful to understand federal regulations related to waste management; the definition of pharmaceutical waste; who is generating it; common waste streams and characterization of hazardous waste streams; and how pharmaceutical waste should be managed. In addition, Figure 1 in this chapter provides a visual description of how pharmaceutical waste enters the environment.

In the third edition of Nursing: Scope and Standards of Practice (2015), the American Nurses Association (ANA), Standard 17: Environmental Health specifically states that the registered nurse “advocates for the safe, judicious, and appropriate use, and disposal of products used in health care (p. 84).” This standard of nursing practice is related to medication use and proper disposal. In other words, our code of nursing practice acknowledges the nurse’s professional responsibility to the environment by assuring our knowledge of these issues and proper management and disposal of medications to assure the health of everyone.

Medications that are unwanted, expired, or unused collect in our homes. Patients may have excess medications, including over the counter and prescription drugs, in their homes due to a change in dosage or medication, intolerance, or over-purchasing such as buying medications in bulk at a big box store or ordering long term supplies from their pharmacy as a means to save money on insurance co-pays. There are significant concerns regarding these excess stores of medications including

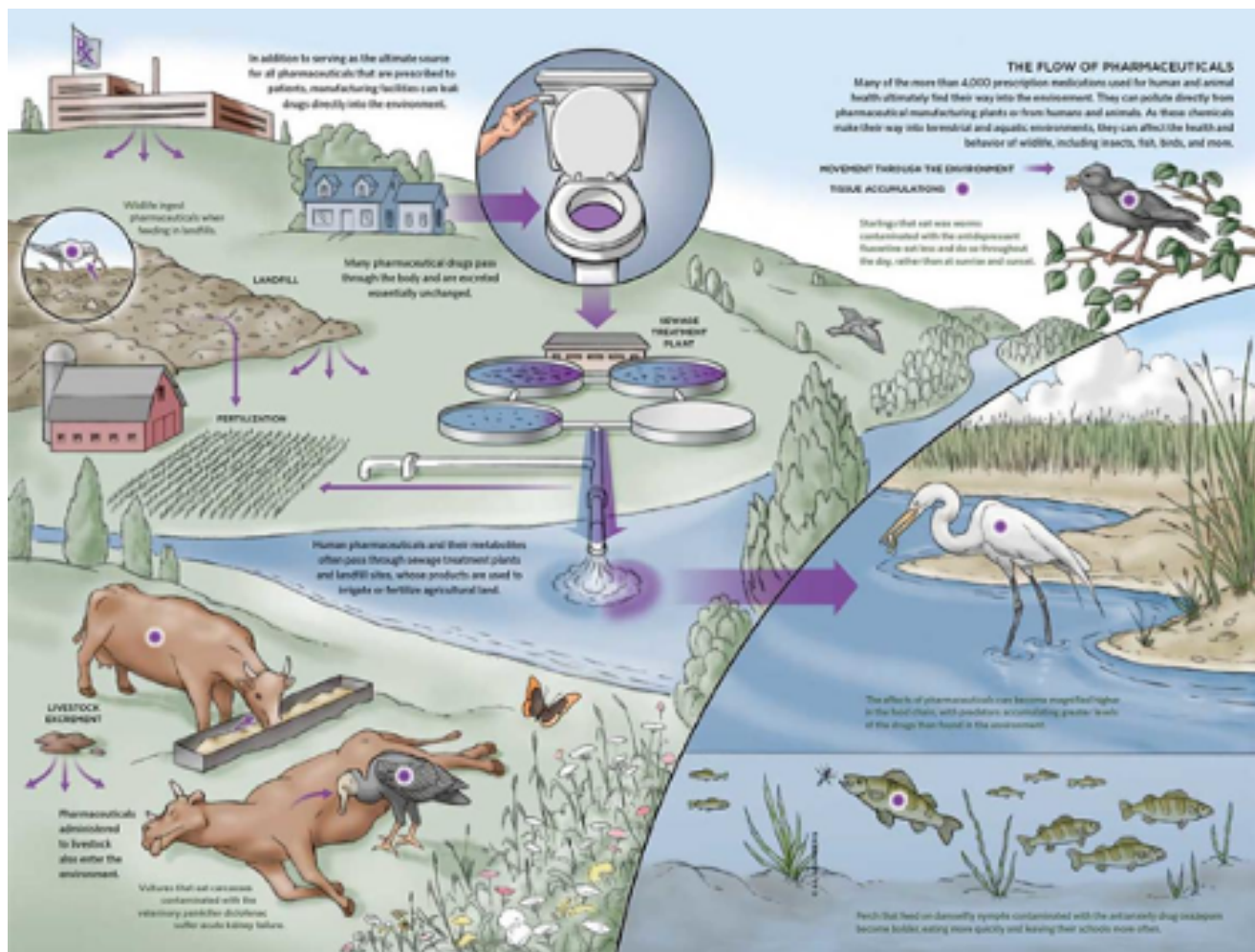


Figure 1: Pharmaceuticals found in our waterways come from human or animal use, or from the pharmaceutical industry. Image from U.S. Geological Survey web site, public domain

accidental ingestion, poisoning of children and pets, accidentally taking the wrong medication, illness from taking expired medications, and diversion. The opioid crisis has placed a greater focus on eliminating excess medications from homes to protect from diversion and accidental ingestion, but additional conversations about minimizing excess medications in homes due to environmental concerns are needed. Despite the concerns of excess medications in our homes, they are rarely disposed of properly (Daughton, 2014).

Healthcare facilities have guidelines and resources for disposal of medications, but nurses in all practice settings, must educate the public about how to properly dispose of unneeded medications to protect the environment, and safety from diversion and accidental ingestion. Often in the community medications are discarded in the trash, in the toilet, or down the drain (Tong, Peake, & Braund, 2011). These disposal methods can contribute to water

contamination and cause health issues for humans and animals alike. For example, in homes with septic tanks and wells as a water source, medications flushed down the drain can leach into the ground, seep into groundwater, and ultimately come out of their tap. Those with private wells are vulnerable of not only what they may be flushing down the drain but also the actions of others in their surrounding area.

Homes that obtain their water from a municipal water source can also be at risk for water contaminated from medications and other chemicals of concern. The municipality may not be equipped or able to test for pharmaceuticals in the water supply (EPA, 2018), and may not have the means to remediate the water if medications are detected and remain in sewage even with water treatment (Daughton, 2014). Low-income, rural, and communities of color may be more likely to have poor infrastructure, or the resources to manage contaminants

including discarded pharmaceuticals (Cook, Curtis, & Huffling, 2017). Education for all community members regarding pharmaceutical disposal and other means for protecting water quality is vital to ensure optimal water quality for all. Hospital nurses should include proper medication disposal in the discharge plans. School nurses should talk to students (depending on child's age) and parents about proper storage and disposal of medications. Nurses working in the community should make medication storage and disposal part of the care that is provided to the individual, family, or community. (See the end of this chapter for resources to support the nurse in medication disposal information.)

Proper prescribing, purchasing, and disposal of medications helps to protect our water supply, protects from accidental ingestion and misuse, removes potentially harmful expired medications, and protects pets and wildlife. Daughton (2014) calls for changes to the current practice of prescribing medications by avoiding imprudent, unnecessary, excessive prescribing, misuse and overconsumption as effective “upstream” measures to protect our water supply. Other suggestions are to consider the excretion profile of the medication and prescribing the lowest dose necessary. It is noted that some medications can even be ordered at a lower “off-label” dose but still be effective (Daughton, 2014). Additionally, proper prescribing and administration of antibiotics may help to prevent antibiotic resistance.

The Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) specifically instructs citizens not to flush medications down the drain or toilet unless the label or patient instructions specifically tell the patient to do so. Medications such as controlled substances and narcotics have specific instructions to discard via flushing down the drain to reduce the danger of overdose stemming from unintentional or illegal use (EPA (a), 2018). An example of this is a fentanyl patch, which after use may still have medication remaining in the patch and the FDA recommends the patch be discarded by flushing. The FDA recognizes there are concerns with medications being disposed of this method, but states “there has been no sign of environmental effects caused by flushing recommended drugs” (2018). For aerosol medications and inhalers, instructions include following local regulations and contacting the local trash and recycling facility (FDA, n.d.).

Proper disposal of medications is not always available due to high costs and knowing the appropriate method. The FDA and EPA recommend citizens dispose of excess medications at community take-back programs in which they will be disposed of in a “safe and environmentally-

conscious way” (EPA (a), 2018, FDA, 2018). Community take-back programs may be combined with a hazardous waste collection event but may also require a pharmacist for identifying medications and security for controlled substances that may be submitted. In 2018, over 6,000 sites participated in the bi-annual National Prescription Drug Take Back Days and collected nearly one million pounds of unwanted drugs. Click here for more information on National Prescription Drug Take Back Days.

Other sources for community disposal of medications include drug disposal kiosks at pharmacies or secure drop-off containers in police departments. Click here to find a Controlled Substance Public Disposal Location by using your zip code. An informal survey of a few towns with these collection containers found the police bring the medications to an incineration company. The EPA describes the disposal of medications via incineration as a “environmentally responsible” and “safe and environmentally-conscious” (EPA (b), 2018). There are significant concerns with this method of disposal on the contributions to particulate air pollution not only from the incinerated medications but also for the containers that hold the medication, which are often plastic. Plastic when burned releases dioxin, a known carcinogen and hormone disruptor, which can enter the air and waterways. Some in the pharmaceutical industry recognize the problem of inadvertent pharmaceuticals in the environment and are working on “Green Pharma”, an initiative that addressed more environmentally safe drug discovery, development, and medication products (Pharmaceutical Technology, 2017).

If a community take-back program is not available, the EPA recommends the following for disposal: remove the medication from the original container, making sure to remove any identifying information from the medication label, mix the medication with an inedible substance such as kitty litter, place the medication in a disposable container with a lid (i.e. margarine container, plastic laundry detergent container), and place the sealed container with your trash. While this may make the medication safer from diversion or accidental ingestion there are still concerns with this method of disposal contributing to water contamination, as the container may leak if it becomes torn or crushed and its contents may leach into the water supply. [Click here](#) for the EPA's How to Properly Dispose of Medications.

Nurses must take every opportunity to teach our patients, families, and communities the importance of proper medication administration, storage, and disposal to not only protect from accidental ingestion, poisoning of

children and pets, and diversion, but also to protect our water supply.

#### RESOURCES FOR NURSES:

DEA: Controlled Substances [https://www.deadiversion.usdoj.gov/schedules/orangebook/c\\_cs\\_alpha.pdf](https://www.deadiversion.usdoj.gov/schedules/orangebook/c_cs_alpha.pdf)

EPA: Collecting and Disposing of Unwanted Medications: <https://www.epa.gov/hwgenerators/collecting-and-disposing-unwanted-medicines>

EPA: Resource Conservation and Recovery Act (RCRA) <https://www.epa.gov/rcra>

FDA: Disposal of unused medicines: What you should know. <https://www.fda.gov/drugs/safe-disposal-medicines/disposal-unused-medicines-what-you-should-know>

Health Care Without Harm: <https://noharm-uscanada.org/>

Practice Greenhealth: Pharmaceutical Waste: <https://practicegreenhealth.org/topics/waste/pharmaceutical-waste>

U.S. Geological Survey Podcast: Pharmaceuticals in the Nation's Water <https://www.usgs.gov/media/audio/pharmaceuticals-nations-water>

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## PERFLUOROALKYL SUBSTANCES (PFAS): EMERGING CONTAMINANTS OF CONCERNS

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### BACKGROUND

Most people in the United States and other industrialized countries have measurable amounts of perfluoroalkyl substances (PFAS) in their blood (ATSDR, 2018). Thousands of chemicals that are designated as PFAS which are commonly found in a wide range of consumer products. For example, PFAS may be used to keep food from sticking to cookware, sofas and carpets more resistant to stains, packaging more resistant to grease, clothes and mattresses more waterproof, and as a component of some firefighting foams. Because PFAS are chemically stable, they are unaffected by typical



From: <https://www.defence.gov.au/Environment/PFAS/pfas.asp>

environmental degradation processes, and are persistent in the environment (ATSDR, 2018).

PFAS remain in the human body for long periods, and data from human studies suggest that some PFAS can take years to be cleared from the body. Certain PFAS have estimated half-lives that can range from two to nine years. These long half-lives result in body burdens that persist for years, even after identified exposure sources have been reduced (ATSDR, 2019; Bartell et al., 2010).

### HEALTH IMPACTS

A large number of studies have examined possible relationships between levels of PFAS in blood and harmful health effects in people. There is evidence that exposure to PFAS can lead to adverse health outcomes. If humans ingest contaminated food, water, or dust, the PFAS are absorbed and can accumulate in the body.

Studies have indicated that PFAS may:

- Affect growth, learning, and behavior of infants and older children;
- Lower a woman's chance of getting pregnant;
- Lower infant birthweight;
- Increase the risk for pre-eclampsia;
- Interfere with the body's natural hormones;
- Increase cholesterol levels;
- Disrupt thyroid hormones;
- Result in cardio-metabolic disruption;
- Affect the immune system; and
- Increase the risk of some cancers (ATSDR, 2019).

The widespread nature of PFAS exposures from everyday consumer products and drinking water, coupled with the potential for long-term health impacts has raised community concerns about health impacts from exposure. There is a critical need to reduce and eliminate these exposures to improve community health over a lifetime. Since 1999, the National Health and Nutrition Examination Survey (NHANES) has measured blood PFAS in the U.S. population. Based on data collected from previous NHANES 3 cycle years, levels of the most common of the PFAS, PFOA and PFOS, are decreasing in the blood of the general population. This decrease appears to be a result of the 2006 agreement by eight major companies in the PFAS industry to phase out—voluntarily—these two PFAS by 2015 (ATSDR, 2018). ATSDR provides tables for two PFAS chemicals: PFOA and PFOS - with breakdowns by age, ethnicity, and gender are available in Appendix A (CDC, 2018).

A major source of PFAS is drinking water, which is currently not regulated in the U.S. The U.S. Environmental Protection Agency (EPA) has not yet issued an enforceable standard called a Maximum Contaminant Level (MCL). In 2016 the EPA established a lifetime Health Advisory Level (HAL), which is set at 70 parts per trillion (ppt) for the combined concentrations of PFOS and PFOA. HALs are not legally enforceable and are not designed to be a definitive health-effect level but rather, provide a margin of protection over a lifetime (EPA, 2016a, 2016b). Above these levels, EPA recommends that public drinking water systems take steps to assess contamination, inform consumers, and limit exposure (EPA 2017, 2019). Because of this uncertainty and lack of federal regulation, some states are beginning to establish their own guidelines. The Association of State Drinking Water Administrators (2019) provides information on states with proposed or established standards. For families interested in testing their water, EPA suggests using a lab that is approved to use the EPA 537 method to detect PFAS. Locations can be found at: <https://www.epa.gov/sites/production/files/2016-10/documents/ucmr3-lab-approval.pdf>.

### CLINICAL IMPLICATIONS

In addition to the absence of a drinking water regulation, there are no established clinical reference levels for PFAS in the blood. This absence provides uncertainty by providers looking to manage cases, especially of mothers exposed to PFAS and their children. If your patient presents with health concerns that might be associated with PFAS exposure, it is appropriate to discuss these concerns and perform a thorough exposure history and a physical exam relative to any symptoms. Since there is no consensus related to long-term medical management for those exposed to levels higher than the background, reducing and preventing exposure is the critical intervention (Anderko & Pennea, 2020; Anderko, Pennea, & Chalupka, 2020).

Reduction and prevention of PFAS exposures can be accomplished by offering guidance to families about how to identify and reduce current sources of PFAS exposure, including drinking water and consumer products. When health concerns arise that might be associated with PFAS, it is important to conduct a complete history, including exposure assessment and physical exam relative to any symptom reported and manage the issue with established evidence-based guidelines (e.g., routine cholesterol screening; thyroid function tests if a patient has symptoms consistent with thyroid dysfunction) (Anderko & Pennea, 2020; Anderko, Pennea, & Chalupka, 2020).

Health providers should determine the need for monitoring based on risk factors such as age, source of drinking water, consumer products used, and occupational exposures. If there are concerns about PFAS exposure, a blood sample can test for the level of PFAS in the body. However, health effects from PFAS at low environmental doses or at bio-monitored levels from low environmental exposures are unknown. Since there currently is no established blood level of PFAS, the tests cannot predict past or future health problems. Most laboratories do not have testing methods for PFAS, however, a few laboratories can offer these tests. Information can be found by contacting your local Pediatric Environmental Health Specialty Unit (PEHSU). Dedicated to educating health professionals and the general public about reproductive and children's environmental health issues, the federally funded PEHSU national network offers fact sheets, webinars, and lectures to discuss emerging research and assist in translating findings to clinical practice and public health protections ([www.pehsu.net](http://www.pehsu.net)).

### PREVENTING EXPOSURES

Since there is no known treatment once exposure occurs, prevention of exposures is critical. In the absence of federal regulation, clinicians can provide pregnant women and families with resources and several strategies for reducing exposures including:

- Water filtration of contaminated water sources by using granulated activated carbon (GAC) and/or reverse osmosis (RO) (Anumol, Clarke, Merel, & Snyder, 2015)
- Dust control in the home (including wet mopping, wet dusting, and vacuuming) to reduce exposure from PFAS-contaminated house dust
- Avoid purchasing and using products with PFAS such as non-stick pans, waterproof garments, and stain-resistant carpets
- Check local fish advisories in your community, as some states have fish consumption advisories for certain water bodies where PFOS has been detected in fish

*PFAS: An Overview of the Science and Guidance for Clinicians on Per- and Poly-fluoroalkyl Substances (PFAS)* offers more detailed information for clinicians (ATSDR, 2019).

### LOOKING FORWARD

The CDC and Agency for Toxic Substances and Disease Registry (ATSDR) measures PFAS as part of its national biomonitoring program. Current PFAS levels can be found

in its 2018 report (CDC, 2018). Recently, CDC/ATSDR launched a nationwide multi-site risk assessment to expand the science about the relationships between PFAS exposure near current or former military installations (CDC, 2019a) and is beginning to conduct a multi-site study on the human health effects of exposures to PFAS through drinking water (CDC, 2019b). See Appendix B for information about the Exposure Assessments. The goal of the health assessment study is to learn more about the relationship between PFAS exposure and health outcomes among differing populations. These findings can be used to advance the science, and help health professionals to address health issues in communities impacted by PFAS. See Appendix C for Exposure Assessment sites.

While research continues to emerge on health outcomes associated with PFAS exposure, the PEHSU national network is working closely with CDC/ATSDR to provide the most up-to-date information to guide clinicians' practice and protect the public's health ([www.pehsu.net](http://www.pehsu.net)). Ultimately, a healthy public policy that regulates PFAS is needed to reduce exposures and health impacts negatively impacting children.

### Serum Perfluorooctane sulfonic acid (PFOS) (2013 – 2014)†

Geometric mean and selected percentiles of serum concentrations (in µg/L) for the U.S. population from the National Health and Nutrition Examination Survey.

#### Special Sample of Serum PFAS in Children 3 to 11 Years Old, 2013 – 2014

| Categories            | Survey years | Geometric mean<br>(95% conf. interval) | 50th Percentile<br>(95% conf. interval) | 75th Percentile<br>(95% conf. interval) | 90th Percentile<br>(95% conf. interval) | 95th Percentile<br>(95% conf. interval) | Sample size |
|-----------------------|--------------|----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-------------|
| <b>Total</b>          | 13-14        | <b>3.88</b> (3.53-4.27)                | <b>3.75</b> (3.44-4.17)                 | <b>5.56</b> (4.83-6.33)                 | <b>7.99</b> (7.02-9.53)                 | <b>11.0</b> (9.03-12.4)                 | 639         |
| <b>Age group</b>      |              |                                        |                                         |                                         |                                         |                                         |             |
| 3-5 years             | 13-14        | <b>3.38</b> (3.04-3.77)                | <b>3.41</b> (2.84-3.78)                 | <b>4.78</b> (3.98-6.32)                 | <b>7.18</b> (5.50-8.71)                 | <b>8.82</b> (7.18-11.0)                 | 181         |
| 6-11 years            | 13-14        | <b>4.15</b> (3.76-4.58)                | <b>4.02</b> (3.54-4.45)                 | <b>5.77</b> (5.10-6.43)                 | <b>8.78</b> (6.75-11.8)                 | <b>12.4</b> (9.32-14.1)                 | 458         |
| <b>Gender</b>         |              |                                        |                                         |                                         |                                         |                                         |             |
| Males                 | 13-14        | <b>4.07</b> (3.56-4.65)                | <b>4.13</b> (3.44-4.76)                 | <b>6.19</b> (5.29-7.18)                 | <b>8.78</b> (7.18-11.8)                 | <b>11.8</b> (8.01-15.4)                 | 343         |
| Females               | 13-14        | <b>3.70</b> (3.38-4.05)                | <b>3.54</b> (3.24-3.98)                 | <b>4.88</b> (4.45-5.70)                 | <b>7.02</b> (6.33-8.71)                 | <b>9.44</b> (7.17-12.0)                 | 296         |
| <b>Race/ethnicity</b> |              |                                        |                                         |                                         |                                         |                                         |             |
| All Hispanics         | 13-14        | <b>3.53</b> (3.13-3.99)                | <b>3.41</b> (2.85-3.84)                 | <b>4.71</b> (4.13-5.65)                 | <b>7.60</b> (5.43-9.44)                 | <b>9.32</b> (6.50-11.0)                 | 220         |
| Other                 | 13-14        | <b>4.01</b> (3.62-4.44)                | <b>3.96</b> (3.44-4.48)                 | <b>5.97</b> (5.02-6.49)                 | <b>8.06</b> (6.98-11.3)                 | <b>12.0</b> (9.10-13.6)                 | 419         |

†See Calculation of PFOS and PFOA as the Sum of Isomers for additional information.

#### Biomonitoring Summary

[http://www.ode.gov/biomonitoring/PFAS\\_BiomonitoringSummary.html](http://www.ode.gov/biomonitoring/PFAS_BiomonitoringSummary.html)

#### Factsheet

[http://www.ode.gov/biomonitoring/PFAS\\_FactSheet.html](http://www.ode.gov/biomonitoring/PFAS_FactSheet.html)

| Categories            | Survey years | Geometric mean<br>(95% conf. interval) | 50th Percentile<br>(95% conf. interval) | 75th Percentile<br>(95% conf. interval) | 90th Percentile<br>(95% conf. interval) | 95th Percentile<br>(95% conf. interval) | Sample size |
|-----------------------|--------------|----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-------------|
| <b>Total</b>          | 11-12        | <b>2.08</b> (1.95-2.22)                | <b>2.08</b> (1.98-2.26)                 | <b>3.03</b> (2.76-3.27)                 | <b>4.35</b> (3.82-4.85)                 | <b>5.68</b> (5.02-6.49)                 | 1904        |
|                       | 13-14‡       | <b>1.94</b> (1.76-2.14)                | <b>2.07</b> (1.87-2.20)                 | <b>3.07</b> (2.67-3.37)                 | <b>4.27</b> (3.57-5.17)                 | <b>5.57</b> (4.60-6.27)                 | 2165        |
| <b>Age group</b>      |              |                                        |                                         |                                         |                                         |                                         |             |
| 12-19 years           | 11-12        | <b>1.80</b> (1.71-1.91)                | <b>1.74</b> (1.67-1.89)                 | <b>2.41</b> (2.17-2.62)                 | <b>2.93</b> (2.68-3.19)                 | <b>3.59</b> (2.93-4.25)                 | 344         |
|                       | 13-14‡       | <b>1.66</b> (1.50-1.84)                | <b>1.67</b> (1.37-1.97)                 | <b>2.20</b> (1.87-2.57)                 | <b>2.87</b> (2.57-3.40)                 | <b>3.47</b> (2.87-4.37)                 | 401         |
| 20 years and older    | 11-12        | <b>2.12</b> (1.98-2.28)                | <b>2.16</b> (2.01-2.33)                 | <b>3.15</b> (2.90-3.36)                 | <b>4.64</b> (3.93-5.25)                 | <b>5.94</b> (5.34-7.45)                 | 1560        |
|                       | 13-14‡       | <b>1.98</b> (1.79-2.19)                | <b>2.07</b> (1.90-2.27)                 | <b>3.17</b> (2.77-3.47)                 | <b>4.47</b> (3.70-5.27)                 | <b>5.80</b> (4.67-6.40)                 | 1784        |
| <b>Gender</b>         |              |                                        |                                         |                                         |                                         |                                         |             |
| Males                 | 11-12        | <b>2.37</b> (2.22-2.53)                | <b>2.38</b> (2.26-2.56)                 | <b>3.25</b> (3.00-3.56)                 | <b>4.61</b> (4.11-5.02)                 | <b>5.62</b> (4.85-6.20)                 | 966         |
|                       | 13-14‡       | <b>2.29</b> (2.09-2.50)                | <b>2.37</b> (2.17-2.57)                 | <b>3.27</b> (2.87-3.60)                 | <b>4.67</b> (3.77-5.60)                 | <b>5.67</b> (4.67-6.27)                 | 1031        |
| Females               | 11-12        | <b>1.84</b> (1.68-2.01)                | <b>1.78</b> (1.62-1.96)                 | <b>2.65</b> (2.34-3.14)                 | <b>3.91</b> (3.38-4.99)                 | <b>5.68</b> (4.33-6.45)                 | 938         |
|                       | 13-14‡       | <b>1.66</b> (1.48-1.87)                | <b>1.67</b> (1.47-1.87)                 | <b>2.67</b> (2.27-3.07)                 | <b>3.77</b> (3.37-4.70)                 | <b>5.07</b> (4.07-6.70)                 | 1134        |
| <b>Race/ethnicity</b> |              |                                        |                                         |                                         |                                         |                                         |             |
| Mexican Americans     | 11-12        | <b>1.66</b> (1.37-2.02)                | <b>1.71</b> (1.32-2.23)                 | <b>2.43</b> (1.98-2.98)                 | <b>3.38</b> (2.43-4.48)                 | <b>4.08</b> (2.98-6.15)                 | 211         |
|                       | 13-14‡       | <b>1.36</b> (1.25-1.47)                | <b>1.37</b> (1.27-1.47)                 | <b>1.97</b> (1.87-2.10)                 | <b>2.70</b> (2.40-3.10)                 | <b>3.17</b> (2.57-3.77)                 | 332         |
| Non-Hispanic blacks   | 11-12        | <b>1.80</b> (1.71-1.90)                | <b>1.94</b> (1.76-2.09)                 | <b>2.82</b> (2.65-2.95)                 | <b>3.94</b> (3.51-4.40)                 | <b>5.11</b> (4.40-5.79)                 | 485         |
|                       | 13-14‡       | <b>1.52</b> (1.34-1.73)                | <b>1.67</b> (1.37-1.97)                 | <b>2.57</b> (2.17-2.97)                 | <b>3.60</b> (3.07-4.50)                 | <b>4.60</b> (3.40-5.77)                 | 455         |
| Non-Hispanic whites   | 11-12        | <b>2.25</b> (2.05-2.47)                | <b>2.25</b> (1.98-2.48)                 | <b>3.21</b> (2.90-3.50)                 | <b>4.68</b> (3.95-5.35)                 | <b>6.20</b> (5.34-7.74)                 | 666         |
|                       | 13-14‡       | <b>2.20</b> (1.91-2.52)                | <b>2.27</b> (1.97-2.67)                 | <b>3.37</b> (2.77-3.77)                 | <b>4.77</b> (3.77-5.67)                 | <b>5.77</b> (4.80-6.87)                 | 861         |
| All Hispanics         | 11-12        | <b>1.70</b> (1.48-1.95)                | <b>1.79</b> (1.59-1.95)                 | <b>2.46</b> (2.15-2.91)                 | <b>3.60</b> (2.95-4.48)                 | <b>4.70</b> (3.87-5.94)                 | 408         |
|                       | 13-14‡       | <b>1.45</b> (1.33-1.59)                | <b>1.47</b> (1.37-1.67)                 | <b>2.10</b> (1.97-2.40)                 | <b>3.07</b> (2.67-3.27)                 | <b>3.47</b> (3.17-3.97)                 | 537         |
| Asians                | 11-12        | <b>2.08</b> (1.83-2.36)                | <b>2.21</b> (2.04-2.27)                 | <b>2.92</b> (2.55-3.45)                 | <b>4.66</b> (3.42-5.79)                 | <b>5.79</b> (4.93-8.91)                 | 291         |
|                       | 13-14‡       | <b>1.97</b> (1.75-2.23)                | <b>1.87</b> (1.67-2.27)                 | <b>2.97</b> (2.47-3.57)                 | <b>4.67</b> (3.97-5.77)                 | <b>5.90</b> (5.00-6.40)                 | 234         |

Limit of detection (LOD, see Data Analysis section) for Survey year 11-12 is 0.1.

‡See Calculation of PFOS and PFOA as the Sum of Isomers for additional information about Survey years 2013-2014.

**Serum Perfluorooctane sulfonic acid (PFOS) (2013 – 2014)†**

Geometric mean and selected percentiles of serum concentrations (in µg/L) for the U.S. population from the National Health and Nutrition Examination Survey.

**Special Sample of Serum PFAS in Children 3 to 11 Years Old, 2013 – 2014**

| Categories            | Survey years | Geometric mean<br>(95% conf. interval) | 50th Percentile<br>(95% conf. interval) | 75th Percentile<br>(95% conf. interval) | 90th Percentile<br>(95% conf. interval) | 95th Percentile<br>(95% conf. interval) | Sample size |
|-----------------------|--------------|----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-------------|
| <b>Total</b>          | 13-14        | <b>3.88</b> (3.53-4.27)                | <b>3.75</b> (3.44-4.17)                 | <b>5.56</b> (4.83-6.33)                 | <b>7.99</b> (7.02-9.53)                 | <b>11.0</b> (9.03-12.4)                 | 639         |
| <b>Age group</b>      |              |                                        |                                         |                                         |                                         |                                         |             |
| 3-5 years             | 13-14        | 3.38 (3.04-3.77)                       | 3.41 (2.84-3.78)                        | 4.78 (3.98-6.32)                        | 7.18 (5.50-8.71)                        | 8.82 (7.18-11.0)                        | 181         |
| 6-11 years            | 13-14        | 4.15 (3.76-4.58)                       | 4.02 (3.54-4.45)                        | 5.77 (5.10-6.43)                        | 8.78 (6.75-11.8)                        | 12.4 (9.32-14.1)                        | 458         |
| <b>Gender</b>         |              |                                        |                                         |                                         |                                         |                                         |             |
| Males                 | 13-14        | 4.07 (3.56-4.65)                       | 4.13 (3.44-4.76)                        | 6.19 (5.29-7.18)                        | 8.78 (7.18-11.8)                        | 11.8 (8.01-15.4)                        | 343         |
| Females               | 13-14        | 3.79 (3.38-4.05)                       | 3.54 (3.24-3.96)                        | 4.88 (4.45-5.70)                        | 7.02 (6.33-8.71)                        | 9.44 (7.17-12.0)                        | 296         |
| <b>Race/ethnicity</b> |              |                                        |                                         |                                         |                                         |                                         |             |
| All Hispanics         | 13-14        | 3.53 (3.13-3.99)                       | 3.41 (2.85-3.84)                        | 4.71 (4.13-5.65)                        | 7.60 (5.43-9.44)                        | 9.32 (6.50-11.0)                        | 220         |
| Other                 | 13-14        | 4.01 (3.62-4.44)                       | 3.96 (3.44-4.48)                        | 5.97 (5.02-6.49)                        | 8.06 (6.98-11.3)                        | 12.0 (9.10-13.6)                        | 419         |

†See Calculation of PFOS and PFOA as the Sum of Isomers for additional information.

**Biomonitoring Summary**

[http://www.epa.gov/biomonitoring/PFAS\\_BiomonitoringSummary.html](http://www.epa.gov/biomonitoring/PFAS_BiomonitoringSummary.html)

**Factsheet**

[http://www.epa.gov/biomonitoring/PFAS\\_FactSheet.html](http://www.epa.gov/biomonitoring/PFAS_FactSheet.html)

| Categories            | Survey years | Geometric mean<br>(95% conf. interval) | 50th Percentile<br>(95% conf. interval) | 75th Percentile<br>(95% conf. interval) | 90th Percentile<br>(95% conf. interval) | 95th Percentile<br>(95% conf. interval) | Sample size |
|-----------------------|--------------|----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-------------|
| <b>Total</b>          | 11-12        | <b>6.31</b> (5.84-6.82)                | <b>6.53</b> (5.99-7.13)                 | <b>10.5</b> (9.78-11.1)                 | <b>15.7</b> (14.7-17.5)                 | <b>21.7</b> (19.3-23.9)                 | 1904        |
|                       | 13-14‡       | <b>4.99</b> (4.50-5.52)                | <b>5.20</b> (4.80-5.70)                 | <b>8.70</b> (7.90-9.40)                 | <b>13.9</b> (11.9-15.5)                 | <b>18.5</b> (15.4-22.0)                 | 2165        |
| <b>Age group</b>      |              |                                        |                                         |                                         |                                         |                                         |             |
| 12-19 years           | 11-12        | 4.16 (3.70-4.68)                       | 4.11 (3.48-4.65)                        | 5.90 (5.14-7.25)                        | 9.05 (6.49-10.8)                        | 10.8 (8.52-14.2)                        | 344         |
|                       | 13-14‡       | 3.54 (3.17-3.96)                       | 3.60 (3.10-4.20)                        | 5.20 (4.60-6.20)                        | 7.80 (7.00-8.90)                        | 9.30 (7.90-11.7)                        | 401         |
| 20 years and older    | 11-12        | 6.71 (6.24-7.20)                       | 7.07 (6.65-7.52)                        | 11.0 (10.4-11.9)                        | 17.0 (15.3-18.5)                        | 22.7 (20.4-24.8)                        | 1560        |
|                       | 13-14‡       | 5.22 (4.70-5.81)                       | 5.60 (5.10-6.00)                        | 9.10 (8.20-10.2)                        | 14.5 (12.9-16.1)                        | 19.5 (15.8-23.0)                        | 1764        |
| <b>Gender</b>         |              |                                        |                                         |                                         |                                         |                                         |             |
| Males                 | 11-12        | 7.91 (7.19-8.70)                       | 8.31 (7.35-9.15)                        | 12.5 (11.4-13.5)                        | 19.3 (15.7-21.4)                        | 24.1 (22.2-28.5)                        | 966         |
|                       | 13-14‡       | 6.36 (5.62-7.20)                       | 6.40 (5.70-7.30)                        | 10.2 (8.70-11.5)                        | 15.5 (13.2-19.8)                        | 22.1 (16.7-26.8)                        | 1031        |
| Females               | 11-12        | 5.10 (4.70-5.53)                       | 5.27 (4.67-5.84)                        | 8.57 (7.87-9.30)                        | 12.5 (11.0-14.9)                        | 17.5 (14.9-20.5)                        | 938         |
|                       | 13-14‡       | 3.96 (3.60-4.35)                       | 4.00 (3.60-4.60)                        | 7.20 (6.40-7.70)                        | 11.8 (9.70-13.6)                        | 15.1 (13.9-17.3)                        | 1134        |
| <b>Race/ethnicity</b> |              |                                        |                                         |                                         |                                         |                                         |             |
| Mexican Americans     | 11-12        | 4.79 (4.07-5.64)                       | 5.18 (3.92-6.33)                        | 7.91 (6.18-9.48)                        | 10.5 (8.50-12.6)                        | 12.1 (10.0-14.4)                        | 211         |
|                       | 13-14‡       | 3.47 (2.90-4.16)                       | 3.70 (3.00-4.40)                        | 5.20 (4.60-6.40)                        | 8.80 (6.40-10.3)                        | 10.8 (9.20-11.8)                        | 332         |
| Non-Hispanic blacks   | 11-12        | 6.35 (5.41-7.46)                       | 6.57 (5.71-7.65)                        | 11.3 (9.74-13.9)                        | 21.8 (13.9-31.3)                        | 30.7 (21.8-45.1)                        | 485         |
|                       | 13-14‡       | 5.32 (4.12-6.88)                       | 5.30 (4.30-6.80)                        | 10.2 (7.60-13.7)                        | 17.4 (12.4-24.5)                        | 24.5 (16.3-39.7)                        | 455         |
| Non-Hispanic whites   | 11-12        | 6.71 (6.15-7.32)                       | 6.83 (6.07-7.73)                        | 10.7 (9.89-12.2)                        | 15.7 (14.8-18.1)                        | 21.3 (18.7-23.5)                        | 666         |
|                       | 13-14‡       | 5.31 (4.72-5.98)                       | 5.70 (5.10-6.40)                        | 8.90 (8.20-9.90)                        | 14.1 (12.2-15.6)                        | 18.0 (15.5-20.4)                        | 861         |
| All Hispanics         | 11-12        | 4.63 (3.86-5.55)                       | 5.18 (4.41-6.19)                        | 8.10 (6.64-9.78)                        | 11.0 (9.96-12.6)                        | 13.4 (11.5-16.1)                        | 406         |
|                       | 13-14‡       | 3.51 (3.09-3.98)                       | 3.70 (3.20-4.20)                        | 5.50 (4.90-6.40)                        | 8.80 (8.00-9.70)                        | 10.8 (9.70-12.1)                        | 537         |
| Asians                | 11-12        | 7.10 (5.80-8.68)                       | 7.53 (5.96-9.25)                        | 12.6 (10.8-17.0)                        | 24.6 (19.1-33.3)                        | 35.1 (28.4-42.3)                        | 291         |
|                       | 13-14‡       | 6.18 (5.08-7.52)                       | 6.30 (5.00-7.90)                        | 13.2 (9.40-15.4)                        | 23.8 (15.2-33.9)                        | 33.6 (20.1-69.0)                        | 234         |

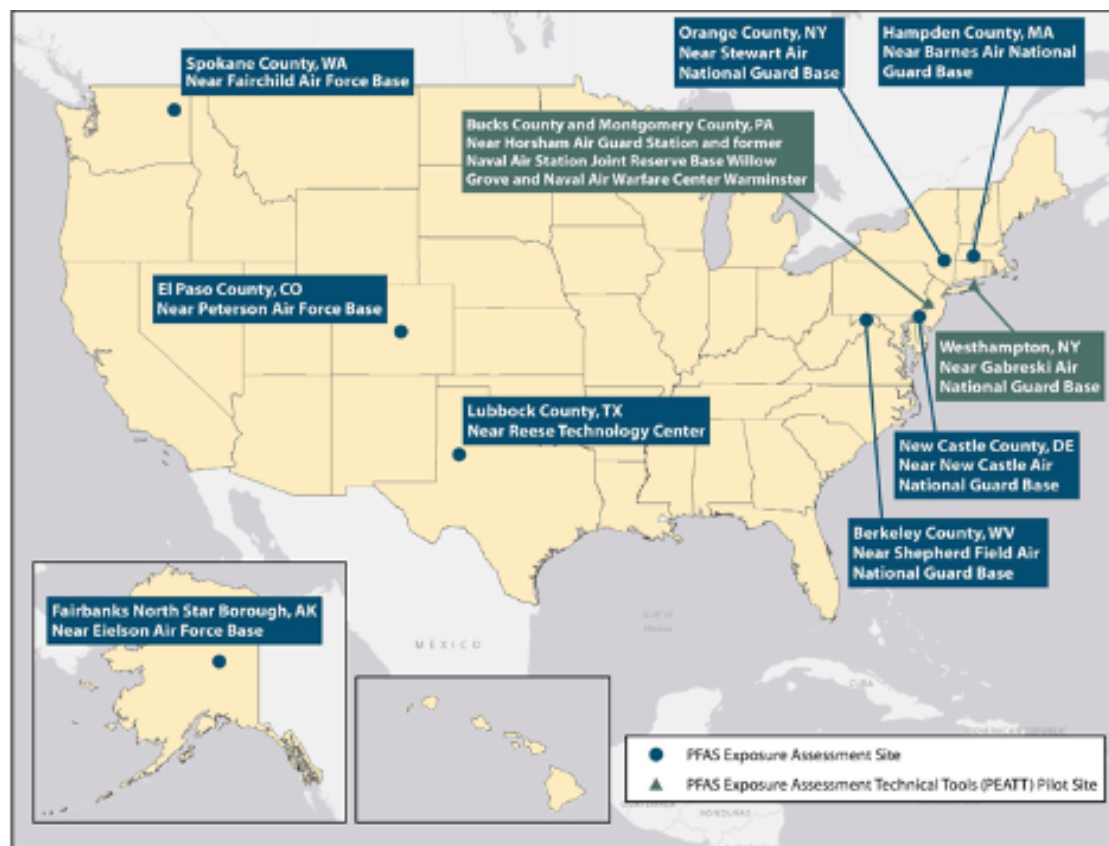
Limit of detection (LOD, see Data Analysis section) for Survey year 11-12 is 0.2.

‡See Calculation of PFOS and PFOA as the Sum of Isomers for additional information about Survey years 2013-2014.



From: <https://www.atsdr.cdc.gov/pfas/docs/PFAS-EA-Factsheet-508.pdf>

## APPENDIX C



From: <https://www.atsdr.cdc.gov/pfas/docs/PFAS-EA-Factsheet-508.pdf>

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## LEAD RISK AND PREVENTION

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Lead, a toxic metal, is found in air, soil, dust, water and consumer products. For many years, its uses in household plumbing, and paint, as well as gasoline, were sources of human exposure. The declining lead levels in children since the 1970s, resulting from the use of unleaded gasoline and lead-free paint, form an important public health progress over the last several decades. Ingestion and inhalation form the two primary modes of entry into the body.

Prevention (CDC) dropped the standard blood level to 5  $\mu\text{g/dL}$  (Raymond, Wheeler, & Brown, 2014). As more evidence becomes available, it is clear that small amounts of lead still pose harm.

Even low lead levels affect IQ, academic achievement and mental and behavioral problems (Hauptman, Bruccoleri & Woof, 2017). While decreases in the acceptable lead level reflect an improved understanding of the consequences of lead exposure, the United States Environmental Protection Agency (EPA) states that there is no safe level of lead exposure. Numerous factors increase a child's likelihood of lead poisoning including normal hand-to-

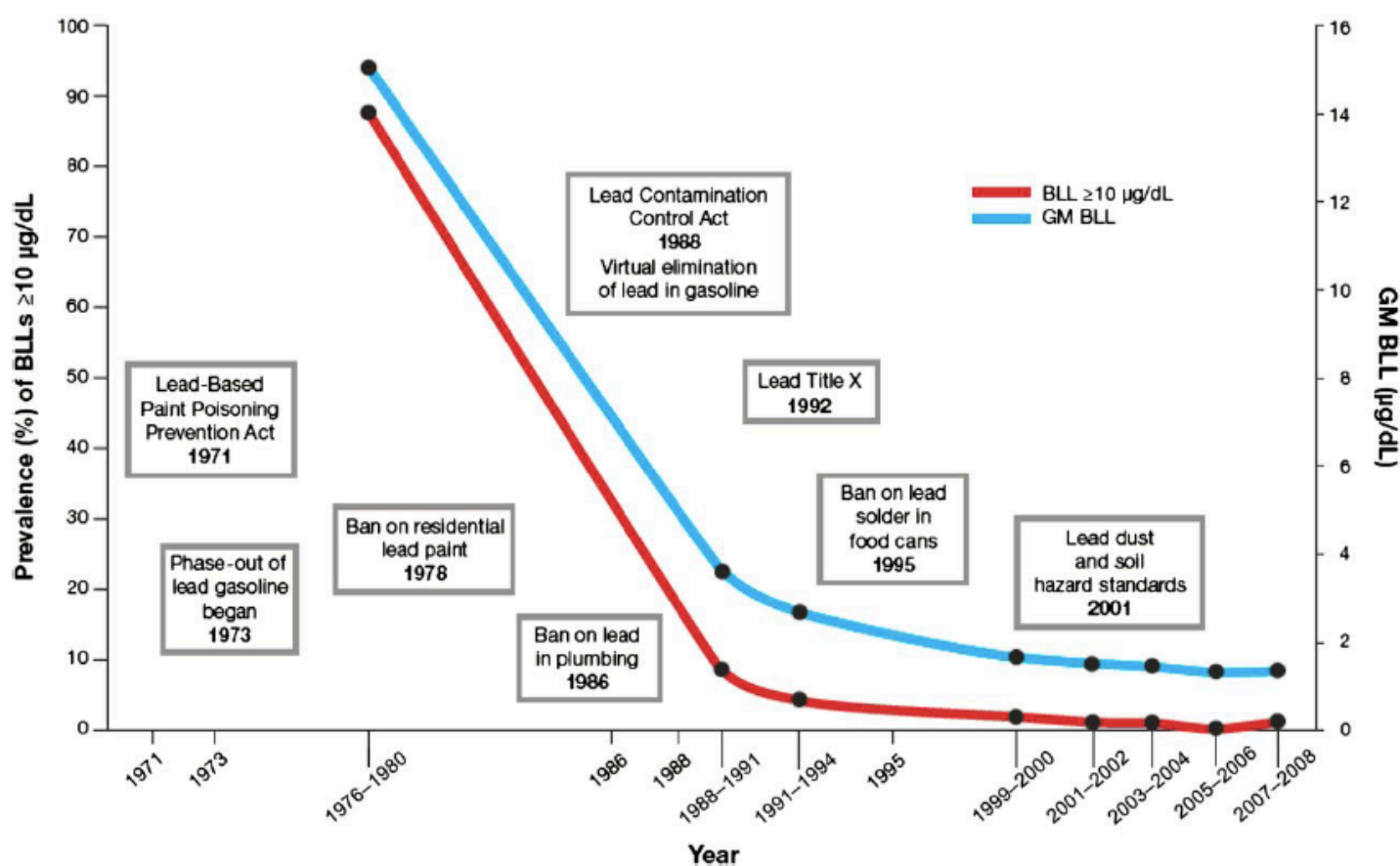


Table I: Lead Levels and Legislation to Reduce Lead in the Environment

Lead exposure can lead to adverse cognitive problems, neurobehavioral issues, poor test scores and Attention Deficit Disorder. In the 1970s, the Surgeon General deemed a serum level of 40  $\mu\text{g/dL}$  as safe (Wessel & Dominski, 1977). As science advanced, blood levels of less than or equal 10  $\mu\text{g/dL}$  was considered an acceptable level. However, in 2012, the Centers for Disease Control and

mouth behaviors and an immature blood brain barrier during a period of rapid brain development (Schnur & John, 2014).

While prevalence data by exposure type remains scarce, nursing advocates continue to stress the need to educate consumers and patients regarding unusual sources which plague low income, ethnic minorities, and immigrants

disproportionately (Hauptman, Bruccoleri & Woof, 2017). Children of low socioeconomic means may have increased risks of lead poisoning due to poor housing and nutritional deficits, as iron deficiency anemia increases lead absorption through the gastrointestinal track. The New York City Department of Health provides outreach to clinicians and [patient education materials](#) regarding common potential lead sources in the ethnically diverse city, including spices, candies, nuts brought from abroad, health remedies, cosmetics, jewelry, and toys (Hore, Ahmed, Nagin & Clark, 2014). A convenience sample in the United States of Afghani eye liner products (also called Surma or Kohl), used on children to ward off evil, showed that 70% of the samples contained lead (McMichael & Stoff, 2018). Researchers in India found out of 97 random toys selected to assess for lead, 22 samples showed levels above the permissible rate (Dutta, et al., 2016). Forbes magazine investigated the lack of regulations on permissible lead levels in shooting ranges and military facilities where lead bullet dust on clothing led to cases of elevated levels in adults and subsequently in their infant children inhaling the dust from the parents' clothing (MacBride, 2018). The concept of take-home lead, a term from the National Institute for Occupational Safety and Health (NIOSH), includes lead brought into the home from building renovations, scrap metal work, recycling, and shooting range work (Hauptman, Bruccoleri, & Woof, 2017). Researchers in China identified numerous folk and herbal medications as a source of childhood lead poisoning (Ying, Markowitz & Yan, 2018).

Lead also produces long-term social and economic costs to society. A study by Columbia University's Mailman School of Public Health on the lead crisis in Flint, Michigan, reported that the social cost of lead poisoning is valued over \$400 million (Muennig, 2016) and that high lead levels costs to society include lower economic productivity, dependence on welfare programs and costs to the criminal justice system due to neurological problems leading to aggression and violence that can occur as poisoned children mature into adulthood. Additionally, young men jailed for juvenile delinquency issues show higher lead levels than other men in their same neighborhoods (Landrigan & Landrigan, 2018). Lead-exposed children require an estimated \$5600 in medical and special health services (Hauptman, Bruccoleri & Woolf, 2017)

Therefore, recognizing potential sources of lead risk allows for interventions to prevent lead exposure before they occur as a primary prevention strategy, as well as potentially making an impact on disparities in lead poisoning cases. Lead risk assessment screening [questionnaires](#) help nurses identify potential lead sources

in a patient's environment and most state health departments can provide them to nurses. Increasingly, electronic health records (EHRs) are adopting these screening questions as part of routine history and physicals for children.

## EXPOSURE SOURCES: THE ROLE OF NURSES

Lead screening tests focus on secondary prevention in that they identify lead exposure hopefully before it manifests to a problem. However, given that there is no known safe level and the risk of extreme toxicity of lead exposure, nurses can reframe the issue with a primary prevention approach. This focus should be on regulation and legislation to prevent lead in the environment, as well as patient education on potential exposure sources. The most common source of lead exposure in the US is attributed to paint exposure, but numerous other sources exist and should be part of preventive education.

**Household exposures:** Windows, walls and door frames, as well as old painted furniture, are potential exposure sites for children in the home setting. Additionally, remodeling and home construction can stir up lead in the home. Most homes built prior to 1978 contain lead paint and nurses should discuss this with patients and offer prevention methods for families at risk of lead exposure. Flaking and peeling paint are potential exposure sources for children and if noted, should be addressed by homeowners and landlords.

**Water Systems:** Lead in water systems is most likely caused by lead service lines or lead solder, both banned in 1986. Many communities coat lead pipes with biofilms to keep the lead pipes from contact with the water and sometimes additional chemicals need to be added to protect this film. This important step was missing in Flint, Michigan, thus causing numerous cases of lead poisoning in 2014. Local and state health and water officials must inform consumers about lead issues in public water sources. Nationally, lead in public drinking water is regulated under the Clean Drinking Water Act. Lead can be eliminated in water by running cold water to flush the lines when it has been sitting in the pipes all day.

**Cosmetics:** Traditional eye make-up and other cosmetics manufactured in Asia, the Middle East, and Africa have been reported to contain lead. Known as khol, kajal, tiro or surma in different countries, the practice of putting on eyeliner is thought to protect the eyes and ward off evil in several countries (McMichael & Stoff, 2018). Yet, this practice can result in lead absorption through the conjunctiva. In the US, this problem shows up mostly in newly arrived refugee children and thus, the CDC recommends that all refugee children in the US ages 6

months-16 years be screened upon arrival and six months later, as outlined in a [tool kit](#) focusing on lead poisoning prevention for newly arrived refugee children. Nurses can raise awareness about this potential source of lead exposure and discuss lead-free alternative products to families engaging in this cultural practice.

**Occupational/Recreational exposures:** Lead ammunition continues to be used for hunting and shooting. Lead poisoning from game hunted with lead ammunition posed a threat to those eating the meat (Arnemo, et al, 2016). Nontoxic shot has been required nationally in the US, though it is rarely enforced. Furthermore, military and police personnel as well as staff in shooting ranges, may be exposed to lead dust through their activities involving lead bullets. Lead dust on their clothing has been shown to lead to elevated lead levels in their children, due to inhalation (Gorospe & Gerstenberger, 2008). In a study of lead contamination among construction workers, researchers found that children of lead-exposed construction workers were six times more likely to have blood lead levels over the recommended limit than children whose parents did not work in lead-related industries (Whelan, 1997). This study indicates the importance of conducting an occupational history with the parents of pediatric patients and providing appropriate education on prevention of childhood exposure from parents. The [Minnesota Department of Health](#) offers guidance on what types of occupations may lead workers to carry lead home with them including battery manufacturing, radiator repair, and home remodeling.

**Gardening:** Urban soils may be contaminated with lead particles from old homes, proximity to highways, and previous industrial sites. Nurses should encourage that urban gardeners learn the previous use of the site, place garden plots far from wooden homes with peeling paint built prior to 1940 and test the soil for lead and other toxicants before planting. Food should not be grown in soil over 400 ppm. Lead is more likely to be found in leafy green vegetables and root vegetables. Plants in potted receptacles or raised beds with fresh soil are safer options.

**Children's Toys, Jewelry, other household items:** Imported toys and jewelry made in China and older toys painted with lead paint can contain lead. Children putting toys and other objects in their mouths increases the risk of lead ingestion. Some mini-blinds contain lead, as well. Ceramic and pottery with lead-based glazes can leach into food. Glassware with painted surfaces or leaded crystal are other sources. Families should be counseled to check all dishes, especially those from

abroad and antiques, with lead testing kits that are easily available from local hardware stores. A thorough environmental assessment by the nurse can address these potential lead exposures.

**Consumables:** Candies, spices and herbs from abroad have been associated with high levels of lead. Both the packaging and the product could contain lead particles. Families should be asked about the country of origin of their food sources, as well as the folk remedies used. Local alternatives should be suggested in exchange for goods brought into the country or purchased in local ethnic stores.

**Perinatal Exposure:** Lead crosses the placenta and has been detected in the fetal brain as early as the first trimester (ACOG, 2012). Elevated lead levels during pregnancy have been associated with preeclampsia, spontaneous abortion, low birthweight, and impaired neurological functioning. Not all pregnant women should be tested for lead exposure, however, risk assessments, such as the one utilized in [Illinois](#) provide nurses with an overview of potential exposure sources and blood testing should be performed if a single risk is identified. The lead exposures sources discussed here should all be discussed with the pregnant or preconceptional patients.

According to the [CDC](#), homes with pregnant women where water lead levels exceed 15 ppb should use water filters or bottled water for cooking, drinking, and baby formula. Breast milk is a potential source of lead exposure. Lead is found in breast milk as the result of a current exposure or a past exposure where lead is stored in the bones and leaches out during the breast-feeding process. Mothers with elevated risks should be screened and counseled appropriately if maternal lead levels are high. The CDC offers [Guidelines for the Identification and Management of Lead Exposure in Pregnant and Lactating Women](#). If someone in the home has been identified as having an elevated lead level, the pregnant woman should be tested.

## LEAD TESTING

The only way to know if a child has been exposed to lead is through blood testing. This is particularly important for children ages 1 to 3 both because of brain development and normal hand-to-mouth developmental processes occurring at that age. Universal lead screening guidelines recommend testing all children twice before the age of two, generally at 9-12 months and again at 2 years. Previous best practices focus on targeted screening based on year of housing, foreign-born status or Medicaid recipient. Lead screening laws vary by state, but most focus on the idea of “2 by 2” or two screenings by age 2.

Venous lead testing is more accurate than capillary testing, due to potential for contamination from the skin's surface. Elevated capillary blood lead levels are confirmed with follow up venous samples.

## NATIONAL SURVEILLANCE

The CDC collects data to understand what areas of the country face continued high exposures to lead. Financial support to states and local governments vary, but nurses should advocate for appropriate lead poisoning data collection, surveillance, case coordination, and remediation in their community.

## ASSESSMENT AND MANAGEMENT OF CHILDHOOD LEAD EXPOSURES

Once screening tests indicate an elevated lead level from capillary testing, venous blood samples are used to confirm. Treatment options include identifying lead sources through home assessments and continued testing to assure lead levels are decreasing, notification of the local or state health department, nutritional counseling to treat potential iron deficiency, development and psychological evaluations and interventions, and consultation with specialists if chelation therapy indicated. The state of Maryland has a simple set of [guidelines](#) for the assessment and management of childhood lead exposure. The [Pediatric Environmental Health Specialty Unit](#) and the [American Academy of Clinical Toxicology](#) have a [chelation therapy guide](#) for the general public.

## PREVENTION STRATEGIES FOR PATIENT EDUCATION

Children with mildly elevated lead levels typically are asymptomatic. Conducting risk assessments regarding potential exposures through screening forms is part of the nursing role. Nutritional assessments are important, as good nutrition can minimize lead absorption. Children with iron and calcium deficiencies are at increased risk for lead poisoning. Nurses working with the childbearing population should assess the country of origin of recent arrivals, due to industrial, and automobile emissions. The location and year of construction of housing should be assessed, as homes near lead mines, and battery recycling plants can put the pregnant woman at risk. Pregnant women should avoid living in an older home during renovation or remodeling. Water systems should be checked for lead. Any pregnant woman with pica during pregnancy requires testing for lead exposure. Occupational exposure from factory work or exposure to lead bullets should be discussed, as well as potential exposure from hobbies including stained glass work and lead fishing lures. Complementary and alternative medications and herbs pose a risk for lead exposure as well. There is a greater risk of lead exposure from

alternative medications and herbs if the product comes from India, Africa, Asia or Latin America.

In addition to the resources listed here, videos in office waiting rooms can provide patients with education on lead poisoning prevention. [Be Proactive-Lead Poisoning Prevention PSA](#) is one such resource. Nurses must inform themselves and their communities of the hazards of lead poisoning and ways communities are affected by it through the [Public Broadcasting System's Poisoned Water](#) show, focusing on the situation in Flint, Michigan leading up to the recent lead crisis there.

Table 2: Lead Resources-I

|                                                                                         |                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Pediatric Health Specialty Unit (PEHSU) Interpreting and Managing Low Blood Lead Levels | <a href="https://envirn.org/documents/PEHSU-interpreting-and-managing-lead-levels.pdf">https://envirn.org/documents/PEHSU-interpreting-and-managing-lead-levels.pdf</a>                                                   |
| Agency for Toxic Substances and Disease Registry (ATSDR)                                | <a href="https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=22">https://www.atsdr.cdc.gov/substances/toxsubstance.asp?toxid=22</a>                                                                               |
| Environmental Protection Agency (EPA): Lead                                             | <a href="https://www.epa.gov/lead">https://www.epa.gov/lead</a>                                                                                                                                                           |
| American Academy of Pediatrics: Lead Exposure and Lead Poisoning                        | <a href="https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/lead-exposure/Pages/default.aspx">https://www.aap.org/en-us/advocacy-and-policy/aap-health-initiatives/lead-exposure/Pages/default.aspx</a> |
| Environmental Working Group (EWG): Lead                                                 | <a href="https://www.ewg.org/key-issues/toxics/lead#.W7ZC_FJRdBw">https://www.ewg.org/key-issues/toxics/lead#.W7ZC_FJRdBw</a>                                                                                             |
| Centers for Disease Control and Prevention (CDC): Lead                                  | <a href="https://www.cdc.gov/nceh/lead/toolstraining.htm">https://www.cdc.gov/nceh/lead/toolstraining.htm</a>                                                                                                             |

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## ENVIRONMENTAL NOISE IMPACTS HEALTH AND WELL-BEING

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### OVERVIEW

Hearing loss is the third most common chronic physical condition in the United States and is twice as prevalent as diabetes or cancer (Blackwell et al., 2014). Although noise is one of the leading causes of hearing loss (Center for Hearing and Communication, n.d.), the debilitating and potentially life-altering effects of environmental noise on health are not limited to hearing loss. They extend to virtually every system of the human body, affecting millions of people annually. Nurses, healthcare workers, and others will recognize the problem of noise as a cause of hearing loss (Humes et al., 2006). Although the relationship between noise and hearing loss is well-recognized, far fewer are aware of the non-auditory effects of noise on health that place a high economic burden on our society, comparable to the economic impact of passive smoking

environmental noise is not evenly distributed across different groups. There is evidence that socially disadvantaged groups such as racial minorities, the poor, and those with lower levels of educational attainment experience the highest levels of exposure. The dual stresses of noise and low socio-economic status represent a double jeopardy for vulnerable populations, contributing to observed health disparities across diverse groups in the United States and elsewhere (Casey et al., 2017; Dale et al., 2015; Dreger et al., 2019; Park et al., 2018).

### NOISE AND OTOTOXINS: A DANGEROUS COMBINATION

A number of environmental chemicals have toxic effects on the cochlea, vestibula, or auditory nerve, with related negative effects on hearing and balance. These include exposure to tobacco smoke, many industrial solvents, and some medicinal drugs. In a meta-analysis involving 27 studies and 30,000 participants, there was a direct relationship between smoking and hearing loss (Li et al., 2020). Furthermore, smoking is believed to have a synergistic effect on noise and hearing loss (Wang et al., 2017). Drugs that are associated with auditory nerve damage include aspirin (in large doses), nonsteroidal anti-inflammatory drugs (NSAIDs), aminoglycosides (such as gentamicin, streptomycin, and neomycin), diuretics (including furosemide), and cancer chemotherapeutic agents (cyclophosphamide, cisplatin, and bleomycin) (Ganesan et al., 2018). Industrial solvents that are known to have ototoxic effects include toluene, styrene, carbon disulfide, trichloroethylene, and xylene (Hodgkinson & Prasher, 2006). Persons exposed to these chemicals are more likely to experience hearing loss, particularly if they are exposed to hazardous noise.

### WHAT IS NOISE?

We commonly refer to any unwanted sound as noise. Noise volume is measured in decibels (dB) and can be determined using a noise level meter or (somewhat less accurately) a smartphone app, such as the NIOSH sound level meter for iPhone (EA LAB, 2016) and the Sound Meter for android, both free. Some common noise levels are illustrated in Figure 2 Noise Thermometer. A person's noise exposure is a function of both noise level (volume) and duration (time exposed). However, a commonly used way to estimate hazardous noise is to apply the following standard: if you need to raise your voice to be heard by a person standing at arm's length from you, then you are in hazardous noise and should use hearing protection or other noise control strategy, such as removing yourself from the source.

Figure 1 Noise and Health: By the Numbers



Source: WHO, 2015

(Basner et al., 2014). On a global level, the World Health Organization conservatively estimates that at least one million healthy years of life are lost every year in western Europe because of traffic-related noise alone (WHO, 2015) (Figure 1).

Similar to other environmental hazards, such as air pollution and hazardous waste, the problem of

Figure 2 Noise Thermometer



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### Occupational Noise

Occupational sources of noise vary by economic sector and job type, but are particularly problematic in manufacturing, construction, agriculture, and mining. Common noise sources include machinery such as air jets, exhaust fans, compressors, motors, woodworking machines, pneumatic tools (Gerges et al., 2020).

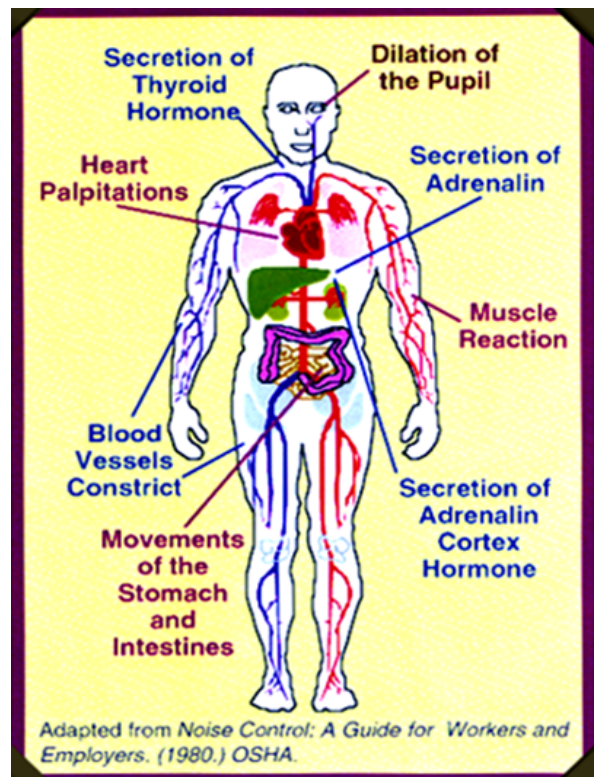
In the US, the National Institute for Occupational Safety and Health has determined that workplace noise exposure at or above 85 decibels is hazardous and should be limited. The US Occupational Safety and Health Administration (OSHA) sets legal limits for workers' exposure to noise and has set a permissible exposure limit (PEL) at 90 decibels for an eight-hour day, while acknowledging that implementation of that standard does not protect 25% of the workers from hearing loss (NIOSH, 1998).

Occupational hearing loss is one of the most prevalent work-related illnesses in the United States. In the US alone, about 22 million workers are exposed to hazardous noise levels at work. Over 30 million US workers are exposed to chemicals, some of which are harmful to the ear (ototoxic) and hazardous to hearing. In addition to damaging workers' quality of life, occupational hearing loss carries a high economic price to society, including lost productivity, medical costs, social isolation, communication difficulties, and stigma (NIOSH, 2018).

### Environmental Noise

In contrast with occupational noise exposures, environmental ones are more difficult to measure and quantify due to their multiple sources and variable exposures. These sources include noise from aircraft, road traffic, trains, construction machinery, lawn maintenance equipment, and windmills, as well as from entertainment (concerts and movie theaters) and recreational equipment (motorboats, power water skis, motorcycles, and off-road vehicles). Further, unlike the work setting, there are no standards for acceptable levels of environmental noise exposure, or science-based knowledge regarding the effects of noise on human health at various decibel levels.

Figure 3 Non-auditory effects of noise



Source: OSHA, 1980. Reproduced as part of the public domain.

Little attention has been devoted in the US to attempting to quantify the effects on human health, but with leadership from the World Health Organization, more studies are currently being conducted in Europe. Much more data will be needed to determine “safe” levels of noise exposure.

Although OSHA published a graphic in 1980 depicting the non-auditory stress response effects on the body due to worksite exposure to noise, research was primarily conducted on its effects on hearing (Figure 3). Around the turn of the last century, studies around the world expanded to focus on the non-auditory effects of noise, and on environmental noise sources. These studies found significant effects on body systems, contributing to multiple negative effects on health (Figure 4). There are several reasons why these effects are relatively unknown: (a) the effects slowly build over time; (b) health professionals are not aware of all of these effects so fail to assess for noise as a contributor to health problems; and (c) while most persons are aware of the effect on hearing, they are not well informed that noise also causes tinnitus, or contributes to many other health problems.

### WHAT ARE THE EFFECTS OF NOISE ON HEALTH?

Many of the negative effects of noise on health are believed to be related to stimulation of the human stress response and interference with sleep. Noise initiates a cascade of events that includes the release of stress hormones, which in turn, trigger inflammatory and oxidative stress pathways (Hahad et al., 2019).

In the following pages, selected research studies reporting the adverse effects of noise on health are described (Figure 4). Although many of the effects of noise on health are interrelated, for simplicity, they are discussed separately. For example, the physiological stress response effects, as well as the noise itself, contribute to sleep problems which in turn, contribute to many of the other health problems and diseases.

#### Cognition/Learning/Memory

Effects of noise on cognition, learning, and memory have primarily been studied in children in school settings, finding learning difficulties, decreased reading skills, and memory for children in noisier environments while controlling for other factors such as intelligence and socioeconomic status. As reported in the analysis by WHO, this results in 45,000 healthy years of life due to the cognitive impairment of children (Figure 1).

Figure 4 Selected Effects of Noise on Auditory and Somatic Health



## Behavior/Performance

As noted above, noise decreases children's school performance, but it also impacts adults' performance and interpersonal behaviors (WHO, 2015). WHO (2015) has documented its effect on negative emotions including anger, dissatisfaction, withdrawal, disappointment, helplessness, depression, anxiety, distraction, agitation, and exhaustion; all of which would affect behavior and performance.

## Sleep/Fatigue

Acute and chronic sleep disorders can lead to fatigue, and obvious effects on quality of life. Additionally, sleep problems can lead to changes in insulin and appetite-regulating hormones which in turn contribute to metabolic syndrome and Type 2 diabetes (Hume, 2010; Münzel et al., 2014). As noted in Figure 1, studies by WHO indicated that 903,000 healthy years of life were lost due to sleep disturbance from noise.

## Cardiovascular

Noise exposure is linked to multiple diseases that are among the top causes of death (e.g., heart disease, heart attacks, and strokes) in the US and the world. Elevated blood pressure is a well-known contributor to heart disease and stroke (Subramaniam & Lip, 2009). Lusk, et al. (2002 & 2004) reported both a chronic effect and an acute effect of noise exposure on blood pressure as noise levels increased. In meta-analyses of studies, both Babisch (2014) and Vienneau, et al. (2015) found a relationship between road noise and heart disease. Novel experimental studies have revealed oxidative stress-related vascular damage and changes in the genes responsible for vascular function, vascular remodeling and cell death due to noise exposure providing a physiological explanation for increased cardiovascular disease due to noise (Münzel, Schmidt, Steven, Herzog, Daiber, Sørensen, 2018). WHO estimates that 61,000 years of healthy life are lost annually due to ischemic heart disease related to noise (Figure 1). Important to note is a projected reduction in health care costs of 3.9 billion dollars per year in the USA alone with a small reduction on decibel levels! (Swinburn, et al, 2015).

## Mental Health/Depression

It should come as no surprise that environmental noise has an effect on mental health and depression, and several studies have found relationships. A very large case-control study involving 77,295 persons with new depression diagnoses over a 5-year period, found increased risk for depression related to aircraft, road traffic, and railway

noise. All three sources of noise, and the combined sources, contributed to increasing the odds for a depression diagnosis, with traffic noise the greatest contributor (Seidler et al., 2017).

## Low Birth Weight

An infant weighing less than 2500 g. is considered to be low birth weight (LBW), regardless of gestational age. LBW is the leading cause of infant mortality and contributes to serious morbidity problems such as ophthalmologic, neurologic, cognitive, and pulmonary disorders. This is a major public health problem and care of these infants is very costly. Ristovska, Lazlo, and Hansell (2014) reviewed 23 studies of reproductive outcomes associated with noise exposure. Their conclusions were: (a) although the evidence is sparse, it supports interactions between noise exposure and reproductive outcomes (LBW, preterm birth, spontaneous abortion, and gestation length); (b) of these reproductive outcomes, epidemiological studies have shown very high noise exposure was associated only with LBW; and (c) a hierarchy of biological mediators may create a pregnancy stress syndrome that leads to increased susceptibility for problems in the mother and fetus.

## Body Weight

Because obesity contributes to a multitude of health problems, it is a serious public health problem. In a 2015 Swedish study of over 50,000 persons, Pyko et al. (2015) found a significant rise in both waist circumference and waist/hip ratio as decibel levels of noise exposure from road, railway, and aircraft noise increased, with the largest effect from a combination of these sources of noise. These effects remained, even after controlling for the numerous confounders of obesity, such as age, gender, socioeconomic status, and dietary habits. It is of less concern that these changes were not seen for body mass index (BMI), because more recent research has identified problems in using BMI as a measure of obesity, as it is not accurate due to differences in musculature, body type, age, gender, and ethnicity (O'Sullivan, 2020).

## Hearing and Tinnitus

Tinnitus may be experienced as ringing, chirping, or other sounds in one or both ears (or in the head) when there is no source of sound in the environment. It often accompanies hearing loss. Tinnitus and hearing loss are prevalent in the U.S., but especially among noise-exposed workers. Particularly affected are workers in agriculture,

manufacturing, and construction. Tinnitus can disrupt sleep and concentration, increase fatigue, decrease alertness, erode performance, and potentially increase risks for injuries at work, while driving, and at home. Although many work settings offer programs to reduce noise exposure and associated development of tinnitus, the prevalence of this problem demonstrates the need for increased awareness, and improvised programs and policies to promote personal and public safety, and quality of life.

More recently, studies have focused not on just the level of environmental noise, but on noise annoyance as a factor influencing health, finding that individuals vary in their response to noise and their level of response affects health issues. For example, Hammersen, et al. (2016), used data obtained from a German national health interview survey of adults ( $n = 19,294$ ) to measure associations between individual levels of noise annoyance due to noise (road traffic, neighbors, and air traffic) and mental health. While controlling for covariates, they found a more than doubled odds of impaired mental health among those annoyed. This, of course, does not prove causation, but suggests the need for further study.

Other European research has focused on the relationship between well-being and noise exposure. Braubach et al. (2015) studied the effect of traffic noise reduction projects in three cities on perceived well-being. The noise reduction projects in the three cities used different methods to mitigate noise and resulted in marginal, but positive effects on population well-being. While noting the inadequacies of the measures of both noise and well-being, researchers reported that survey data showed that perceptions of high noise levels were associated with lower reported levels of well-being.

Lawton & Fujiwara (2016) obtained records of 24-hour decibel levels of noise at the 17 main airports in England, and using mail codes, correlated the noise data with five subjective measures of well-being collected by the Office of National Statistics. They found that daytime noise, but not nighttime noise, consistently negatively impacted wellbeing, and there was also a marginal effect with each additional decibel of noise. They concluded that the negative effect of living in airport flight paths on overall and momentary wellbeing was equivalent to one-half the negative effect of smoking (Lawton & Fujiwara, 2016).

## SUMMARY

Environmental noise is a public health hazard, not merely an annoyance. The impact of noise on health is universal and widespread, and this impact increases health care costs, creating an additional burden on society. As noted

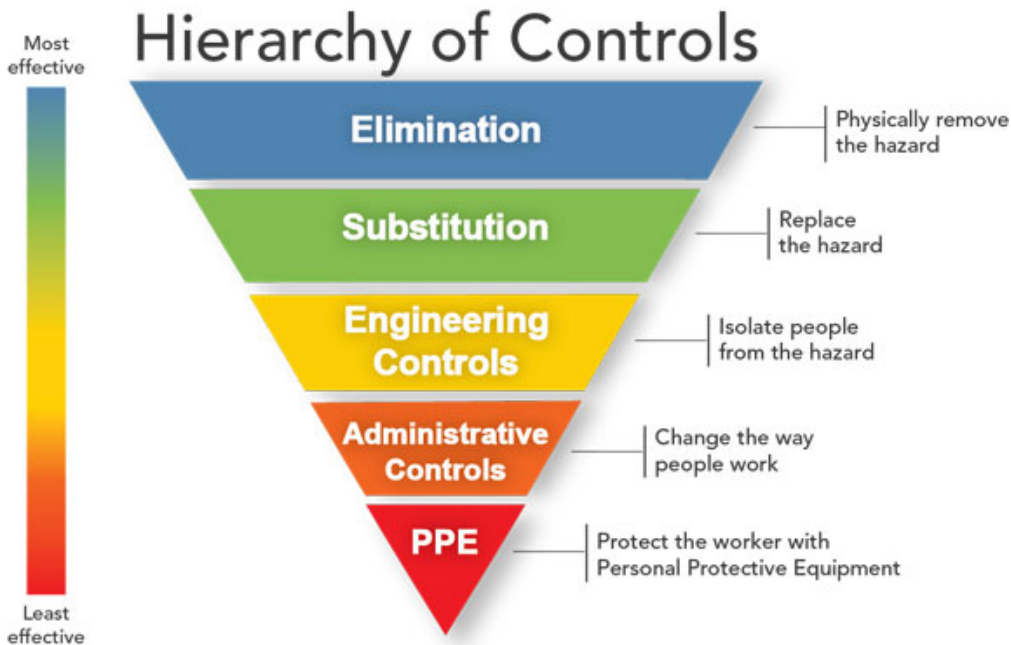
above, WHO has supported many studies documenting the effect on healthy life years, validating this impact by association. The seriousness of these associations is well accepted; however, for a number of reasons, it has not been possible to prove causation. These reasons include (a) inadequacies of surveillance and measurement of noise levels and sources; (b) inconsistencies in the measurement of noise exposure (both objective and subjective measures have been recommended by Ristovska et al. (2014)); (c) lack of knowledge regarding “safe” levels of noise for the human body; and (d) inability to conduct controlled experimental studies to document causation.

Of critical importance are environmental justice issues when assessing the impact of all these negative health effects noise and the burden of health care costs. Although the authors of the previously described study on depression, Seidler et al. (2017) did not address the issue of socioeconomic status as a factor, their study may well represent an example of environmental justice concerns. Areas of the community where lower income and minority persons reside are also more likely to be those with greater environmental noise. Thus, it is reasonable to assume that this noise exposure contributes to the higher rates of mortality and morbidity in disadvantaged populations. There is a growing body of literature that supports the concept of environmental racism. For example, both polluters and pollution are often disproportionately located in communities of color (Miranda, 2016). Environmental racism can be readily applied to noise pollution of neighborhoods. To achieve health equity, promote health, and prevent disease, environmental noise must be reduced.

## CAN NOISE EXPOSURE BE CONTROLLED?

Many people think of using hearing protection as a primary method of protecting themselves from hazardous noise exposure. Actually, the use of hearing protection is the least desirable approach to the problem. Using the NIOSH hierarchy of controls (Figure 5), the most preferred approach is to eliminate the noise source. If elimination is not possible (for occupational or environmental noise), then it may be possible to use engineering controls to isolate people from the noise. Engineering controls might include sound insulation, lubrication, securing loose parts, and other mechanical means of reducing the noise generated or peoples’ exposure to it in the occupational setting. Engineering controls for controlling environmental noise exposure may include erecting sound barriers (around highways and airports), adjusting flight patterns (for airport noise), and using electric-powered vehicles (rather than internal combustion engines). Another approach would be to use

Figure 5 Hierarchy of Controls



Source: NIOSH, 2018. Reproduced as part of the public domain.

administrative controls, such as relocating workers to a location remote from the hazardous noise. Administrative controls for environmental noise include policy changes (e.g., limiting the use of train horns). Only after these alternative approaches are exhausted is it appropriate to recommend use of personal protective devices to reduce exposures to hazardous noise.

Personal protective devices for noise exposure control are called hearing protection devices (HPDs). Several types are available: roll-down (foam) ear plugs, pre-molded ear plugs, semi-aurals (or canal caps), and muffs. All of these choices are available for purchase in stores and online. Purchase in bulk is more cost-effective. (Some people may also use custom-molded ear plugs.) Selection of hearing protection is highly individual; the best hearing protector is the one that the noise-exposed person will use. Many factors influence personal preference of type of protector, including noise intensity, duration, weather, personal anatomy, exposure to harmful chemicals or animal waste, and type of work. Each type of HPD has its own benefits and drawbacks. For example, some users will find earmuffs easy to apply, and cleaner to use around chemicals, but uncomfortable in warm environments. With the large number of variables, many experts recommend that users purchase a sample package of hearing protection devices and use several types on a trial basis before investing in a larger supply. Since convenience is

highly associated with level of use, hearing protectors should be strategically placed near common noise sources and in settings where hearing protectors are supplied by one other than the user, more than one type should be available to enable each worker to select what works best (Lusk et al., 1995).

The effectiveness of ear plugs is highly dependent on their proper insertion. Short videos are available online to guide clinicians in developing this skill and training their clients (3M, 2015). A properly inserted (“fitted”) ear plug should be barely visible beyond the tragus of the ear, should offer some resistance to being removed, and should result in the user’s voice sounding lower, or more resonant.

Hearing protection devices are labeled for the level of noise that they reduce in a laboratory setting; this rating is called the noise reduction rating (NRR). Although this rating indicates that the device may reduce noise by 20 or more decibels, in field use, users should expect the level of protection to be far less, perhaps as much as 50 percent less. Although some shoppers select HPDs with larger NRR levels, the best hearing protector simply lowers the hazardous noise level down to a safe level (e.g., 84 dB or less), and allows the user to benefit from hearing desirable sounds, such as voices, warning sounds, and unusual equipment noises. Use of hearing protection is usually not practicable for most environmental noise but is useful when homeowners are exposed to more time-limited sources, such as gas-powered leaf blowers, mowers, and heavy equipment.

#### HOW CAN HEALTHCARE WORKERS DISPEL MYTHS ABOUT NOISE AND HEARING?

Some people may attribute their hearing loss to age, rather than noise exposure. However, for most people, age-related hearing loss is usually not detectable until after age 60. So most healthy people can expect to keep their good hearing for much of their lives, as long they protect themselves from noise. However, we know that noise-exposed people who do not protect their hearing begin to lose their hearing at an early age (CDC, 2018; McAdams et al., 2011; NIOSH, 2018). For example, farm

youth are known to have noise-induced hearing loss by the time they are in high school (Marlenga, 2012).

One factor that sometimes is a barrier to people wearing hearing protection is fear of not hearing warning sounds, like sirens. Failure to react to warning sounds is more often the result of high background noise or severe hearing loss; rarely because of wearing hearing protectors. Most hearing protectors will reduce both the background noise and the warning sound, so the person will hear both sounds (NIOSH, 2018).

Some people are reluctant to wear hearing protection because they fear that it will make hearing equipment noises, warning sounds, and co-workers' voices difficult or impossible to hear. One's hearing protection should lower environmental noise levels, but not eliminate them. However, for workers in settings where hearing certain sounds is particularly important, workers can seek the assistance of an audiologist or safety specialist, who can help select a hearing protection device that will reduce the unwanted frequencies more than the frequencies one needs to hear. Another option is to consider a noise-activated hearing protector that allows normal sounds to pass through the device, and block only the hazardous noise. Musicians can select devices that lower the sound volume, while retaining sound fidelity (NIOSH, 2018).

Some people mistakenly think that if they already have hearing loss, then protecting their hearing is not necessary. However, exposure to loud noise can continue to damage a person's hearing, making communication and other hearing functions even more difficult. Also, the exposure to noise will continue to contribute to the non-auditory (somatic) effects of noise, such as cardiovascular disease (NIOSH, 2018). Reducing noise and the health problems it causes will result in a reduction in disease and health care costs (Swinburn et al., 2015), and improve public health.

### WHAT HEALTH POLICIES CAN REDUCE NOISE EXPOSURES?

In recognition of the importance of noise reduction, the federal government enacted two landmark legislations: The Noise Control Act of 1972 and the 1978 Quiet Communities Act. The Office of Noise Abatement and Control (ONAC) in the Environmental Protection Agency was created and charged with coordinating federal noise reduction programs, promoting noise education and research, and assisting state and local noise abatement (Shapiro, 1992). For the first time, this legislation established the primary responsibility for control of noise at the state and local levels. Today, state and local regulations vary widely (FindLaw Attorney Writers, 2018). Additionally, ONAC funding was terminated in 1982, and

today there is little action in noise abatement and control (Shapiro, 1992).

Consistent with the WHO guidelines, the United Kingdom and other European countries previously established legislation that requires quieter industrial and household equipment, product labeling for noise levels, and incentives for manufacturers to develop quieter products. In comparison, the US National Institute for Occupational Safety and Health promotes the implementation of Buy Quiet programs that encourage companies to use quieter machinery to reduce worker exposure to noise (CDC, 2014). Although well-intended, these US noise reduction programs are not required by law, creating a need for additional legislation to reduce environmental noise and enhance enforcement in workplaces, the community, and at all levels: local, state, and national. Examples include, but are not limited to, noise surveillance, and development and testing of programs to reduce noise exposure.

As noted in the reports of research regarding the effects of environmental noise exposures, few studies have addressed the differential effects of varying levels of noise and length of the exposures. Although there is debate about whether the standards for occupational noise exposures are stringent enough, some standards do exist. This is not the case for environmental noise. Surveillance to determine the actual level of noise is almost nonexistent, and thus far scientific studies can only report associations between noise of varying levels and health problems. For, example, while multiple studies support the negative health effects of traffic noise, they do not provide enough consistency in types, levels, and duration of the noise to develop specific guidelines. Therefore, even though there is agreement about the deleterious effect of noise on health, it is not possible to set permissible levels of exposure to prevent health problems.

The WHO is providing direction and leadership in identifying the harmful effects of environmental noise and promoting programs to mitigate its effects. However, in the US, with the defunding of the Office of Noise Abatement and Control (ONAC) at the EPA, there is no organization to lead efforts to reduce environmental noise and its harmful effects on health. In addition to supporting the reestablishment of ONAC, the American Academy of Nursing has indicated its support for:

1. "requiring production and use of quieter equipment and appliances;
2. "implementing measures to reduce airport, railway, and road noise;

3. “enacting legislative restrictions at state and local levels to reduce environmental noise levels, including those at public events” (Lusk et al., 2017, pp. 655).

Further, the Academy has committed to collaborate “with federal agencies, state and federal legislators, and nursing and non-nursing organizations to support the reduction of environmental noise.

Actions that individual nurses can take to influence policy should include:

1. Become an advocate for reducing noise by informing state and local governments about the hazards of noise;
2. Promote local ordinances and their enforcement to reduce noise;
3. Promote state efforts to enact legislation to assist with surveillance of noise sources and remediation programs to reduce it;
4. Inform legislators at all levels of government, and the public, of environmental justice and environmental racism issues associated with environmental noise and its effects on health and disease disparities.
5. Be a resource to US congressional members in promoting federal legislation to address the problems of environmental noise and environmental justice; and
6. Collaborate with relevant groups, for example health professional organizations and societies, National Hearing Conservation Association, American Speech-Language-Hearing Association, and Noisefree America: A Coalition for Quiet.

### WHAT EDUCATION MEASURES OF HEALTH PROFESSIONALS AND THE PUBLIC CAN REDUCE NOISE EXPOSURES?

Persons who are well-informed about their noise exposures at work, home, school, and in the community are more prepared to protect themselves from the adverse health effects of noise. A few suggestions for health professionals and the public are listed here.

1. Develop and distribute worker and employer education materials specific to the use of engineering controls to reduce noise exposure;
2. Disseminate information regarding risk factors for noise exposure, hearing loss, and other adverse effects of noise exposure to workers, employers, and students;
3. Prepare and distribute resource materials to aid in educating health professionals and the public about

the harmful effects of noise exposure, using existing web and other media;

4. Seek opportunities to provide education, guidance, and advice regarding how workers, employers, and students can protect themselves from noise exposure;
5. Collaborate with other professionals, and organizations with common interests to assist in dissemination of information, and promotion of strategies to mitigate noise, e.g., Alliance of Nurses for a Healthy Environment, American Public Health Association, and American Association of Nurse Practitioners; and
6. Ensure that curricula in health professional schools include content on the effects of noise on health and environmental justice issues associated with noise.

### HOW CAN CLINICIANS IN PRACTICE REDUCE NOISE EXPOSURES?

Nurses and others can implement evidence-based practice to promote hearing health and prevent the adverse effects of noise on health. Much can be done to help workers, employers, students, and others increase their awareness of hazardous noise in their work and home environments, and in the community. In addition, they can help their clients understand the hazards to their hearing and non-auditory health that noise presents, and promote measures to protect oneself, such as reducing the volume, distancing themselves from noise, and using hearing protection. Nurses in clinical practice can include an assessment of noise exposure and use of protective measures in their routine health assessment procedures. Based on assessment data, nurses can tailor information to clients in meeting their needs to acknowledge their hazardous noise exposures, and implement strategies to reduce noise exposures. One of the most impactful messages that nurses can offer persons exposed to noise is to store hearing protection near commonly-used noise sources, where they can be conveniently accessed when needed (McCullagh & Robertson, 2009). Nurses can work with employers and government agencies to reduce noise exposure and implement effective noise control measures. Nurses and other healthcare workers can contribute to the development of business cases to justify adopting noise control interventions. Furthermore, nurses can work with interdisciplinary teams to develop, test, and promote programs to reduce noise exposures among workers and in communities.

### HOW CAN RESEARCH REDUCE NOISE EXPOSURES?

There are many opportunities to develop our understanding of noise and prevention of its negative

effects on health. For many workers, industries, and communities, there is a need to identify and inventory sources of noise and ototoxic chemical exposures putting populations at risk for noise-related health problems. Because development of hearing loss and other noise-related health problems have multiple causative and risk factors, there is a need to determine the contribution of individual, behavioral, and exposure factors on the development of these health problems. Employers and communities need to know how to develop and maintain cost-effective interventions (such as engineering controls) to reduce noise exposure, or mitigate its effects. Finally, policy makers and others need information about the effectiveness of individual-, family-, and population-based interventions.

As previously described, researchers have typically used cross-sectional studies and correlational methods to find associations between noise and several health conditions. However, these types of studies are not robust enough to establish a causal relationship between noise and disease. While the associations found in multiple and repeated studies clearly indicate negative effects of noise exposures, more specific information about the types of noise and its sources, as well as the levels at which it causes problems would be useful in designing prevention programs. Knowledge of levels of noise which may be acceptable from a health standpoint, and evaluation of the cost-effectiveness of various mitigation programs will inform the development of related policies and services.

### HOW CAN COMMUNITY ACTIONS REDUCE NOISE EXPOSURES?

As concerned citizens and informed health professionals, nurses have a role in influencing noise issues in their communities. Actions include ensuring that local ordinances are promulgated and enforced to reduce environmental noise which may require meeting with city and county officials, police, and legislative bodies. Health professionals have a responsibility to call attention to health disparities and work to alleviate them. Therefore, it is critical to address environmental justice and environmental racism issues in relation to noise exposures.

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## INTRODUCTION TO FRACKING AND RENEWABLE ENERGY

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ANHE Intern

While renewable energy accounted for only 11% of total U.S. primary energy consumption in 2019 by source, petroleum and natural gas has dominated U.S. energy consumption and represents 69% of total primary energy use (U.S. Energy Information Administration, 2020). This is problematic because a widespread method to obtain unconventional natural gas and oil trapped underneath shale rock layers, known as hydraulic fracturing or fracking, is deeply harmful to both the local environment and communities.

Given the numerous health effects with hydraulic fracturing and the influence of fossil fuels on climate change (which is outlined in this chapter), it is important to consider alternative energy sources such as renewable energy. There are many different types of renewable energy, such as wind, solar, geothermal, and hydroelectric. Each of these energy sources has its own advantages and disadvantages.

**Wind turbines**, which are powered by wind, can generate substantial amounts of electricity without contaminating the air or water, unlike hydraulic fracturing (Office of Energy Efficiency and Renewable Energy, n.d.). Furthermore, since wind is a form of solar energy, evoked by uneven heating across Earth's surface, it is sustainable. Recently, the Biden Administration has supported the development of offshore wind energy off the East Coast (Massachusetts, Rhode Island, New York, and New Jersey) and the Gulf Coast.

**Solar energy** can also be converted to electricity through technology such as photovoltaic panels. The generated electricity can be stored in batteries which would allow for later use, even in the absence of sunlight. According to the Office of Energy Efficiency and Renewable Energy, if all the sunlight that reached the Earth's surface in an hour and a half could be captured, converted, and stored as useful forms of energy, that would be enough to satisfy the total energy demand across the entire globe for a year (Office of Energy and Efficiency and Renewable Energy, n.d.).

**Geothermal energy** is another form of clean energy, meaning its extraction does not rely upon the burning of fossil fuels and lead to the emission of greenhouse gases (Office of Energy and Efficiency and Renewable Energy, n.d.). The source of geothermal energy is heat harnessed from natural processes that occur at Earth's core, such as



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the decay of radioactive isotopes. Hydraulic turbines convert the potential energy of water in motion into mechanical energy, much like wind turbines with moving air.

Overall, renewable energy produces minimal greenhouse gas emissions, and is an avenue that has the potential to diversify energy stores as well as the economy (Environmental Protection Agency, n.d.). For the consumer, renewable energy may also be a cheaper means to achieve household energy demands. According to a New York Times article, solar panels deliver power to homes at \$31 to \$111 a megawatt-hour compared to natural gas plants which deliver power at \$122 to \$162 a megawatt-hour (Penn, 2020). There are concerns, however, that renewable energy alone cannot meet the demands due to the current storage issues of renewable energy. This is an area that will require greater investment in renewable energy technology.

Despite the environmental and other benefits associated with transitioning to renewable energy, it is important to acknowledge that there are still environmental concerns. For example, although hydropower does not directly produce carbon emissions, manufacturing the dams required for the process does depend upon machinery which emit pollutants similar to those that are required to maintain a natural gas well. Furthermore, diverting water to a dam may be harmful to local ecosystems. Some have also pointed out that biomass burning plants produce 300% to 400% the carbon dioxide emissions as natural gas

plants (Partnership for Policy Integrity, n.d.). Although it is important to note here that approximately equivalent amounts of plant used for fuel would be able to sequester the carbon dioxide they release while burning (U.S. Energy Information Administration, 2020).

This section addresses the fracking process and the associated health risks. Nurses have been involved in educating, researching, and advocating for fracking communities. Additionally, nurses have also advocated for cleaner renewable energy to protect the health of communities and mitigate climate change risks. As more renewable sources are used, studying the impacts of renewable energy on communities and human health is an important for future nursing research.

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## THE HEALTH IMPACTS OF UNCONVENTIONAL NATURAL GAS DEVELOPMENT

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Since the 1990s, unconventional natural gas development (UNGD) activities have increased across the United States. In 2000, there were approximately 26,000 hydraulic fracturing wells in the US and by 2015 there were more than 300,000 (Xu, Zhang, Carrillo, Zhong, Kan, & Zhang, 2019). As of 2019, nearly 18 million Americans live within one mile of an active oil or gas well (Concerned Health Professionals of New York & Physicians for Social Responsibility, 2019). UNGD includes the entire process from choosing the site for the drilling (fracking) to the delivery of the gas to the consumer. Drilling and associated industrial activities are often in close to residential areas including schools, playgrounds, and farms. People living in regions where UNGD is occurring have reported experiencing health effects that they attribute to UNGD activities. The purpose of this chapter is to provide an overview of the process involved in UNGD and the emerging issues related to health and the environment that nurses need to consider when assessing their clients for possible environmental exposures.

### OVERVIEW OF THE PROCESS OF UNGD

The process of UNGD includes hydraulic fracturing or fracking. UNGD involves a series of steps and development including 1) building of the well pad and local infrastructure; 2) drilling and construction of the pipelines and other facilities; 3) the actual hydraulic fracturing; 4) the flow back of gas, fluids, and other contaminants; and 5) connection to a system of distribution, such as a pipeline. At each step of this process, there are significant environmental risks and impacts (Adgate, Goldstein, & McKenzie, 2014).

The fracking process begins with dynamite detonations to identify the geological formations under the surface prior to the drilling. The initial drilling is done vertically down to a distance of approximately 8000 feet. After the vertical shaft is completed, horizontal shafts are drilled. Approximately 2-5 million gallons of water mixed with chemicals and propping materials, such as sand, are injected under high pressure down the well and out into the horizontal shafts. The high pressure is needed to create openings, or fractures, in the gas-bearing rock. The propping material enables the fractures in the rock to remain open and provide a way for the trapped gas to flow out of the horizontal shafts into the well. The released gas that flows into the well also contains wastewater. The wastewater includes the chemical

mixture and salts injected into the well, as well as the heavy metals, hydrocarbons, radioactive materials, and other substances from deep under the surface of the earth. At the well, the gas and the wastewater are separated, and the wastewater is stored in open pits or in tanks near the well (Adgate, Goldstein, & McKenzie, 2014). Sometimes the open pits, or impoundments, are lined with black plastic; however, this does not fully prevent leaching of water and chemicals into the surrounding soil. Mistert are commonly used in these impoundments to spray the wastewater into the air to aid in evaporation. Any wastewater that remains is moved via tanker trucks to be disposed of in deep injection well sites, often in another state or miles from where the drilling took place. There is a growing body of evidence linking an increase in earthquakes related to fracking, particularly with the disposal of wastewater in deep injection well sites. An estimated 60% of the water injected into the well head during the drilling process will come back with the gas. This growing volume of wastewater may also be recycled to be used in multiple wells (Adgate, Goldstein, & McKenzie, 2014).

Drilling is a 24-hour/7 day per week operation. There is constant activity related to the drilling site including transportation of materials, machinery, water, sand, and chemicals by diesel trucks (Xu & Xu, 2020). Often the drilling sites are in rural regions. It is not unusual for these diesel trucks to have to travel over single lane, dirt roads to and from the drilling site. Activities at the drilling site include gas production and onsite condensing stations. After well development is completed, flaring is often used as a controlled burning of natural gas at the well site to test and stabilize the well. Flaring can last for several days or weeks. This process of burning natural gas is also used during emergencies at processing plants and compressor stations or to take care of small amounts of waste gas. Flaring involves bright columns of flames shooting into the sky associated with continuous noise, often 24 hours per day. Additional components of UNGD include compressor stations which are used to maintain pressure and velocity of the natural gas to keep the gas flowing in the pipelines to distant ports and refineries. Pipelines can run for hundreds of miles through residential and rural areas to the final destination. Herbicides are often used to control the vegetation along the pipelines. The capacity of pipelines to transport the products from the site of extraction to market is augmented by railroad tank cars. These tank cars carrying flammable fluids pose a risk in the event of puncture or accident (Gorski & Schwartz, 2019).

In addition to the process for natural gas drilling, collection, and distribution, ethane cracker plants are

being built to transform the ethane, a component of natural gas, into plastic products. Using extreme heat methods, these plants break the molecular bonds in ethane to produce ethylene, which can be processed into resin to create plastics. These plants emit tons of toxic air pollution each year. Cracker plants release 484 tons of carcinogenic VOCs (volatile organic compounds) such as benzene and toluene, and 159 tons of fine particles (PM 2.5) into the air annually (Baumgardner, 2017). Not only do these plants create additional environmental impacts through their processes and emissions, they also create additional (potentially inflated) need for more natural gas. Further, they also have the added impact of contributing to the continued dependence on plastic products (Baumgardner, 2017).

### OVERVIEW OF CHEMICALS AND POLLUTANTS ASSOCIATED WITH UNGD

The exact chemical composition of fracking fluid is proprietary information and because of this, specific chemicals cannot be identified at any single drilling site. Using EPA data, Elliot, Trinh, Ma, Leaderer, Ward, and Deziel (2017) identified 1177 distinct chemical compounds used in the fracking process. They further noted that typically 15 – 100 million liters of fluid may be used for each individual well, with more than 114,000 liters of the fluid being chemical additives. The chemical additives include biocides, surfactants, and anti-corrosive agents. Of the 1177 contaminants identified, 91% (1066) had not been previously examined for possible carcinogenicity. Among those compounds that had been evaluated (111), 14 were known human carcinogens, six were probable human carcinogens, and 29 were possible human carcinogens. At least 20 of the compounds used in the fracking process have been linked to the development of leukemia. In addition, at least 74 identified fracking compounds are known to have negative reproductive effects (Inayat Hussain, Fukumura, Aziz, Jin, Jin, Gracia-Milian, Vasiliou, and Deziel 2018). See Figure 1 for the water and chemical cycle in fracking development. .

Looking beyond cancer and reproductive toxins, chemical compounds used in fracking fluid have been identified to result in adverse health effects involving the integument, respiratory, cardiovascular, gastrointestinal, nervous, and endocrine systems. Different times and lengths of exposures to these chemicals can result in different symptoms and diseases. Epidemiological studies have shown that some cancers take years to develop after exposures to carcinogens used in other industries. It is well-documented that endocrine disruptors may take a generation or generations to manifest their effect on human and animal reproduction (Bergem et al., 2013).

Due to the vast number of chemicals used in fracking, a full discussion of each is beyond the scope of this chapter, rather, just a few of the hundreds of chemicals will be highlighted. Additional information about these pollutants can be found in the [EPA Health Effects Notebook](#) (EPA, 2016). *Benzene* (EPA, 2016) is a known carcinogen and reproductive toxin with chronic exposure. Further, acute exposure may result in dizziness, headaches, topical irritation and even unconsciousness. *Toluene* (EPA, 2016) is considered a “potential occupational carcinogen” and is associated with euphoria, hallucinations, dizziness, slurred speech, respiratory symptoms, depression, and coma and death with large acute exposures. Chronic exposures to toluene may result in liver, kidney and neurological damage, contact dermatitis, and is considered a possible teratogen. *Xylene isomers* (EPA, 2016) have been known to cause irritation of the eyes, nose, throat and gastrointestinal and neurological symptoms with acute exposure. Long-term exposure has been known to result in headaches, tremors, fatigue, dizziness, lack of coordination, as well as respiratory, kidney and cardiovascular disease. In addition, developmental effects and maternal toxicity have been documented in relation to these isomers. *Cadmium* (EPA, 2016) is often released with the flaring of drill sites. Evidence has shown a single high-level exposure to cadmium can result in long-lasting respiratory injury.

Figure 1

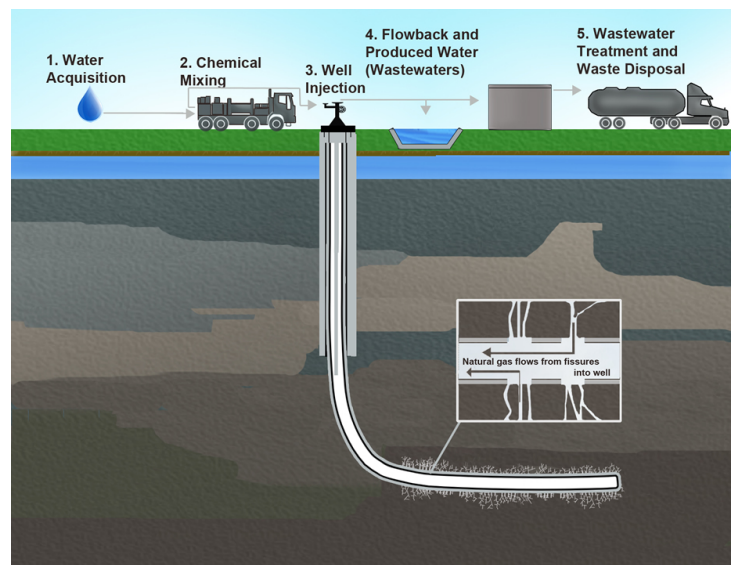


Image from U.S. Environmental Protection Agency (reproduced as part of the public domain).

Fine particulate matter, a result of silica dust and carbon monoxide, has also been identified in and around drilling sites (OSHA-NIOSH, 2012). Crystalline silica is a known lung carcinogen. Silicosis develops after chronic exposure. Inhalation of silica dust is associated with chronic obstructive pulmonary disease, chronic renal disease, and autoimmune diseases. Diesel exhaust is associated with human health hazards (Hesterberg, Long, Bunn, Lapin, McClellan, & Valberg, 2012). Long term inhalation is “likely” to result in a lung cancer risk to humans as well as cause lung disease. Acute, short term exposures can result in irritation and inflammation as well as cause an exacerbation of pre-existing conditions such as allergies, bronchitis, and asthma. Diesel exhaust also contributes to the dissemination of other toxins such as fine particulates and nitrogen oxides.

### ENVIRONMENTAL HEALTH ISSUES ASSOCIATED WITH UNGD

The environmental health issues surrounding the process of UNGD are complex. Impacts have been identified on public health, animal health, air and water quality, and crime incidence (Mayer, 2017). There are three major sources of exposure to chemicals and other potential health hazards associated with UNGD. Individuals can be exposed through contact with contaminated air, water, or soil. Negative health impacts have been noted among those living within several thousand feet of drilling stations. However, most state regulations, which vary widely, allow drilling to occur as close to 300 – 500 feet from residential areas (Mayer, 2017).

#### Sources of Exposure

Potential sources of air contamination include fine particles of silica dust from the sand used in the fracking fluid, diesel exhaust, emission from the well head, flaring off of the methane, evaporation of wastewater from impoundments, venting of condensation tanks during filling, compression stations emissions, and herbicide spraying to control vegetation along pipelines. More than 200 airborne chemical contaminants have been found near fracking sites, with 61 of them identified as hazardous air pollutants (including carcinogens) and another 26 identified as endocrine-disrupting compounds. Further, the volatile organic compounds (VOCs) used and produced in fracking, along with nitrogen oxides are leading to increases in ground level ozone. Individuals living near industrial sites may experience air contaminated by increased traffic from diesel trucks and the fine particulates of silica dust from the sand used in the fracking fluids (Mayer, 2017; Saberi, Propert, Powers, Emmett, & Green-Mckenzie, 2014). A potential source of

water and ground soil contamination includes leakage that seeps from impoundments into the ground soil. Contaminated soil can affect food supply in the form of crops and meat production through undetected animal exposure. Because animals reproduce more frequently than humans, animal health can be an early indication of potential impacts of UNGD on human health (Bamberger & Oswald, 2012).

#### Health Effects

In recent years, a great deal of evidence has emerged documenting the connection between UNGD and specific health impacts. The most commonly reported symptoms include sleep disruption, headache, throat irritation, stress or anxiety, cough, shortness of breath, sinus problems, fatigue, nausea, and wheezing, (Weinberger, Greiner, Walleigh, & Brown, 2017). Other reported impacts include burning of the eyes, decreased ability to smell, bleeding from the nose, “a sweet metallic taste” in the mouth, and a gradual decrease in the ability to taste. Commonly reported dermatological signs and symptoms include a burning sensation, lesions, rashes, and chemical burns. Pulmonary complaints include an increase in the symptoms of chronic conditions such as asthma and chronic obstructive pulmonary disease. Increased drilling in areas has been linked to significant increases in the number of childhood asthma-related hospitalizations, with this effect lasting for up to eight years after drilling started in a community (Willis et al., 2018). Overall increases in number and severity of asthma exacerbations in all age groups has also been identified (Rasmussen et al., 2016). Further, higher rates of pneumonia in the elderly have been associated with UNGD (Peng et al., 2016). Cardiovascular impacts, including increased blood pressure and increased risk of heart disease have also been documented (McKenzie et al., 2019). Neurologically, individuals have reported headache, migraines, dizziness, and confusion (Tustin et al., 2017).

Generalized psychological impacts have also been noted by numerous researchers (Fisher et al., 2018; Elliot et al., 2018; McDermott-Levy & Garcia, 2016). Residents in areas of UNGD reported increased general stress and uncertainty, social stress, fear related to water and air contamination, fatigue, concerns about their physical health, and frustrations with increased traffic congestion. Further, residents have reported concerns related to the future of their community, lack of “peace” in the community due to constant noise and disruption, a generalized sense of powerlessness, and mistrust of elected/government officials. (Please see the chapter on noise in this unit.)

Increases in maternal antenatal anxiety and depression, as well as increases in adverse birth outcomes have also been correlated with areas of UNGD (Casey et al., 2019). Further, pre-term births, miscarriages, low birth weight, birth defects, diminished sperm quality and fertility, and endocrine disruption have all been associated with UNGD (Balise et al., 2016).

### ENVIRONMENTAL HEALTH CONCERNS FOR SPECIAL POPULATIONS

Young children, pregnant women, and older adults are at greater risk for exposures to environmental toxins. More than 1.4 million children and 1.1 million elderly US residents live within one mile of an active drilling site. Due to their smaller stature, faster metabolism rate, and faster breathing rate, children are more vulnerable to environmental toxins. Associations between children living near high traffic areas and childhood asthma have been reported (Kim et al., 2012). Childbearing age women and pregnant women are also vulnerable to these toxins. Low birth weight, small for gestational age, and low APGAR scores have been reported in births of women living near UNGD activities. Also, congenital heart defects and a trend toward neural tube defects have been found in mothers living near UNGD activity (McKenzie et al., 2014).

Hospitalization rates for female genitourinary problems such as kidney infections, calculus of ureter, and urinary tract infections have been noted to significantly increase in areas of UNGD (Denham et al., 2019). Older adults who tend to have chronic illnesses are also at a higher risk for experiencing negative health effects related to UNGD. Exposure to the ground level ozone, increased diesel fumes and other air contaminants have the potential to further aggravate chronic lung problems. Long term exposure has been reported to increase the risk of cancer of the lung. Peng, Meyerhoefer, and Chou (2017) identified that elderly living in areas of UNGD experienced significantly higher rates of hospitalization due to pneumonia.

Finally, in general, minorities may be more adversely affected by UNGD. Zwickl (2019) identified that African Americans were disproportionately more likely to live near drilling sites, placing this group at a greater risk for the negative health impacts. Zwickl noted that the same seems to be true for Hispanic populations, though the evidence was less robust. Consequently, UNGD is an environmental justice issue.

### COMMUNITY HEALTH ISSUES RELATED TO UNGD

Weber, Geigle, and Barkdull (2014) reported changes in local communities brought about the “boom and bust”

cycles of the drilling activities. As an example, North Dakota has experienced one of the largest economic booms in the country due to the UNGD. Many community residents recognize the increase in jobs during “gas booms” but are also quick to note that many of the jobs are filled by individuals not from the local area. Further, as reported by McDermott-Levy and Garcia (2016), community members worry about the future of their communities, as well as experience mistrust of elected officials.

UNGD in the community will likely also impact the local built environment. Changes in traffic patterns and volume often lead to increases in motor vehicle accidents (Gorski & Schwartz, 2019). Xu and Xu (2020) identified an 8% increase in fatal crashes, with the majority involving a heavy truck from the fracking industry and a passenger car. Along with increases in accidents, including both motor vehicle and job site incidents, a corresponding increase in emergency response calls and local healthcare infrastructure needs has been noted (Ward, et al., 2014).

Crime rates in counties with both high (at least 75 wells) and low (less than 75 wells) fracking activity have been shown to significantly increase. In particular, violent crimes, such as rape and aggravated assault have been shown to significantly increase, when compared to counties without UNGD. In Pennsylvania, cases of sexually transmitted infections were found to be higher in rural counties where UNGD occurred compared to rural counties where no UNGD was occurring (Ward et al., 2014). More recently, Komarek and Tesh (2017) identified that increased fracking activity in a region was associated with increased rates of gonorrhea.

### IMPLICATIONS FOR NURSES

The 2010 edition of the American Nurses Association (ANA) publication, *Nursing: Scope and Standards of Practice*, included a new Standard 16: Environmental Health. This Standard mandated that environmental health knowledge and skills are a requirement for all nurses at the entry level of practice and this has been supported in the third edition in 2015. Because the process of UNGD is a relatively new environmental health concern, nursing education at both the entry level and advanced practice level may not include information about the need to assess possible environmental exposure as a cause of presenting illnesses.

#### Clinical Practice

For all levels of nursing, it is important to assess if the client is living near or working near or with oil and gas drilling activities; if so, a more in-depth assessment needs

to be completed. This screening may include an individual exposure health assessment, a home exposure assessment, and a residential environmental screening. In rural areas, special consideration must be given if the water source is well water and must include questions about animal exposure such as livestock and health of pets.

### Research

Research in the area of the health impact of UNGD has been steadily increasing, with numerous published systematic reviews and analyses available. More than half of the peer-reviewed literature on the health impacts of UNGD have been published in the last decade (Hays & Shonkoff, 2016). As this body of evidence continues to develop, nurses must remain abreast of the research trends, as well as communicate these findings to peers, colleagues, and the general public. Research must continue to examine the health, economic, social, and long-term greenhouse effects of UNGD. Without such studies, humans, animals, and the earth will potentially be at great risk now, in the future, and for generations to come. Mayer (2017) identified seven general areas of research that must be addressed as we move forward; in particular looking at long-term quality of life across communities affected by UNGD. Nurses must develop research questions and investigate the health impacts of UNGD and strategies to protect the health of populations.

### Advocacy

Nurses and other health care providers have an ethical obligation to “first do no harm” and to promote disease prevention and health promotion interventions. When there is an absence of evidence-based studies, the Precautionary Principle serves as a guide to practice. The Precautionary Principle states “When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically” (Wingspread, 1998). The American Nurses Association adopted the Precautionary Principle in 2003 and the importance of nursing’s role in environmental health issues was further clarified in the ANA Principles for Environmental Health for Nursing Practice guidelines (ANA, 2007). Nurses play a vital role in the advocacy of health for individuals, families, and communities. In this role, the nurse has a great deal to contribute by staying informed of environmental health issues, meeting with elected officials, taking part in community meetings, and sharing information about health and safety issues in the community.

## UNGD AS A GLOBAL HEALTH PHENOMENON

Concern about environmental health and UNGD is a global issue. Numerous countries including France, Bulgaria, Austria, Luxembourg, the Flanders region of Belgium, Scotland, Wales, Northern Ireland, Germany, several states in Australia, several Canadian territories, along with many others, have all banned fracking via legislative initiatives. In the United States, Vermont, New York, numerous counties in California, Maryland, Washington, and Oregon have banned fracking; numerous other states and localities have pending legislation to ban fracking ((Townsend, 2020)

### SUMMARY

The environmental health concerns involved in UNGD are complex. A growing body of literature continues to provide more evidence of the link between UNGD and significant health impacts. Environmental health concerns related to UNGD are a global health concern and not limited to drilling in the United States. Contamination concerns are not from one source, but from multiple routes (non-point source) including possible contamination from air, water, and ground sources. The profession of nursing is charged with having environmental health knowledge and skills. Nurses are held to the standard of including environmental health knowledge and skills in their practice which includes assessment for environmental health concerns.

### ONLINE RESOURCES

Since early 2012, the Southwest Pennsylvania Environmental Health Project (SWPA-EHP) has been in operation in Southwestern Pennsylvania, an area which has experienced a proliferation of natural gas drilling. The purpose of the [Environmental Health Project](#) is to provide education and referrals to area residents experiencing adverse health and resources to health care providers in the areas.

[State Impact PA](#) has developed a broad range of resources regarding the many impacts of fracking.

The National Library of Medicine offers environmental health and toxicology data that can be used to examine the toxicology of specific chemicals used in fracking ( <https://medlineplus.gov/poisoningtoxicologyenvironmentalhealth.html>). In addition, EJScreen by the Environmental Protection Agency, offers a mapping tools to examine indicators such as air quality, water quality, and proximity to hazardous waste sites by location. It can be found at: <https://www.epa.gov/ejscreen/overview-environmental-indicators-ejscreen>.

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## FRACKING CASE STUDY: THE GORDIS FAMILY OF NORTHEASTERN PENNSYLVANIA\*

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The Gordis family heard them coming. Suddenly, their quiet country road was no longer quiet. Trucks carrying drilling equipment, millions of gallons of water, fracking chemicals, and the drilling crews passing their home seven days a week, all day, and all night. The first thing, Marica Gordis noted was noise and then the odor of diesel from the trucks. She and her 14-year-old son, Dylan, were having trouble sleeping from the noise of trucks driving by all night long. Her husband, Bob, and her 11-year-old daughter, Lucy, did not have any problems sleeping.

Marcia Gordis had spent the previous 5 years working with a coalition of other community members trying to get zoning regulations passed that restricted unconventional natural gas (UNG) drilling in her quiet Northeastern Pennsylvania community. But the gas companies' lawyers were able to thwart the efforts of the community members. Marcia worked very hard with the coalition that her community formed. All the people in the coalition had "visits" from mysterious white cars parked in their driveways for an hour or so. The cars would finally drive off when the homeowner called the police, and the patrol car would come by. People in the community suspected that the white car drivers were from the gas drilling companies that were trying to intimidate people who were resistant to gas development in the region.

Now, her neighbor signed a lease to allow drilling on his property and the Gordis family had to live through this as their rural community began to look like an industrial zone. After a week of sleepless nights Marcia and Dylan were becoming irritable. Dylan was getting in trouble at school and Marcia had been receiving calls from Dylan's teachers.

Two weeks after the trucks arrived, the drilling started. Marcia assumed this happened because when she was outside tending to her vegetable garden, she could smell a sweet strong odor in the air. Her eyes and throat burned a bit, so she went in the house. Later that night, Marcia could hear Lucy coughing. Marcia went to check on Lucy and found her wheezing and beginning an asthma attack. Marcia reached for Lucy's inhalers and could see the lights of the drilling crew and the flames from the "flaring" that occurs to burn off the excess methane. Lucy was breathing better after her rescue medications, so everyone returned to bed.

The next morning, once the children were off to school, Marcia began answering her emails for the rental properties that she managed. Marcia noted that she had been very busy with rental properties since fracking had begun in her area and the cost to rent a house had more than doubled. Once her rental emails were answered, she started searching the internet for more information about living near a fracking well. She found the Southwest Pennsylvania Environmental Health Project (EHP) (<https://www.environmentalhealthproject.org/>) that is located across the state. She learned that constant noise and light can affect her health (see the chapter on Noise in the Environmental Health Sciences Unit). According to the EHP site, exposure to noise, light, and constant vibrations of heavy machinery can cause:

- Headaches
- Hearing problems
- Increases in blood pressure
- Problems sleeping
- Stress and anxiety

Marcia, thought, "Well, at least I have an explanation for Dylan's behavior at school and the way I have been feeling." She went on to read about the impacts of fracking on the air quality and found that there was a relationship between the drilling of the wells and the episode of burning eyes and scratchy throat. As she read more, she learned that her well water (see Water Quality in the Environmental Sciences Unit) could be threatened by the UNG wells on her neighbor's property and there was a risk of soil contamination on her property. Marcia discussed these things with Bob when he returned from work later that evening. They both agreed to have their well water tested for contamination from fracking.

The following week, Lucy had a check-up with the nurse practitioner (NP). Maria told the NP about the Lucy's asthma episode and the new fracking wells near her home. The NP was aware of the risks to air and water quality from fracking and the stress it can cause for community members. The NP reviewed Lucy's medications, added another rescue medication, and taught Lucy and Marcia ways to reduce risk of air pollution, such as closing windows using air purifiers and taking steps to reduce indoor air pollutants (see Air Quality chapter the Environmental Sciences Unit).

At the end of the visit with the NP, Marcia stated, "Thank you, what you told us is helpful. But we need to stop this activity to protect everyone, including the gas workers." The NP agreed and shared that policy change would make

a big difference. The NP also shared that nurses and other health providers are advocating for policies to protect communities from the risks of fracking. Among those organizations are the Alliance of Nurses for Healthy Environments, Concerned Health Professionals of Pennsylvania, and Concerned Health Professionals of New York. Marcia shared that she would be letting her coalition know about these groups and reaching out to see how the community and health care providers groups might work together to protect the health of everyone in the community.

\*The case is a composite of media reports (newspaper, radio), peer-reviewed literature, and the author's research in unconventional gas development communities. The names are made up by the author of the case. The Gordis family is fictional.

### FURTHER READING

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### ADDITIONAL RESOURCES

Concerned Health Professionals of New York: <https://concernedhealthny.org/>

Physicians for Social Responsibility – Pennsylvania: Fracking and Health <https://www.psrpa.org/environmental-health>

Southwest Pennsylvania Environmental Health Project <https://www.environmentalhealthproject.org/>

**ENDOCRINE DISRUPTORS**

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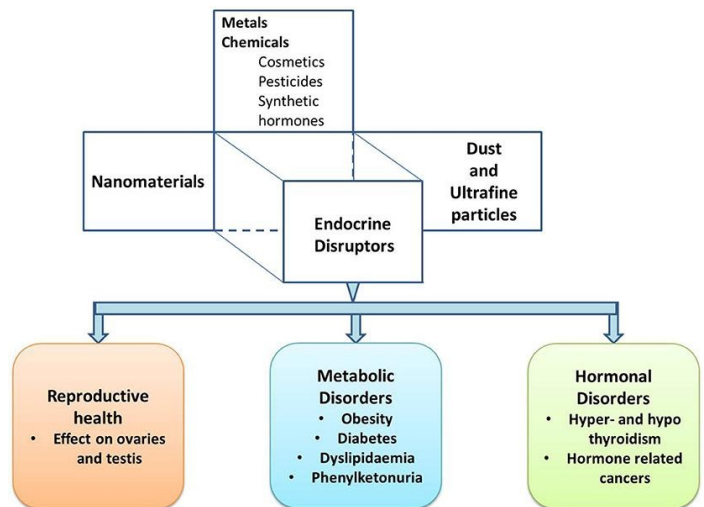
**ENDOCRINE DISRUPTORS**

The endocrine system is a series of glands that produce hormones that regulate various systems in our body. These hormones control a variety of bodily functions including metabolism, growth, mood, sleep, reproduction and sexual function. Endocrine disrupting chemicals (EDCs) are chemicals that interfere with hormone function through a variety of methods, including: mimicking naturally occurring hormones, binding to a hormone receptor thus blocking a naturally occurring hormone from binding to the receptor or by interfering with the production of natural hormones and receptors. Because the endocrine system is responsible for regulating so many of our body systems, when it is impaired, it can increase risk for a variety of diseases. There is increasing evidence that exposure to EDCs increase risk for obesity and diabetes, female and male reproduction, hormone-sensitive cancers in females, prostate cancer, thyroid, and neurodevelopmental and neuroendocrine system disorders (Gore et al., 2015)

EDCs are ubiquitous and exposure often begins in the womb. One study of pregnant women in the United States found that 99-100% of the women were exposed to EDCs (Woodruff, Zota, Schwartz, 2011). As many as 1,000 chemicals of the 85,000 currently on the market are classified as EDCs. However, this number might be much higher because many chemicals currently in use have not been sufficiently tested. Common sources of EDCs include phthalates, polybrominated diphenyl ethers (PBDEs) such as brominated flame retardants (perfluorochemicals) found in clothing, bedding and electronics, alkylphenols, and pesticides. Phthalates (used to make products fragrant and pliable) are common in food packaging, children's products and personal care products. The pesticide chlorpyrifos that has been cited for human safety concerns is a common insecticide used in commercial agriculture. Other pesticides that are known EDCs include DDT, 2,4-D glyphosphate and atrazine. Banned EDCs such as PCBs are still present in electronics, insulation and paints and the health effects of the pesticide DDT are still present in the environment (Gore et al., 2014). Recent research suggests that

nanomaterials also might cause endocrine damage (Priyam, Singh & Gehlout, 2018). The Endocrine Society's [Introduction to Endocrine Disrupting Chemicals](#) is a useful guide to better understand EDCs. See Figure 1 below.

Figure 1



Source: Priyam A, Singh PP and Gehlout S (2018) Role of Endocrine-Disrupting Engineered Nanomaterials in the Pathogenesis of Type 2 Diabetes Mellitus. *Front. Endocrinol.* 9:704. doi: 10.3389/fendo.2018.00704

BPA is one of the more well-known EDCs that has been linked to a variety of health issues including infertility, various reproductive system disorders, neurodevelopmental and cardiovascular diseases (Gore et al., 2014). It is commonly found in canned food lining and rigid plastic food containers, and, while its use has been phased out or banned in some products, the CDC estimates that 96% of the American population would test positive for BPA exposure (Gore et al., 2014). This can be because of continued exposure through non-food sources and environmental contamination from discarded plastics. Furthermore, exposure to BPA is not evenly distributed across the population as African Americans and people with lower income levels have been shown to have higher BPA body burden compared to their counterparts (Ruiz, Becerra, Jagai, Ard & Sargis, 2018).

**ROLE OF THE NURSE IN REDUCING EDC EXPOSURE**

Nurses can play a key role in helping to prevent exposure to EDCs. At the individual level, nurses working in clinical settings would benefit from being informed about EDCs in order to incorporate that knowledge when providing assessment, and education focusing on sources of EDCs in the home environment and the use of safer alternatives. For example, the hormone, insulin, regulates our blood

sugar. When insulin production and delivery is impeded by EDCs, it can increase risk for insulin resistance or diabetes. Being able to identify and thus eliminate sources of exposure to EDCs has the potential to reduce the burden of endocrine diseases, such as diabetes (Ruiz, et al., 2018).

While working at the individual level is essential, it is not enough. Other actions that nurses can engage in at the community and policy level include collaborating with other disciplines in finding safer alternatives and pushing for policy change. For example, within the healthcare setting, EDCs are found in medical devices, gloves, cleaning products, textiles, flooring and IV tubing and bags (Healthcare without Harm, 2018). Hospitals in European countries have been able to phase out some EDCs (Healthcare without Harm, 2018), thus nurses can advocate for green purchasing options within their healthcare settings. Healthcare without Harm has additional resources that elaborate on sources of EDCs and ways to reduce EDC exposure in the healthcare environment. Getting involved in policy and advocacy can be achieved by working with organizations that specifically focus on endocrine disruptor research and policy. The endocrine disruption exchange and International POPs (Persistent Organic Pollutant) Elimination Network are good resources to reach out to. For additional resources about EDC sources, alternatives and policy, please see Table I.

Table I: Additional resources to learn more about endocrine disruptors

| Website                                                                                                                                                     | Resource Description                                                                                                        |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| <a href="https://www.nrdc.org/stories/9-ways-avoid-hormone-disrupting-chemicals">https://www.nrdc.org/stories/9-ways-avoid-hormone-disrupting-chemicals</a> | 9 ways to avoid hormone disrupting chemicals<br>Source: NRDC                                                                |
| <a href="https://www.ewg.org/research/dirty-dozen-list-endocrine-disruptors">https://www.ewg.org/research/dirty-dozen-list-endocrine-disruptors</a>         | Dirty dozen list of endocrine disruptors- List of 12 most offensive EDCs and sources<br>Source: Environmental Working Group |
| <a href="https://www.youtube.com/watch?v=ibfAF66JzFE">https://www.youtube.com/watch?v=ibfAF66JzFE</a>                                                       | Endocrine disrupting chemicals- Brief video overview about EDC<br>Source: Hormone Health Network                            |

|                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                            |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <a href="https://endocrinedisruption.org">https://endocrinedisruption.org</a>                                                                                                                                                                                                                                               | The endocrine disruption exchange- TEDX provides list of potential EDCs, links to webinars and systematic reviews.                                                                                                                                                         |
| <a href="https://www.endocrine.org/-/media/endosociety/files/advocacy-and-outreach/important-documents/introduction-to-endocrine-disrupting-chemicals.pdf?la=en">https://www.endocrine.org/-/media/endosociety/files/advocacy-and-outreach/important-documents/introduction-to-endocrine-disrupting-chemicals.pdf?la=en</a> | Introduction To Endocrine Disrupting Chemicals (EDCs)<br>A Guide For Public Interest Organizations And Policy-Makers<br>An introductory guide to EDCs specifically targeted towards policy makers and public interest organizations.<br>Source: IPEN and Endocrine Society |
| <a href="https://noharm-europe.org/issues/europe/edcs-infographic">https://noharm-europe.org/issues/europe/edcs-infographic</a>                                                                                                                                                                                             | Non-toxic healthcare-reducing risk with safer alternatives<br>List of EDCs in healthcare environment and available alternatives to EDCs in infographic form.<br>Source: Healthcare without Harm                                                                            |
| <a href="https://www.epa.gov/saferchoice">https://www.epa.gov/saferchoice</a>                                                                                                                                                                                                                                               | EPA safer choice program<br>Helps to find products that perform and are safer for human health and the environment.<br>Source: EPA                                                                                                                                         |
| <a href="https://endocrinedisruption.org/interactive-tools/endocrine-disruption-audio-and-video">https://endocrinedisruption.org/interactive-tools/endocrine-disruption-audio-and-video</a>                                                                                                                                 | Links to presentations and videos on endocrine disruptors<br>Source: TEDX                                                                                                                                                                                                  |
| <a href="https://www.niehs.nih.gov/health/materials/endocrine_disruptors_508.pdf">https://www.niehs.nih.gov/health/materials/endocrine_disruptors_508.pdf</a>                                                                                                                                                               | Endocrine Disruptors and Your Health<br>Source: NIEHS                                                                                                                                                                                                                      |

The Environmental Protection Agency (EPA) is charged with regulating chemicals to protect the environment and to protect human health. Such regulation is led by specific offices within the federal agency. For example, the Office of Chemical Safety and Pollution Prevention protects risks from pesticides and toxic chemicals through federal laws such as the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Federal Food, Drug and Cosmetic Act (FFDCA) and Toxic Substances Control Act (TSCA) (EPA, 2021).

Table 2: Traditional concepts in chemical testing and why they are inadequate to determine endocrine disrupting activity

| Traditional Approach to Chemical Testing: 'The Dose is the Poison'                                                       | Why this approach is insufficient for Endocrine-Disrupting Chemicals                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Tests individual chemicals one at a time                                                                                 | Every person in the world now carries a body burden of chemicals that did not exist before 1940. Many more are being produced and released into the environment each year. Testing chemicals one at a time can't keep pace with exposure and doesn't take into account how combinations of chemicals within the body are impacting human development or health.                                                                                                                                      |
| Assumes individual chemicals have a "safe or acceptable" level of exposure below which there are no adverse effects      | The endocrine system regulates virtually every aspect of human health from development in the womb, to growth, to reproduction, and overall health. Recent science shows that even very small amounts of these chemicals or mixtures of these chemicals disrupt the endocrine system, reducing intelligence, disrupting reproductive systems, and causing other health problems. There may, in fact, be no safe level, especially when individuals have hundreds of these chemicals in their bodies. |
| Tests are focused on adult animals                                                                                       | Hormones regulate body systems beginning in the womb and throughout life. Tests conducted only on adult animals can't capture the impact of chemicals on the endocrine system throughout the body's life cycle.                                                                                                                                                                                                                                                                                      |
| Presumes doses below the amounts which cause test animals to die or develop a target disease (usually cancer) are 'safe' | Endocrine-disrupting chemicals have many impacts beyond death or disease.                                                                                                                                                                                                                                                                                                                                                                                                                            |

Source: Endocrine Society and IPEN report an Introduction to Endocrine Disrupting Chemicals (EDCs) A Guide for Public Interest Organizations and Policy Makers  
<https://www.endocrine.org/-/media/endosociety/files/advocacy-and-outreach/important-documents/introduction-to-endocrine-disrupting-chemicals.pdf?la=en>

EDC PROPERTIES AND THE CHALLENGES OF REGULATION

Some EDCs are persistent and bioaccumulate, particularly in fatty tissue. Babies and fetuses are exposed to EDCs via transmission through the placenta and breast milk. Furthermore, EDC exposure can change genes, potentially impacting the health of future generations. Harmful effects of EDCs can occur at very low and very high levels, with the dose response following a U-shaped curve (Calabrese & Baldwin, 2003). This can make regulation of EDCs very challenging. Traditional approaches to chemical testing are problematic when applied to the testing for EDCs. Most chemical testing measures the effect of one chemical at time but most people alive today have had many exposures to a variety of chemicals produced since the 1940s and interactive effects must be considered in the human body. Testing is based upon the assumption that there is a safe level for a chemical in the human body however science has not shown that any level is actually safe in humans. Finally, most tests are conducted in adult animals and the impact of chemicals in animals cannot be determined for the fetus, infant, child or along the life span. (Gore et al, 2014). This can make regulation of EDCs very challenging. Other challenges to assessing risk and developing policy are listed in Table 2.

TSCA OVERVIEW

Most people interact with hundreds of different products and materials (such as toys, clothing, cosmetics, lotions, electronics, furniture cleaning products, cars, building materials, food, food storage containers, etc.) every day in their homes, schools, and workplaces without giving a second thought to the potentially harmful chemicals contained within them. However, with more than 85,000 chemicals currently registered for commercial use in the United States, and 2,000 more being introduced each year, exposures to these chemicals is virtually certain (CA DTSC, 2007).

Research reveals numerous chemicals used in these products can be measured in the bodies of adults, pregnant women, children and newborns, including polybrominated diphenyl ethers (PBDEs, used as chemical flame retardants in furniture and building materials), Bisphenol A (BPA, used in plastics and resins),

perchlorate (used in explosives and fireworks, and per- and poly-fluoroalkyl substances (PFAS, used to make carpet and clothing stain-resistant and non-stick cookware). These chemicals have been linked with a variety of adverse human health effects including neurodevelopmental disorders such as ADHD and autism, reproductive issues such as birth defects and low birth weight, endocrine disruption such as hypothyroidism, and cancer.

The major legislation regulating chemicals in the United States is the Toxic Substances Control Act (TSCA), enacted in 1976 (15 U.S.C. Secs 2601 et seq.). This law was intended to protect the public from toxic exposures by regulating the use of harmful chemicals in everyday products, but instead it proved over the next four decades to be weak and highly ineffective. Of the tens of thousands of chemicals on the market, 62,000 chemicals already on the market when the law was passed were grandfathered in and deemed “safe” unless the Environmental Protection Agency (EPA) later determined. Since then, only a couple hundred chemicals have since been evaluated for safety by the EPA, and only five chemicals or classes of chemicals have actually been banned (GAO, 2005). Complex and cumbersome administrative burdens, data limitations, requirements to consider financial implications to industry, and recurring corporate lawsuits created such roadblocks that it became virtually impossible for EPA to ban or regulate any chemicals, even when strong scientific evidence of danger was present. An example of the clear inadequacies of TSCA was the failure of EPA in 1989 to ban asbestos, a known human carcinogen, after being overruled by the courts after industry groups sued (Stadler, 1993).

After years of criticism, debate, and different versions of proposed amendments, on June 22, 2016 President Obama signed the [Frank R. Lautenberg Chemical Safety for the 21st Century Act](#) (“Lautenberg Act”), the first major overhaul of TSCA since its original passage. The Lautenberg Act offered several tools that increased the ability of EPA to act on harmful chemicals. The EPA announced on January 14, 2021 that the final evaluation of the first 10 chemicals that were mandated for risk evaluation after passage of the Lautenberg Act was completed. (EPA, 2021). However the Environmental Defense Fund argues that steps to examine the risk of chemicals and take action were blocked or ignored during the years of the Trump administration allowing for major toxic emissions and hazards to health to occur (Environmental Defense Fund, 2019).

| Website                                                                                                                                                                 | Description                                       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|
| <a href="https://www.edf.org/sites/default/files/denison-primer-on-lautenberg-act.pdf">https://www.edf.org/sites/default/files/denison-primer-on-lautenberg-act.pdf</a> | Environmental Defense Fund Primer on TSCA         |
| <a href="https://ucsf.app.box.com/v/lb2018">https://ucsf.app.box.com/v/lb2018</a>                                                                                       | UCSF press kit on TSCA                            |
| <a href="https://www.epa.gov/laws-regulations/summary-toxic-substances-control-act">https://www.epa.gov/laws-regulations/summary-toxic-substances-control-act</a>       | EPA summary of TSCA and link to full text of TSCA |

### CASE STUDY: TSCA CHEMICAL HBCD AND ENDOCRINE DISRUPTION

One of the first ten TSCA chemicals EPA is evaluating under the Lautenberg Amendment is hexabromocyclododecane (HBCD), a chemical commonly used as a flame retardant. HBCD can be found in a number of different products, including:

- Expanded (EPS) and extruded (XPS) polystyrene foam
- Foam boards and insulation
- Textiles
- High impact polystyrene (HIPS), used in toys, plastic cups, shipping and packing material, refrigerator linings, televisions, wire and cable applications

Globally, HBCD use has decreased subsequent to a ban implemented in 2013 (Stockholm Convention, 2012) by several industrial countries. However, it is still heavily produced and used in the US, who signed but has not yet ratified the agreement. In the U.S., HBCD produced and imported an estimated 1-10 million pounds in 2015 alone (EPA, 2017). HBCD is added to consumer products rather than bonded to them, and therefore will slowly be released into the environment through all phases of the production and life cycle of these products. Due to its high production volumes and persistency in air, water, and soil there is high potential for human exposure and resulting adverse health effects (EPA, 2015).

People who may be exposed include workers in HBCD manufacturing and processing industries and people using commercial and consumer products containing HBCD. Pregnant women/ developing fetus/children may be more

susceptible to adverse health effects (EPA, 2015). HBCD has been detected in indoor air and dust (Abdallah et al., 2008), outdoor air (Jo et al., 2017), soil (Meng et al., 2011, Desborough et al., 2016), human serum and breastmilk (Carnigan et al., 2012, Rawn et al., 2014), and lake sediments (Harrad et al., 2009a, Yang et al., 2012). It can also bioconcentrate and biomagnify in fish and wildlife (Covaci et al. 2009, Harrad et al. 2009b, Johnson-Restrepo et al. 2008).

Animal studies indicate that HBCD is toxic, especially in the liver, immune system, on serum thyroid hormone (TH concentrations), interference with thyroid hormone signalling, and TH-dependent developmental processes (Canton et al., 2008, Germer et al., 2006, van der Ven et al., 2006). HBCD exposures lower thyroxine (T4) hormone levels with increased levels of thyroid stimulating hormones in rat and, in female rats, reduce the number of ovarian primordial follicles (Ema et al., 2008). Prenatal and neonatal exposure to HBCDs in rodents has been shown to decrease TSH levels and alter spontaneous behavior even at low exposures (Saegusa et al., 2009, Ema et al., 2008, Eriksson et al., 2006). The few human studies investigating HBCD health effects that exist demonstrate adverse effects from HBCD prenatal exposure on sexual and psychomotor development (Meijer et al., 2008).

Hypothyroidism can negatively affect neurological development, energy metabolism, early development and can lead to heart failure (Miller et al., 2016). In particular, normal thyroid functions are a necessity for healthy neonatal development, particularly the brain, and so prenatal exposures to HBCD could result in serious health outcomes such as neurotoxicity or infertility (Roze et al., 2009, Hond et al., 2015).

In September 2020 the EPA published their [final risk evaluation of HBCD](#) for the TSCA review. From what you have read in this case study and your examination of the EPA risk evaluation what concerns do you have for human health? Will you sign up for email alerts to keep following this chemical of concern?

Case study developed by Dr. Juleen Lam (2019)

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## A NEW FORM OF ENVIRONMENTAL POLLUTION: WIRELESS AND NON-IONIZING ELECTROMAGNETIC FIELDS

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The wireless revolution and the expansion of the internet of things is rapidly increasing our exposure to non-ionizing electromagnetic fields (EMFs) now considered a new form of environmental pollution (Russell, 2018, Bandara & Carpenter, 2018). Health and medical professionals recommend that we reduce these EMF exposures because of a growing body of research that documents adverse biological effects from low level exposures (Miller, 2019).

This chapter will introduce what EMFs are, how people are exposed, science documenting health effects of exposure, U.S. and international policy on protection from EMFs and nursing implications for clinical practice and advocacy in concert with ANA's principles.

### WHAT ARE EMFS?

EMFs are invisible energy waves consisting of electric and magnetic fields. For thousands of years, humans have been exposed to natural EMFs - such as the magnetic field of the earth and light from the sun. However, exposure to human-made EMFs are a relatively recent phenomenon and the more complex data carrying signals of cellular networks have been found to have significant biologic effects. (Panagopoulos, 2015).

Humans are electrical beings. Our cells communicate with tiny electrical impulses which affect our heart, our brain, our nervous system, and our endocrine system. In health care, these electrical impulses are recorded as electric waves on electrocardiograms and electroencephalograms.

### IONIZING RADIATION VERSUS NON-IONIZING RADIATION

Electromagnetic fields include two types of radiation: ionizing and non-ionizing. Ionizing radiation has intense high energy, high frequency waves which can remove electrons from atoms or "ionize them" causing cellular damage and directly breaking DNA. Ionizing radiation is known to cause cancer.

Ionizing radiation is used in healthcare both diagnostically (e.g. x-rays and CT scans), and therapeutically to reduce tumors (radiation treatment). Protective precautions such as lead shields and minimizing exposure are required. Health care institutions have procedures for nurses and other staff who with patients receiving ionizing radiation therapy to minimize the health care providers' exposures (Kaiser, 2001).

In contrast, non-ionizing radiation (e.g. Wi-Fi, wireless networks, cell tower radiation) has much lower energy and lower frequency waves. Decades ago, cell phones and wireless networks were brought to market without long term safety studies because the frequencies were non-ionizing and assumed to be safe. While non-ionizing radiation is not thought to cause DNA damage in the same way that ionizing radiation does, recent studies indicate that DNA damage and other adverse health effects can result from non-ionizing radiation, via a more complex indirect process (Lai, 2021, Panagopoulos et al., 2021).

The American Nurses Association Principles of Environmental Health for Nursing Practice were based on a Foundation of Principles including (among them): Human health is linked to the quality of the environment.

- A healthy environment is a universal need and fundamental human right.
- Current generations should meet their needs without compromising the ability of future generations to meet their own needs.
- Pollution prevention should occur at its source. The concern of nurses is the promotion, maintenance, and restoration of people's health.
- Nurses have an obligation to address health disparities and environmental injustice. The nurse collaborates with other professionals, policy makers, advocacy groups, and the public in promoting local, state, national, and international efforts to meet health needs.

(ANA's Principles of Environmental Health for Nursing Practice with Implementation Strategies, 2007)

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There are two main categories of non-ionizing EMF's of scientific research conducted to identify possible biological and environmental effects for over four decades.

- Magnetic Field Extremely Low Frequency (ELF-EMFs)- which are generated anywhere electricity flows such as powerlines, electrical wiring and charging cords.
- Radiofrequency (RF- EMFs) - also known as Radiofrequency Radiation (RFR) -which are the data/information carrying waves of cell phones and wireless networks (Moon, 2020).

In this chapter, unless otherwise noted, the acronym “EMF refers to both ELF and RFF.

### WHY ARE EMF EXPOSURES IMPORTANT?

A large and increasing body of research in both human and animal studies have found that even legally allowed low level exposures are linked to a myriad of harmful biological effects including cancer, DNA damage and impacts to reproduction, nervous system and brain development (Bandara & Carpenter, 2018). The effects of new technology on human health are challenging to study because there is no unexposed control group in humans (Russell, 2018.)

### SOURCES OF EMF EXPOSURES

#### Home and School Exposures

People are directly and indirectly exposed to EMFs from cell phones, computers, smart electronics and the myriad of Wi-Fi networks in their homes, workplaces and schools (see table 1). The use of wireless electronics by every age group continues to increase each year (Common Sense Media, 2019). Many school districts have robust Wi-Fi networks and students now use computers in school and at home for hours a day.

The use of electronics close to the body -e.g. laptops on laps, cell phones carried in a pocket or bra- create two kinds of intense EMF exposures to the body part closest to the device- RF from the wireless and ELF from the electricity. In addition, ELF exposures are elevated near charging cell phones, appliances, and electronics (Behrens et al., 2004).

### Occupational Exposures

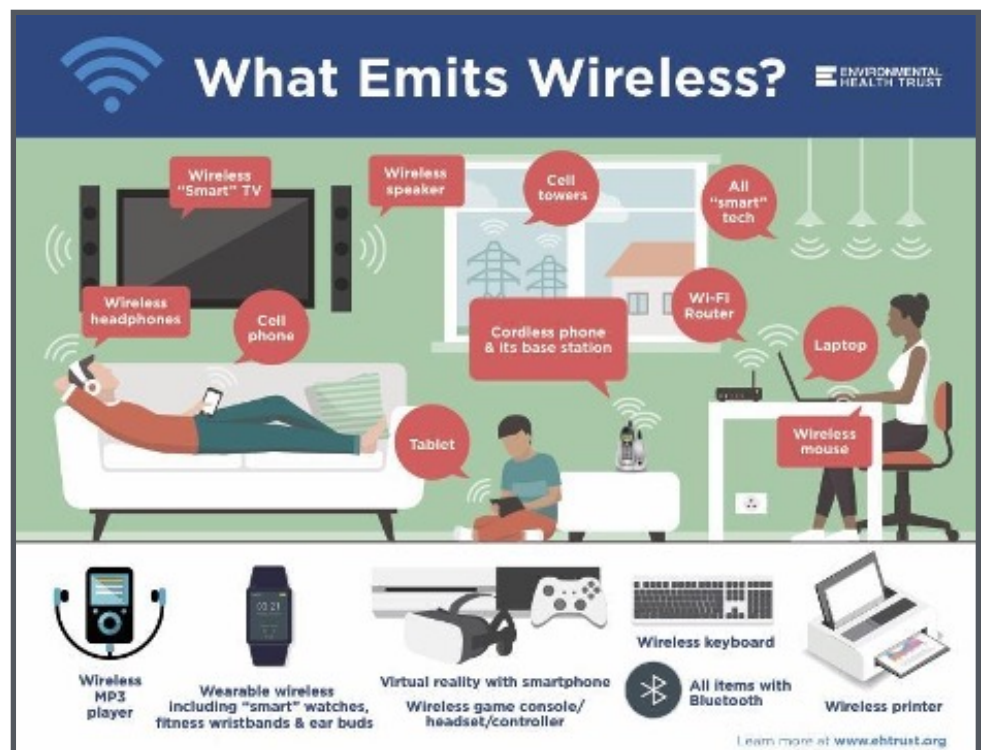
Cell phones, and wireless networks are common in today's workplace -e.g. in hospitals, schools, retail, transportation and numerous industries. There is a critical need to gather health data on these exposures (Stam, 2021). For example, many delivery drivers use cell phones and tablets to track packages and hospital workers often have a cell phone in their pocket, a walkie talkie clipped to their chest, and they use numerous wireless devices over the course of one day.

Cell tower/antenna maintenance workers, physical therapists using diathermy, and operators of dielectric welders have elevated EMF exposures. The latter two directly use high frequency EMFs to generate heat produced by EMFs (Aniołczyk et al., 2015). Overexposure has been documented to induced central nervous system demyelinating disease mimicking Multiple Sclerosis (Raefsky et al., 2020). Although U.S. National Institute for Occupational Safety and Health (NIOSH) scientists developed recommendations to reduce EMF, they were never implemented (Bowman, 2016).

### Environmental Exposures

Environmental exposures to non-ionizing EMFs have dramatically increased over the last few decades (Bandara& Carpenter, 2018). People who live near high voltage powerlines and substations may have elevated ELF-

Figure 1



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Table I: Types and sources of EMF exposures

| First-Hand Exposure (Devices Used Close to the Body)                                                                                                                                                                                                                                                                | Second-Hand Exposure (Devices and Networks Inside Homes, Schools and Buildings)                                                                                                                                                                                                                                                                                     | Environmental Exposure                                                                                                                                                                                  |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>ELF- EMF and Magnetic fields (*Also emit RF if wireless)</b>                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                         |
| <ul style="list-style-type: none"> <li>• Cell phones, tablets and laptops *</li> <li>• Electric blankets</li> <li>• Charging phones and electronics *</li> <li>• Alarm clocks and radios plugged in directly near the body such as near beds</li> </ul>                                                             | <ul style="list-style-type: none"> <li>• Wiring errors in electrical systems</li> <li>• Electric cars</li> </ul> <p><b>Occupational sources</b></p> <ul style="list-style-type: none"> <li>• Microwave ovens</li> <li>• Welding equipment</li> <li>• Appliances</li> <li>• Electrical equipment</li> <li>• Motors</li> </ul>                                        | <ul style="list-style-type: none"> <li>• High-voltage power lines</li> <li>• Power cables</li> <li>• Electrical transformers</li> <li>• Substations</li> <li>• Railways and electric trains</li> </ul>  |
| <b>RF-EMF</b>                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                         |
| <ul style="list-style-type: none"> <li>• Cell phones</li> <li>• Cordless phones</li> <li>• Wi-Fi tablets, laptops &amp; computers</li> <li>• Walkie talkies</li> <li>• Wearable technology</li> <li>• Smart watches</li> <li>• Wireless keyboard and mouse</li> <li>• Bluetooth</li> <li>• Wireless Toys</li> </ul> | <ul style="list-style-type: none"> <li>• Wi-Fi networks</li> <li>• Wi-Fi routers</li> <li>• Cordless phone base station</li> <li>• Wireless devices such as:</li> <li>• Baby monitors</li> <li>• Gaming consoles</li> <li>• Speakers</li> <li>• Security systems/hubs- doorbells with cameras</li> <li>• Virtual Assistants</li> <li>• Wireless printers</li> </ul> | <ul style="list-style-type: none"> <li>• Cell towers</li> <li>• Small cell towers aka: Personal Wireless Facilities</li> <li>• Antennas mounted on buildings</li> <li>• Smart Meter networks</li> </ul> |

EMF throughout their home (Gagsek et al., 2013, Amoon et al., 2020).

Cell tower networks are a significant source of a person's daily RF-EMF exposure, especially in urban areas (Sagar et al., 2018). Cell tower RF-EMF penetrates into homes, especially through windows facing the beam of a nearby wireless antenna (Hardell et al., 2018). The newest generations of wireless - 4G and 5G- will increase RF-EMF as these networks consist of thousands of new "small" cell towers built closer to homes (El Hajj and Naous, 2020, Mzloum et al., 2019). It is estimated that 800,000 new cell towers will be needed in the U.S. (Shepardson, 2018). Researchers caution that increasing cell antennas closer to the ground, close to homes and schools will increase ambient RF exposures to people (Frank 2021, Koppel et al 2022, Pearce 2020).

## WHO ARE MOST VULNERABLE TO HEALTH EFFECTS OF EMFS?

### Children

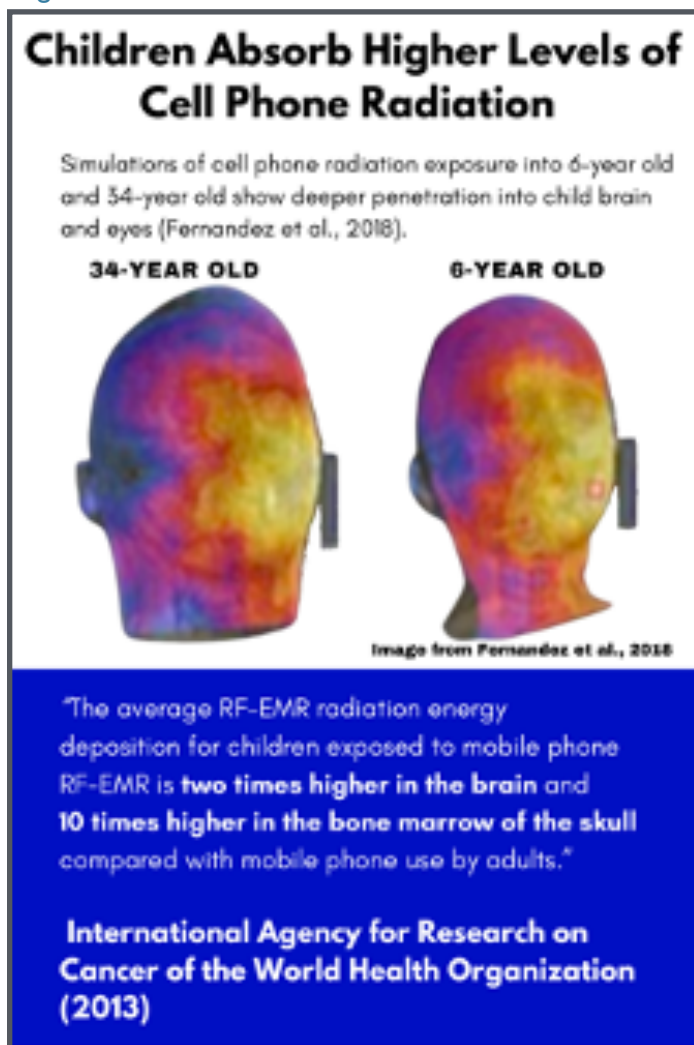
When cell phones first came on the market, no one could imagine the need for a child to use one. Now they are a favorite toy and used as babysitters. Children are uniquely vulnerable to EMFs just as they are to other environmental toxins. As wireless technology is now ubiquitous, children will receive a greater cumulative exposure than today's adults, with exposure starting before they are born (Miller et al., 2019). Both their ongoing physical development and physiology put them at greater risk.

- Children absorb proportionally higher doses of cell phone RF-EMF in the eyes and critical brain regions than adults due to their smaller heads, thinner undeveloped skulls and the higher water content in both their bodies and brain (Fernandez et al., 2018).

- Children's developing brains are more susceptible to neurotoxic exposures (Redmayne and Johansson, 2014 and 2015).
- Children have more active stem cells and stem cells have been found to be more sensitive to RF-EMF exposure (Markova et al., 2010).
- Safety limits for RF-EMF from cell phones and cell towers are outdated as they were set over two decades ago in 1996 and are based on the body of a large adult, not a child (Gandhi et al., 2012).

Researchers at Penn State Medical Center found reducing EMFs improved health outcomes in preterm infants (Passi et al., 2017). NICU equipment is linked to various impacts to the autonomic nervous system including melatonin production and heart rate and a 2017 review concluded that incubators should be redesigned to reduce exposure to the babies and caregivers (Bellieni et al., 2017).

Figure 2



Used with permission from Environmental Health Trust and Professor Claudio Fernandez.

## Pregnancy

As with other environmental toxins, the developing fetus is particularly sensitive to exposure during critical developmental windows. Although more research needs to be done to fully understand the risk during windows of vulnerability, research on pregnant women has linked prenatal cell phone radiation exposure to oxidative stress and DNA damage in cord blood (Bektas et al., 2021); increased risk for miscarriage (Mahmoudabadi et al., 2015), lower birth weight (Lu et al., 2017), fetal growth impacts (Boileau et al., 2020), and preterm birth (Tsarna et al., 2019); as well as emotional/behavioral problems (Divan et al., 2012, Sudan et al., 2016) and hyperactivity (Birks et al., 2017) in their children. Animal studies have linked prenatal wireless exposure to DNA damage (Smith-Roe et al., 2020), brain damage (Tan et al., 2017), memory problems (Shahin et al., 2018) and hyperactivity (Aldad et al., 2012).

A Kaiser Foundation Research Institute team took measurements of the magnetic field ELF-EMF exposure of pregnant women and followed their pregnancies and subsequent birth and health of their children over time. They published a series of studies documenting links between higher prenatal magnetic field exposure (ELF-EMF) and miscarriage (Li et al., 2017) as well as ADHD (Li et al., 2020), obesity (Li et al., 2012), and asthma (Li et al., 2011) in children exposed prenatally.

Watch [BabySafe Project press conference](#) where Hugh Taylor MD, Chief of OBGYN at Yale Medicine and Devra Davis PhD, MPH presented on the scientific basis for the recommendations to reduce exposure.

## PHYSIOLOGICAL IMPACTS OF ELECTROMAGNETIC FIELDS

### Oxidative Stress and Preexisting Conditions

Reviews of animal and cell studies consistently find even very low EMF exposure associated with increased oxidative stress. Oxidative stress plays a role in the development of many diseases, such as cancer, diabetes, immune and neurodegenerative syndromes. The young, old and/or medically compromised individuals, whose immune system and defense mechanisms are already compromised, are more likely to experience health effects from the increased oxidative stress (Yakymenko et al., 2015, Schuermann & Mevissen, 2021).

### Cancer

Researchers have long studied EMFs for their relationship to causation. In 2002, magnetic field ELF-EMF was classified by the World Health Organization International Agency for Research on Cancer (WHO/IARC) as a Group

2B possible carcinogen due to research findings that showed a relationship between residential exposure and increased childhood leukemia risk (WHO/IARC 2002). This association continues to be reported in more recent studies (Carpenter 2019, Seomun et al., 2021).

In 2011, the WHO/IARC concluded that wireless radiofrequency radiation (RF-EMF) was a Group 2B possible carcinogen largely based on studies of long term cell phone users with increased tumors-glioblastomas and acoustic neuromas (WHO/ IARC 2011). Several international experts conclude RF-EMF is a proven Group I human carcinogen (Miller et al., 2018, Peleg et al., 2018 Carlberg and Hardell 2017, Belpomme et al., 2018).

Examples of new scientific research that finds a carcinogenic effect for RF-EMF include:

- Two major animal studies investigating long-term exposure found the same tumors as found in human studies (U.S. National Toxicology Program, 2018, Falcioni et al., 2018).
- A 2020 meta-analysis linked cumulative cell phone use over 1000 hours increased tumor risk (Choi et al., 2020).
- Studies have found women who carry cellphones in the bra have elevated breast cancer risk (West et al., 2013, Shih et al., 2020).
- A Yale study funded by the American Cancer Society found elevated thyroid cancer risk in heavy cell phone users with specific genetic susceptibilities (Luo et al., 2020).

## Reproduction

Systematic reviews associate RF-EMF with impacts to sperm (Kim et al., 2021, Yu et al., 2021) and decreased testosterone (Maluin et al., 2021) leading many researchers to conclude “it is recommended to keep the cell phone away from the pelvis as much as possible” (Hassanzadeh-Taheri et al., 2021).

## Nervous System Impacts

The nervous system is sensitive to EMFs (Bertagna et al., 2021). Cell phone radiation has been found to alter brain activity (Volkow et al., 2011, Bin et al., 2014), impact neurotransmitters and alter neuron development (Kaplan et al., 2015, Li et al., 2021, Chen et al., 2021). Teenagers were found to experience memory damage to the area of the brain most exposed to cell phone radiation after just one year (Foerster et al., 2018).

Experimental animal research has found a variety of RF-EMF impacts especially in the brain regions critical to memory and learning (Sonmez, et al., 2010, Dasdag et al., 2015, Shahin et al., 2018, Obajuluwa et al., 2017, Tan et al., 2021, Hasan et al., 2021).

## Electromagnetic Hypersensitivity

In 2021, scientists published a consensus statement calling for the acknowledgement of electrohypersensitivity as a distinct neuropathological disorder (Belpomme et al., 2021) and exposure to non-ionizing radiation has a series of ICD 10 codes.

Electromagnetic hypersensitivity (EHS) is characterized by the development of numerous symptoms linked to EMF exposure including: headaches, sleeping problems, concentration problems, nosebleeds, unexplained skin rashes, digestive problems, neurological problems, heart palpitations and disabling fatigue (Belyaev et al., 2016).

## Synergistic Effects

EMFs can add to our total body burden of carcinogens. Research has found that EMF exposure can act synergistically with other environmental pollutants potentiating harmful effects (Kostoff and Lau, 2017). For example, prenatal and postnatal mobile phone exposure has been linked to greater neurobehavioral effects in children with elevated lead levels (Choi et al., 2017, Byun et al., 2017).

It is challenging to isolate an association epidemiologically because there is no unexposed control group (Russell, 2018.) Scientists must therefore rely on animal experiments which are carefully controlled to understand if the effects are caused by the exposure.

Animal studies have found combining ELF-EMF exposure with known carcinogens can increase tumors (Soffritti et al., 2016, Soffritti et al., 2016). EMFs can increase permeability of the blood brain barrier, thus, allowing more toxic agents to reach the brain (Sirav and Seyhan, 2016, Tang et al., 2015).

## EMFs and the Environment

There are reports that the proliferation of cell antennas will have numerous environmental effects. Analysis is accumulating that electricity and energy consumption of 5G and new wireless networks will contribute to greenhouse gasses and exacerbate climate change (The Shift Project, 2019, Williams et al, 2022).

Further, trees are critical to a healthy environment. They filter toxic chemicals from the air, reduce ground-level ozone and absorb carbon dioxide emissions that are driving climate change (Terzaghi et al., 2020, Bastin et al., 2019). There are studies finding that cell antenna RF-EMF can injure trees (Waldmann-Selsam, C., et al., 2016, Breunig, 2017, Haggerty, 2010) and impact plant growth (Halgamuge, 2017, Pall, 2016).

A 2021 research review on effects to wildlife published in *Reviews on Environmental Health* references more than 1,200 scientific references which found impacts to wildlife, including pollinators, from even very low intensities of non-ionizing EMFs including impacts to orientation and migration, reproduction, mating, nest, den building and survivorship (Levitt et al., 2021a, b, c). The authors assert that the current body of science should trigger urgent protective regulatory action to protect wildlife.

### A COMPLEX SCIENCE WITH LIMITED PROTECTIVE FEDERAL REGULATION AND HEAVY INDUSTRY INFLUENCE

U.S. and international scientists are calling for an update to the 1996 federal regulations and the need for independent research reviews in order to ensure the public is protected (Hardell & Carlberg, 2020). Similar to other environmental pollutants, literature reviews show conflicting results and industry funding has long been found to influence the results both in ELF and RF research (Hardell et al., 2006, Carpenter 2019, Huss et al., 2017). The official reports of many authorities have been criticized as having major conflicts of interest (Hardell 2017, Buchner & Rivasi, 2020).

The book, “Captured Agency” (Alster, 2015) identified a “revolving door” between industry, Congress and the Federal Communications Commission. The investigation compared the tactics of the wireless industry to Big Tobacco citing the heavy industry lobbying, the funding of science that shows no effect and the massive public relations campaigns designed to attack the credibility of the science and of scientists who do find harmful effects.

### U.S. Policy

The Federal Communications Commission (FCC) established human exposure limits for cell phones and cellular network RF-EMF in 1996 and they have not been updated despite the dramatic changes in wireless communications in the last 25 years. The FCC is not a health agency and does not have medical or public health experts on staff. In 2021, a federal court ruled that the FCC needed to reexamine their decision to retain the 1996 limits (No. 20-1025, 2021). To date, governmental

health and environmental agencies such as the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the Department of Health and Human Services and National Cancer Institutes have not reviewed the totality of the latest science on health effects of EMFs.

In 2018, the U.S. National Toxicology Program (NTP) found “clear evidence of cancer” and DNA damage in a large-scale animal study designed to evaluate the effects of long term exposure to radio frequency radiation from cell phones (U.S. National Toxicology Program, 2018). Although the FDA requested the studies, they rejected the study conclusions. Research analyzing the NTP findings conclude U.S safety limits need to be strengthened by 200 to 400 times to protect children according to current risk assessment guidelines (Uche & Naidenko, 2021).

The American Academy of Pediatrics has long recommended that FCC limits be updated to protect children and pregnant women (AAP, 2012 & 2013). In addition, cell phones and electronics are not tested the way people use devices today- in body contact positions. Although it is now commonplace to see children watching videos with a cell phones pressed against their chest, research has found that when phones are tested for exposure levels in body contact positions, they can exceed government limits up to 11 times the FCC limit (Gandhi, 2019). Pregnant women rest cell phones laptops on their abdomens, and research finds these positions create RF-EMF exposures into the fetal brain (Cabot et al., 2014) and can induce ELF-EMF in the fetus Bellieni et al., 2012).

### Magnetic and ELF Safety Limits

The United States has no federal safety limit for magnetic fields or ELF-EMF. In contrast, over a dozen countries have some level of protective policy in place and they limit building homes in areas with magnetic field levels higher than the levels associated with childhood leukemia (Stam, 2018).

### State and Local Policies

In the US, many states and localities have enacted laws related to Cell/Tower/Antenna placement. Physicians for Safe Technology and the Environmental Health Trust track state legislation and local ordinances. In 2020, the New Hampshire State Commission on 5G issued 15 recommendations which included several recommendations including large setbacks to distance cell antennas from homes and schools, replacing Wi-Fi with wired in schools and a public health campaign to educate families.

Figure 3

# U.S. Policy and Recommendations on Cell Phones, Cell Towers and Wi-Fi

## School Districts

"Best Practices" posted in classrooms – to turn Wi-Fi off when not in use.

- Ontario NY
- Ashland, MA

## Information on how to reduce wireless.

- Worcester MA
- Montgomery County MD

## Ban on Cell Towers

- Palo Alto Unified CA
- Los Angeles CA
- West Linn-Wilsonville OR
- Montgomery County MD
- Prince George's MD
- Portland OR

## Teacher Unions

### New York State United Teachers

- Resolution "Hazards of Wireless Radiation Emission" and "Best Practices" recommend wired ethernet connections.
- Webinar "Risks of wireless technologies and protecting children and staff in schools."

### United Educators of San Francisco CA

- Resolution on Safer Technology calls for the California cell phone advisory on how to reduce cell phone exposure be disseminated to students and staff.
- Webinars on reducing RF exposure

## State Public Health Departments

### California Cell Phone Advisory (2017)

- Explains how to reduce cell phone exposure- especially for children.

### Connecticut Cell Phone Advisory (2015)

- States that it "is wise" to reduce cellphone radiation to brain.

### North Carolina Department of Occupational & Environmental Epidemiology

- Lists the American Academy of Pediatrics recommendations to reduce cell phone radiation

## Cell Tower Setbacks

Numerous cities restrict cell antennas near homes with setbacks and strict ordinances

including: Los Altos, Petaluma, Mill Valley, Malibu, Santa Barbara, Nevada City, Suisun, Calabasas, San Clemente, Westlake, Sonoma, Sebastopol, San Rafael, Ross Valley, Encinitas, Fairfax, Palo Alto, Walnut City and San Diego County CA, Ithaca and Scarsdale NY, Randolph, Great Barrington and Stockbridge MA

As an example, the Los Altos City ordinance prohibits installation of small cells on public utility easements in residential and has a 500 ft school setback. San Diego County does not allow small cells within 1,000 feet of schools, child care centers, hospitals, or churches.

## Cell Phone Right To Know Laws

### San Francisco CA (2010) & Berkeley CA (2015)

- Informed consumers that phones emit radiation and should not be in body contact.
- Passed but not implemented after wireless industry lawsuits.

## New Jersey Education Association

### Recommendations (2016)

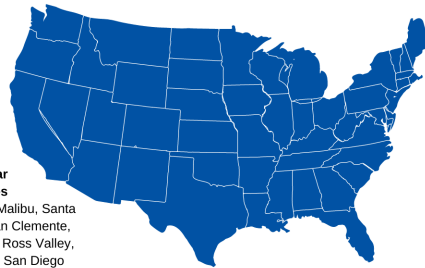
- Hard wire devices, printers, projectors and boards.
- Use hard-wired phones instead of cell or cordless phones.
- Put devices in airplane mode.

## New Hampshire State

### 2020: Final Report of Commission on Health & Environmental Effects of 5G

15 recommendations include:

- An independent federal study of health effects
- Educational campaign to reduce public exposure.
- Replace Wi-Fi with wired in schools and libraries.
- Setbacks for antennas from schools and homes
- Measure cell network radiation levels.
- Establish wireless radiation limits to protect trees, plants, wildlife and insects.
- Require software changes to reduce emissions.
- Establish wireless radiation-free zones.
- An environmental impact assessment on 5G.



## Maryland State Council

### Council on Children's Environmental Health Report (2017)

- Install wired networks instead of Wi-Fi when building schools.
- Reduce wireless exposure in schools.

## Resolutions Halt 5G and/or Study Health Effects

- Hawai'i County HI
- Easton CT
- Farragut TN
- Hallandale FL
- Keene NH
- Carmel City IN

## Proclamations Cell Phone Radiation

- Portland ME
- Pembroke Pines FL
- Jackson Hole WY

## EMF Hypersensitivity

- Alabama
- Colorado
- Connecticut
- Broward County FL



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## International Policies and Actions

Internationally governments have policies and regulations in place to inform the public and reduce exposures. Numerous scientists, medical and public health professionals have issued appeals and recommendations on the need to reduce exposure to electromagnetic radiation and pause the proliferation of new untested networks (EMF Scientists Appeal, 2015, Di Ciaula, 2018, Mallery-Blythe, 2020, Nyberg & Hardell, 2017)

- Switzerland, Italy, China, Russia, India, Israel and several European countries have far more stringent cell tower radiation emission limits compared to the US FCC and many define homes, schools and kindergartens as "sensitive areas" (Stam, 2017).
- Over a dozen countries have clear recommendations that people reduce exposure to cell phone radiation, especially for children (Redmayne, 2016, EHT, 2021).
- France has several policies including: limiting Wi-Fi in classrooms, banning the sale of cell phones designed for young children, banning advertisements aimed at children under 14 years old. Consumers are informed with instructions to use speakerphone, limit children's use and "keep away from the belly of pregnant women and lower abdomen of adolescents."
- Cyprus and French Polynesia have multimedia public education campaigns (EHT, 2021).

- A major hospital in Cyprus removed Wi-Fi from the pediatric Intensive Care Unit and Neonatal units (Cyprus Committee on Environment and Children's Health, 2019).

## IMPLICATIONS FOR NURSING PRACTICE

In 1992, the International Council of Nurses made environmental health, preventing illness by eliminating environmental toxins a priority (as cited in ANA's Principles of Environmental Health for Nursing Practice with Implementation Strategies 2007). Nurses can protect human health and the environment through prevention, clinical practice, and advocacy.

## Prevention

Nurses are trusted advisors. Nurses must first protect themselves and their families, their patients, and their communities by learning how to decrease exposures to EMFs. Small lifestyle changes can significantly reduce cellular damage of our total lifetime exposure. We can then educate our patients- especially parents and vulnerable populations. Nurses can work in coalition with other groups to educate why and how to reduce EMF exposures in the workplace, schools, and communities. People need to know how to eliminate unnecessary sources of EMFs and choose safe alternatives. Tips and checklists follow.

Table 2: Ways to reduce exposure to cell phone radiation

### American Academy of Pediatrics Reducing Cell Phone Radiation Recommendations

- Prefer texting to voice calls
- Use cell phones in speaker mode or hands-free.
- Hold cell phone at a distance from head.
- Make only short or essential calls on cell phones.
- Avoid carrying your phone against the body like in a pocket, sock, or bra.
- Do not talk on the phone or text while driving.
- If you plan to watch a movie on your device, download it first, then switch to airplane mode while you watch in order to avoid unnecessary radiation exposure.
- Minimize use in areas of low signal (i.e. how many bars you have). The weaker your cell signal, the harder your phone has to work and the more radiation it gives off.
- Avoid making calls in cars, elevators, trains, and buses. The cell phone works harder to get a signal through metal, so the power level increases.
- Remember that cell phones are not toys or teething items.

(American Academy of Pediatrics, 2016)

### Resources on How To Reduce Cell Phone Radiation

- [EHT Steps to Reduce Cell Phone Radiation](#)
- [Cell Phone Tip Card from Grassroots Environmental Education](#)
- [Downloadable Posters on Reducing Cell Phone Radiation](#)

### Reducing EMFs During Pregnancy

During pregnancy, new parents are highly motivated to learn everything they can to have a healthy baby. This is a great opportunity for nurses to give parents information.

The [Baby Safe Project](#) website includes [five simple ways to reduce exposure](#), downloadable brochures in French and Spanish.

### Reducing EMFs at Home

- Replace cordless phones with corded telephones
- Minimize wireless use. Start by turning Wi-Fi off at night. Then install wired ethernet connections instead of Wi-Fi.

### Reducing EMFs at Home (Cont.)

- Use wired mouse, keyboard, speaker, and printer.
- Use wired alarm systems and doorbells not wireless
- Keep devices on a table off the lap/body.
- Do not use wireless speakers or virtual assistants.
- Keep mobile devices and chargers out of bedrooms.
- Eliminate baby monitors and wireless cameras.
- Refuse Smart meters and request analog, non-wireless utility (water, electricity, gas) meter options.
- [Safe Technology at Home](#)
- [Checklist for Reducing EMF at Home](#)
- [How to Connect Your Laptop with Ethernet Instead of Wi-Fi](#)

### Tips for Reducing Magnetic Field EMF

- Use tablets, laptops and electronics on a table, not the lap.
- Do not use a cell phone or device while it is charging.
- Charge phones and devices away from beds and away from your body.
- Remove screens and electronics from the bedroom - especially around your bed and the crib.
- Avoid sleeping with electric blankets and heating pads.
- Ensure you are not sleeping against a wall with the utility meter on the other side.
- Get magnetic field measurements, especially if you live close to high voltage power lines.
- [Building science and radiofrequency radiation: What makes smart and healthy buildings: Reduce EMF](#)
- [Collaborative for High Performance Schools Reduce RF and Low EMF Criteria](#)
- [How to Reduce EMF in Schools](#)
- [Safe Tech for Kids: What to do about children's increased use of technology during Covid-19](#)

### Clinical Practice

Nurses can integrate their understanding of EMFs into their clinical practice and include interview questions about technology use and EMF exposure in their assessments. When patients present with EHS symptoms, such as headache, insomnia, irritability, they should be further assessed for EMF sensitivity.

Helpful Resources include:

- [Physicians for Safe Technology](#) EHS information includes Clinical Interview Questions

- [Austrian Medical Association EMF Guidelines](#) Has algorithms and a sample patient questionnaire.
- [The Environmental Health Clinic, Women's College Hospital at the University of Toronto Practice Guidelines for Diagnosis and Treatment](#) (Bray, 2020)
- [EMF Medical Conference 2021 offers CME Online](#)
- [Electrosensitivity Society](#) Providers in US and Canada

## ADVOCACY

### Protecting Health Requires Nurses To Be Advocates for Systematic Policy Change

Just as with other environmental issues, nurses have a responsibility to act to protect individuals and communities by supporting meaningful policy change.

Nurses bring credibility on health issues to advocacy and our voices are important in developing protective policy. Working in coalition with other organizations always strengthens the message (e.g. parent groups, environmental organizations, faith-based organizations, etc.).

- Nursing organizations can adopt resolutions or policy positions on wireless and EMF exposures. See the resolution of the California Medical Association.
- Nurses can join “safe tech” organizations and coalitions to support policies that reduce EMF exposures in our workplaces, schools, and communities. These include the citing of small cell antennas in neighborhood and sensitive areas and advocate for wired internet connection to and into the building: FASTER, SAFER, RELIABLE, and if it is a municipal/community partnership, it will eliminate the digital divide. Learn more at: [SafeG.net](#)
- Nurses and nursing organizations fighting climate change can lobby elected officials to take into account the carbon footprint of wireless technology. Download Environmental Health Trust's Fact sheet on 5G and Climate Change which describes research showing escalating energy consumption from 5G networks.
- As environmental health advocates, nurses can educate and work with schools, parents, teachers, and unions to reduce EMF exposures in schools, replace Wi-Fi with wired internet connections and ensure cell towers are not built near schools or daycare centers.

## RESOURCES

### Resources for Safe Schools

[Environmental Health Trust](#)

### [Physicians for Safe Technology](#)

#### Santa Clara Medical Association

[Wi-fi In Schools: Are We playing It Safe With Our Kids?](#)

[Shallow Minds: How the Internet and Wi Fi in Schools Can Affect Learning](#)

#### How To Reduce EMFs in Schools

[New Jersey Education Association Article](#), [PDF of Recommendations](#)

[Maryland State Children's Environmental Health and Protection Advisory Council](#)

[Collaborative for High Performance Schools Low EMF Criteria](#)

[Grassroots Environmental Education](#)

[Environmental Health Trust Checklist for Schools](#)

#### Websites

[Environmental Health Trust](#)

[Environmental Working Group](#)

[Physicians for Safe Technology](#)

[Americans for Responsible Technology](#)

[Dr. Joel Moskowitz](#), UC Berkeley School of Public Health, Director, Center for Family and Community Health

#### Educational Webinars

[Dr. Joel Moskowitz “Health Effects of Cell Phones and Wireless: Implications for 5G” Center for Occupational and Environmental Health Webinar](#)

[Dr. Devra Davis “Children, Wireless Radiation and Health” Cyprus Pediatric Symposium](#)

[Expert Webinar “What Environmental Health Leaders Need to Know”](#)

#### Downloads/Printables

[EHT Posters and Factsheets](#)

[American Academy of Pediatrics Letters](#)

[Santa Clara Medical Organization](#)

#### Books

Dunkley, V. (2015). Reset your child's brain: A four-week plan to end meltdowns, raise grades, and boost social skills by reversing the effects of electronic screen-time. New World Library.

Aly Cohen MD & Frederick S. vom Saal PhD (2020). Non-Toxic: Guide to Living Healthy in a Chemical World, Oxford University Press.

Davis et al, (2018). Chapter 10: Microwave/Radiofrequency Radiation and Human Health: Clinical Management in the

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# Unit IV:

## *Practice Settings*

### INTRODUCTION

Nursing is known as the caring profession. It is imperative that nurses not only care for the patients and communities that they serve, but also for our environment. The American Nurses Association (ANA) called on all registered nurses to have a working understanding of environmental exposures, the impact on human health and to apply this information into our practice (2007). Nurses are present in nearly every community and work in a variety of settings. As the most trusted profession, nurses have a tremendous opportunity to impact the health of population and the planet by advocating for a healthier environment and healthier people. After all, to have healthy people we need a healthy planet.

This section of *Environmental Health in Nursing* provides many opportunities to learn about the variety of ways nurses can be involved in promoting a healthier environment. For example, a review of the food sources in hospitals to provide healthier options or hosting farmer's markets on a healthcare facility's campus can provide fresh produce not only for the staff, but also the community. Nurses positioned on purchasing committees can review personal care products such as soaps, lotions and shampoo and find safer options with fewer chemicals of concern. These and many other strategies are consistent with the ANA's Nursing: Scope and Standards of Practice (2015), specifically Standard 17 which notes the nurses' role in environmental health and practice.

Each one of the nurses included in this section is an inspiration in their contribution to a healthier environment. Be inspired to work within your full scope of practice and include environmental health not only into your care, but into your daily life to protect yourself, your family, colleagues, patients, and communities.

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## NURSE EXPOSURE IN WORK

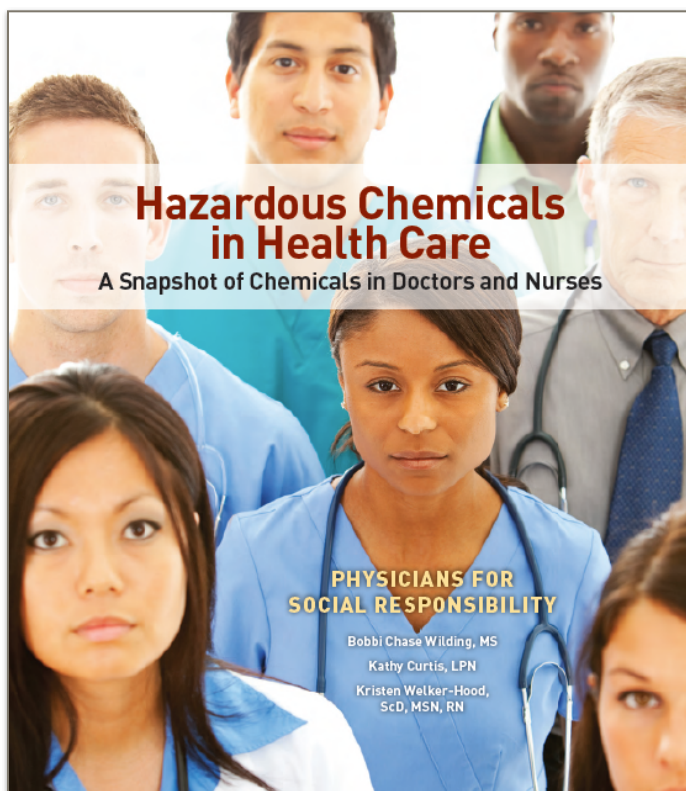
Barbara Sattler, RN, DrPH, FAAN

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Over 60% of nurses in the U.S. work in a hospital setting. While our mission in hospitals is to provide healing environments, the methods of healing often result in chemical, biological, and radiological exposures to the patients and hospital employees. This section will review some of the potential exposures that nurses experience and ways in which nurses are engaging in environmental health changes that are not just decreasing exposures but actually promoting health.

In the past few years, there have been studies that have helped us to understand the importance of addressing our own workplace environments.

The [Nurses' Exposure Study](#) showed us that there are a number of increased risks for disease (asthma, infertility, cancer, and others) that may be associated with chemical and radiological exposures in hospitals.



The [Nurse and Physician Body Burden Studies](#) found measurable amounts of toxic chemicals that are commonly found in hospitals in the blood and urine of doctors and nurses.

In a 2011 study, using the National Health Study II, Lawson et al, found an increased risk of miscarriage in nurses who

were exposed to chemotherapeutic agents, sterilants, or x-Rays. Read the [abstract here](#).

These studies help us to understand that the chemicals and processes that we use in health care create clear and present risks to our health.

## WORKING THE GREEN SHIFT

Occupational and environmental health has not received much attention in nursing curriculum and therefore nurses have lacked the skills to both assess occupational/environmental risks and to reduce or eliminate them. In the last decade or more, some nurses from around the country have begun to look at their hospitals through a new occupational and environmental lens. They have seen unnecessary exposures to toxic cleaning products, batteries that are being tossed in the trash, and product-selection based on lowest cost with little attention paid to potentially harmful exposures to patients and staff. These nurses noted that hospital waste was not segregated, not recycled (nor composted) – practices that they did at home. And they started to question these old workplace practices and bring new and sustainable practices to their hospitals – occupationally and environmentally healthy practices.

This section of the text will guide the reader through a range of issues associated with environmental health and sustainability in health care. It will also help the reader to understand how positive changes are being made – how Green Teams are being created, new collaborators are being found throughout the facility, including housekeeping and dietary services, and how changes in purchasing decisions can have a huge impact on health.

(Note: it will not cover needle stick injuries, lifting policies, workplace violence, nor bloodborne pathogen exposures – all of which are critical occupational health issues in nursing. For more information on these issues, we refer you to the [American Nurses Association's Center for Occupational and Environmental Health site](#)).

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**HAZARDOUS EXPOSURES IN HEALTHCARE**

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While hospitals and other healthcare facilities are meant to be places of healing, many of the chemicals and products used in healthcare can have negative impacts on the health of patients, visitors, nurses, and staff.

**MERCURY**

Most hospitals have replaced their mercury thermometers with digital, mercury-free ones. This process occurred because nurses and others discovered the dangers posed by mercury. A conscious effort was made to substitute the mercury containing devices and provide a healthier choice for one that posed a hazard. Mercury-containing products are particularly problematic if they are incinerated. When the mercury that is released into the air from incinerator emissions lands on bodies of water, a set of processes occur that result in mercury-contaminated fish. Below is an illustration of the “fate and transport” of mercury (Figure 1).

Mercury is a powerful neurotoxicant, linked to health effects in humans and animals. Long-term exposure to mercury can cause effects which develop gradually making identification of exposure difficult. Mercury exposure may cause shaking of the hands, eyelids, lips, tongue, or jaw. It may cause headaches, trouble sleeping, personality change, memory loss, irritability, indecisiveness and loss of

intelligence. It can also cause skin rash, sores in the mouth, or sore and swollen gums. Many of these symptoms go away when the exposure to mercury stops. Mercury is excreted in urine.

**KEY RESOURCES**

- [EWG's Fish List page](#) on website of Environmental Working Group lists mercury levels in fish and other seafood
- [Global Movement for Mercury-Free Health Care Report \(pdf\)](#)
- [Making Medicine Mercury Free \(pdf\)](#)
- [The Mercury Problem: Fast Facts \(pdf\)](#)
- [Mercury-Free Health Care website, a WHO-HCWH Global Initiative](#)
- [Mercury Policy Project website](#)
- [Mercury Thermometers and Your Family's Health \(pdf\)](#)
- [Toward the Tipping Point \(pdf\)](#) WHO-HCWH Global Initiative to Substitute Mercury-Based Medical Devices in Health Care and Two-Year Progress Report

**PLASTICS**

We use a lot of plastics in health care – IV tubing and bags, respiratory therapy tubing, dialysis tubes, etc. There are two major problems with plastics. First, is the problem

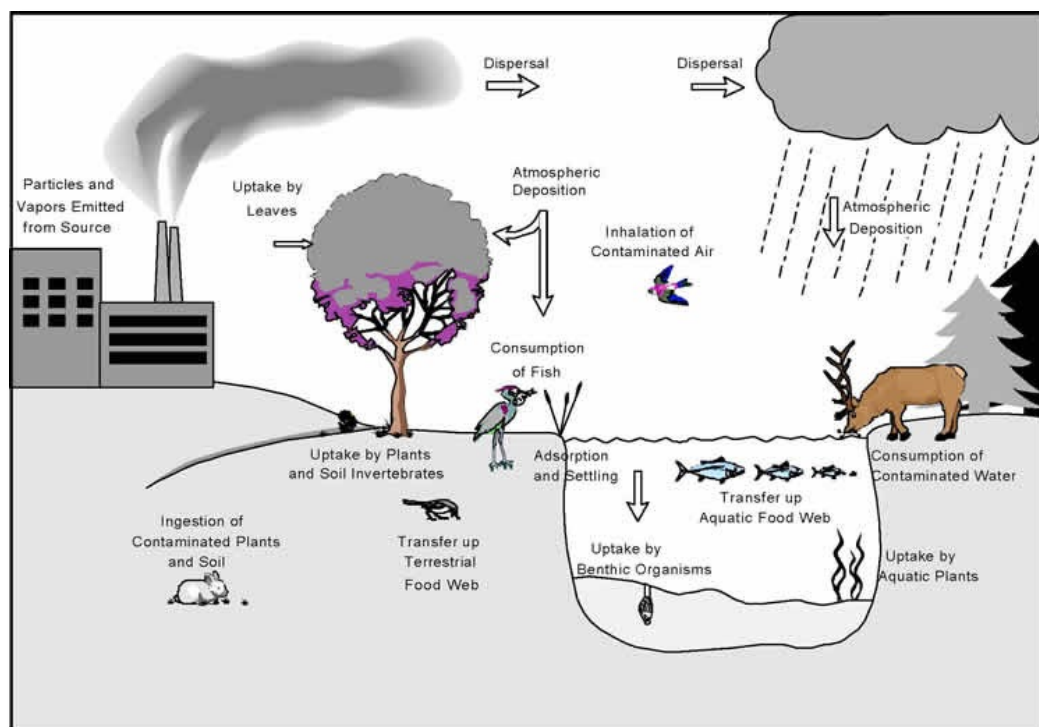


Figure 1: <https://www.epa.gov/fera/multimedia-fate-and-transport-modeling-general>

with polyvinyl chloride which is the component chemical in polyvinyl chloride (PVC) plastics. This particular plastic is toxic during its manufacture when both workers and the environment can be exposed to dioxins, a family of highly toxic chemicals and one of the most carcinogenic chemicals known whose unintentional exposures are the consequence of PVC manufacture. Dioxin contamination also results when PVC products are incinerated, either in medical waste incinerators or municipal incinerators. It's important for nurses to know how and where the waste from their hospital is disposed. When PVC waste products are sent to landfills, there is no real concern regarding exposures, but consider the amount of plastic waste used in hospitals daily entering landfills. However, if PVC waste is sent to an incinerator, very unhealthy air contaminants can result.

Hard plastics are made more malleable (for use in IV bags, tubes and so on) by the addition of phthalates. Phthalates are a group of chemicals that come with a range of health effects, including endocrine disruption. The particular phthalate that is commonly found in hospital equipment is Diethylhexyl Phthalate (DEHP). Studies indicate that there is a risk of testicular problems in baby boys who are exposed to DEHP and it is further recommended that DEHP-free tubing be used in neonatal intensive care units.

Some hospitals have made the shift to DEHP-free NICUs and others are even DEHP-free throughout the hospital. DEHP-free products are now readily available and price competitive.

[Health Care Without Harm](#) has created a set of resources on Plastics and DEHP.

### KEY RESOURCES

- [Alternatives to PVC and DEHP](#)
- [Aggregate Exposures to Phthalates in Humans: HCWH 2002 Report](#) (pdf)
- [DEHP Exposures During the Medical Care of Infants](#) (pdf)
- Find out more about [PVC-Free Building Materials](#) (pdf)
- [Neonatal Exposure to DEHP and Opportunities for Prevention](#) (pdf)
- [Weight of the Evidence on DEHP](#) (pdf)
- [Why Health Care is Moving Away from PVC](#) (pdf)

### GREEN CLEANING IN HOSPITALS

Hospitals have to have high standards for cleaning and disinfecting. However, they can select products that are both effective AND green, as a way of decreasing

exposures to patients, staff, and visitors. Green cleaning refers to using cleaning products that do not contain toxic chemicals (including fragrances), some of which are associated with respiratory and other health problems. Some hospitals are also addressing the paper and equipment used in cleaning processes, requiring paper products used for cleaning to contain recycled material and requiring the use of microfiber mops, which decrease water consumption.

In other hospitals, green cleaning policies have gone so far as to include specifications for cleaning versus disinfecting. It is important to understand the difference between cleaning and disinfecting. Disinfectants pose the highest risk, as they are formulated to kill bacteria. New, safer disinfectants are coming to market in the United States that are hydrogen peroxide based. Because these disinfectants break down into hydrogen and water, there is essentially no risk of adverse health effects. Some of the hydrogen peroxide-based cleaners also boast a shorter contact time that contributes to better infection prevention (Perez et al 2005).

When disinfectants or sterilants are warranted, such as cleaning a NICU warmer or incubator in-between patients, or cleaning equipment in the cath lab or operating room, it is critical for nurses and others to know how to protect themselves when using the products. Reading the safety data sheet (formerly MSDS), the chemical information sheet associated with the product, can be helpful but sometimes it is too vague. The statement “wear gloves” or “use respiratory protection when using this product” is not sufficient guidance. If that is all that is suggested on the safety data sheet, then the manufacturer needs to be called and queried about the precise type of glove and/or respirator (mask) to be used with the product.

Some manufacturers provide substantial guidance and it is then incumbent on nurses and others to make sure they are following the manufacturer's recommendations. For example, on a safety data sheet for gluteraldehyde regarding skin protection, the manufacture states:

“To protect hands and forearm wear gloves of appropriate type and length. MICRO TOUCH latex gloves are acceptable, if changed frequently (i.e. every 5 – 10 minutes) and/or double gloved. Before using other latex gloves contact the manufacturer for permeation information to determine if their gloves are suitable for use with gluteraldehyde solutions. Nitrile rubber, butyl rubber, and similar synthetic rubber gloves (i.e., ALLERGARD Synthetic Surgical Gloves, are acceptable glove materials. Do not use neoprene rubber, or polyvinyl

chloride (vinyl) gloves, as gluteraldehyde may (be) rapidly absorb by these materials.”

If sterilants and disinfectants are potentially hazardous to adults then we can assume that the very susceptible neonate, with its immature, developing organs will be considerably more susceptible to these hazards. For neonates that are not on independent respiratory support it is important to consider their potential exposures to cleaning chemicals, antimicrobial soaps, and disinfectants. Many hospitals use flooring materials that require extensive maintenance by stripping, waxing, etc and many of these products have been linked to respiratory problems (Rosenman et al 2003, Medina-Ramon et al 2005). In addition to looking for safer cleaning chemicals, it is important to also consider changing the surfaces to make them easier to clean. For example, the University of Maryland Medical Center is transitioning to rubber flooring, which does not require the use of wax, and hence, floor strippers. The companies producing these no-wax products are boasting less slips, trips and falls because the rubber floor is less slippery.

Many health care facilities are adopting “fragrance free” policies and these policies can extend to cleaning products. Educating housekeeping staff and others in the hospital about the true smell of clean – which is NO smell – will help them to rethink the need for pine or lemon-smelling products. Real pine and/or lemons are rarely part of the fragrances’ ingredients. The word “fragrance” on a product’s label can mean up to 100 additional chemicals used to create this “fresh” or “clean “ scent.

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## ENVIRONMENTAL HEALTH IN THE SCHOOL SETTING

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The impact that school environments have on asthma and other chronic health conditions has been ignored for too long. The school building is an environment where children and staff spend a significant amount of their time. Physical environmental stressors in schools are significant and affect children's academic achievement (Healthy Schools Network, 2015). Ensuring that schools are free of environmental hazards is a public health necessity. Capital budgets to maintain healthy schools have decreased in the United States (Healthy Schools Network, 2015) making renovations and routine maintenance difficult for many school districts.

According to a work study completed by the National Association of School Nurses (NASN), schools in the United States employ approximately 95,776 full time nurses who practice school nursing in the school setting (National Association of School Nurses, 2017). The school nurse is typically the only health care professional in the building and works collaboratively with their education counterpart provide quality evidence-based care to the school community. The role of the 21st century school nurse is complex and multi-faceted. The NASN outlines this 21st century role in a position statement that includes leadership, community/public health, care coordination and quality improvement (NASN, 2018). Addressing the physical environment of a school is something that must be on the radar and seek the attention of the school nurse to ensure a healthy environment for all occupants.

School nurses can play an important role in reducing environmental stressors and improving school environments (National Association of School Nurses, 2018). The school nurse's role includes assessment, education and advocacy. In the assessment role the school nurse might uncover issues in the home and school environment that need to be addressed. Such stressors can include allergens, bites and need for integrated pest management, toxic cleaning products, paints and solvents, and carbon monoxide, among others. Education about reducing these stressors can be directed to school teachers and staff, parents, students, and the larger community.

School nurses also monitor healthy school environments. They can support interest in environmental issues and bring pressing student health concerns to the attention of other stakeholders who can help to address them. A good

reference for sources of pollutants in schools is published by the Children's Environmental Health Network (n.d.): [Environmental Health in Schools](#). School nurses can stay informed about best practices around issues such as indoor air quality, asthma management, pesticide use, and neuro-toxins causing learning disabilities. The school nurse has the expertise to advocate for preventive environmental measures to help keep students and staff healthy and in school. Environmental health is a very important aspect of school health that tends to get overlooked, partly because the school nurse is typically the only one in the school setting with a health background. Additionally, the school nurse may be in the physical building part time and covering other schools each week. Promoting healthy school environments can help ensure that students are healthy and ready to learn and faculty and staff are ready to teach and support each child.

Another role of a school nurse is that of advocacy. The school nurse can advocate for environmental health needs and concerns in the school setting in different ways. Some examples of this may be walking through the school on a routine basis looking for any concerns, addressing those within the nurse's scope, and then following up with school administrative personnel to ensure that those concerns are addressed routinely. This can be a multidisciplinary approach by touring the building with parents, custodians, administration, and a faculty representative. Reaching out to your local, state or federal legislators with your concerns is another way to advocate for environmental health policy in schools. For example, this can occur by making a request to a local legislator to submit legislation around green cleaning in schools. Asthma awareness month in one state was recognized by a U.S. senator from that state by holding a field hearing to bring awareness around asthma in schools and the impact the school environment has on students and staff (J. Leffers, personal communication, 2015). As a school nurse you have the knowledge and field experience to testify at such hearings.

## REDUCING ASTHMA IN SCHOOLS

Data demonstrating a link between school environment and asthma has been part of the focus in the implementation of Environmental Protection Agency's (EPA) Indoor Air Quality (IAQ) Tools for Schools. An unhealthy school environment consisting of mold, vermin, dust, chemicals from cleaning supplies, poor air quality, or other such hazards can trigger asthma symptoms in students and staff (Sampson, 2012). Respiratory illnesses, such as asthma, have been linked to poor indoor air quality (Massawe & Vaust, 2013). The CDC endorses the

use of the EPA's guidelines to improve the IAQ and reduce asthma triggers in schools (CDC, 2018). However, according to the Centers for Disease Control and Prevention's School Health Policies and Practices Study, the proportion of schools reporting implementation of IAQ management programs dropped from 47.7% in 2012 to 46.1% in 2014 (Schools for Health Report, 2018). Intervening in the school environment can be instrumental in decreasing the impact of asthma by reducing student suffering and absenteeism, parental stress, and cost of medical care for acute asthma attacks. The EPA has focused on creating a healthy school environment across the nation and developed the [Tools for Schools framework](#) that schools can implement to improve indoor air quality. This toolkit is based on research and best practices (EPA, 2016). A study published in 2011 demonstrated the effectiveness of Tools for Schools (TfS) when implemented as part of a collaborative approach to improving the health of schools (Foscue & Harvey, 2011). Creating a healthy school environment may be able to prevent or help mitigate symptoms of illness of students, faculty, and staff.

### SCHOOL NURSE ROLES IN ENVIRONMENTAL HEALTH

The school nurse can be the advocate and take a leadership role in addressing environmental health issues by encouraging schools to utilize the EPA's Indoor Air Quality Tools for Schools action kit (TfS). TfS was developed by the EPA to provide Indoor Air Quality (IAQ) guidance for schools to make voluntary changes that will reduce exposures to indoor environmental contaminants in schools. Indoor air quality TfS recommendations are based on research and best practices and more information can be located on the tool kit website.

Green cleaning is another way to help students stay healthy and in school (Balek, 2012). Green cleaning is cleaning that uses fewer toxic products to protect the health of students and staff without harming the environment. (Web resources listed in table) It also increases the lifespan of facilities, preserves the environment and ultimately saves the school money. The biggest priority with green cleaning is implementing a green cleaning program that eliminates harmful chemicals, manages volatile organic compounds (VOCs), and reduces harmful bacteria keeping students, faculty, and staff healthier.

School nurses can also play a key role in policy development at the school district level and the local, state and federal government. The use of the Precautionary Principle as a strategy to develop policy has also been described in the literature. This principle

provides the justification to support safer policies when information may be lacking, but the potential health consequences of not having the policy are significant, thus justifying precautionary action (Abramson, S.L., 2018). Additionally, the [SAMPRO](#) project was mentioned by Abramson as a potential link to policy development to address indoor air quality. SAMPRO is a school-based asthma management program, developed by the American Academy of Allergy, Asthma and Immunology with the American Academy of Pediatrics, which has many components, including improving IAQ.

The American Public Health Association (APHA) outlines policy that is focused on children and environmental health. The policy calls on development and implementation of public health systems to protect children from harmful environmental exposures in the school setting. It addresses the need for the federal government's responsibility to monitor and assist with public health strategies (American Public Health Association, 2017). Having the awareness of this national resource to assist school nurses is an asset in the advocacy tool box in this environmental work.

School nurses can empower school staff to investigate environmental issues in their buildings and advocate for students through policy development which will help to create environmentally friendly schools that are sustainable. Identifying legislative champions and key stakeholders to provide recommendations for change is one-way school nurses can strategize for healthier, safer environments. Another way is to provide testimony at professional organizations meetings such as, APHA, for policy development focused on environmental health.

Additionally, it is important for the school nurse to have a strong voice for leadership decision-making that impacts the health and safety of students and staff in the school setting. The COVID-19 pandemic has provided many opportunities for school nurses to be part of the team in K-12 school reopening plans. Along with mitigation strategies impacting the school environment and implementing protocols around contact investigation/ contact tracing and testing strategies in schools, are examples of how school nurses can share their expertise in assuring a healthy school environment. Many state school nurse consultants and state school nurse organizations were part of state level leadership making sure that there was a school nursing voice as guidance for policy and protocol development. Also, at the national level the NASN was invited to meet with many key partners at the federal level to ensure a school nurse voice.

This public health crisis that the pandemic has put before us has provided opportunities as well. One being the awareness focused on the school environment. With a virus looming indoor air quality gained much attention and concern for occupants. School administrators assessed school buildings to ensure that classrooms had four to six air exchanges per hour (ACH) necessary for safe occupancy. Inspecting HVAC systems and utilization of HEPA filter units is an example of a strategy used to get to at least four air changes per hour (CDC, 2019). With this increased awareness it is important that school buildings are maintained and sustained moving forward. Climate change promoting natural disasters have the potential to impact school environments. Preparation and advocacy are key to increase awareness around these issues.

### RESOURCES FOR IMPROVING SCHOOL ENVIRONMENTS

There are a number of tools and resources to help support this work. Working together with facilities managers, custodial staff and administrators using these resources is a great place to start. A list of Web resources for school nurses can be found in the table below. Healthy Schools Campaign is an independent nonprofit that believes each child deserves a healthy school. The campaign is supported by industry leaders in the manufacturing and distribution of green cleaning products and services. Another excellent resource is the [Healthy Schools Network](#) that provides resources and opportunities for advocacy efforts. The professional organization for school nurses, NASN, provides resources on environmental health in addition to their position statement mentioned earlier.

### WEB RESOURCES FOR SCHOOL NURSES ON GREEN CLEANING, INDOOR AIR QUALITY AND CHILDREN'S ENVIRONMENTAL HEALTH

#### Green Cleaning in Schools

- <https://www.healthygreenschools.org/>
- <http://www.phi.org/wp-content/uploads/migration/uploads/application/files/khcbtgu0lfuyi5wlowortxqfnpnrwsode32y7sbqs0cfb0uy0.pdf>
- <https://healthyschoolscampaign.org/issues/environment/>
- <http://healthyschools.org/Cleaning-For-Healthy-Schools/>
- <https://greenschoolsnationalnetwork.org/implement-green-cleaning-program-schools-right-way/>

#### Indoor Air Quality (IAQ) and Environment Health:

- [https://www.cehn.org/wp-content/uploads/2015/11/Environmental\\_Health\\_in\\_Schools13.pdf](https://www.cehn.org/wp-content/uploads/2015/11/Environmental_Health_in_Schools13.pdf)
- <https://www.epa.gov/iaq-schools/indoor-air-quality-tools-schools-action-kit>
- <https://www.nasn.org/nasn/nasn-resources/practice-topics/environmental-health>

### CONCLUSION

Environmental health brings nurses back to the basics as Florence Nightingale writes in her memoirs (1860). It is important that all nurses, regardless of their type of nursing practice, must be able to incorporate environmental health principles. The school setting is no exception and environmental issues should be part of every school nurse's practice on a daily basis. School nurses must utilize their advocacy and leadership skills along with their public health expertise to be a driving force to demand a health school environment for all occupants.

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## GREEN TEAMS

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There are a number of names that have been given the committees/groups that have been convened at hospitals to address environmental health and sustainability. One of the most common names is the Green Team. These multidisciplinary teams are convened by nurses, administrators, and others. Their make-up can vary, but the most successful ones have representatives from the departments noted below. They can help to raise concerns, do assessments and audits, compare alternative solutions, make recommendations, and help to implement changes and then evaluate those changes.

[Watch Denise Choiniere](#), who was the first Sustainability Manager at the University of Maryland Medical Center, describe how nurses are working on "greening" their hospitals. A great introduction to incorporating environmental health into nursing practice.



**The Power of Nurses**

- Highest percentage of employees
- Understand the connection between environmental & health
- Precautionary Principle
- Patient Advocates
- Bridge the gap between administrative executives and floor staff
- Find user of most products

**Working the Green Shift: Nurses Greening Their Hospitals**

Related Autoplay

Here's the website for the [University of Maryland Medical Center's Green Team](#)

It's just one example of many green team programs. If you search the internet with the terms "hospital green teams", you'll see lots of other examples. (Note, the University of Maryland Medical Center is conveniently located on Greene Street.)

## WHO'S IN CHARGE IN HOSPITALS?

Really, everyone has a part, but there are several offices/departments/individuals/committees that can be particularly important:

| Hazard Category   | Examples of Hazards                                                                  |
|-------------------|--------------------------------------------------------------------------------------|
| Safety            | Slips, trips, falls, working from heights, faulty equipment, confined spaces         |
| Biological        | Blood and other body fluids, bacteria and viruses, plants, insect bites, mold        |
| Physical          | Loud noise, temperature extremes, radiation                                          |
| Ergonomic         | Repetition, lifting, awkward postures, use of heavy force                            |
| Chemical and Dust | Pesticides, cleaning products, asbestos, particulate matter, vapors, fumes, solvents |
| Work Organization | Sources of stress, workload demands, workplace violence, control over work           |

(OSHA, n.d.-a)

- Environmental Services / Housekeeping / Maintenance – often where the decisions are made about the cleaning processes and products
- Purchasing Department or Committee – make important product selection decisions
- Architects/Planners – often take the lead when building modifications, expansions, and new hospital buildings are being planned and developed
- Infection Control – should be consulted when making decisions are being made about cleaners/sterilants/disinfection products
- Occupational Health and Safety – can help provide additional support for decisions especially regarding physical equipment
- Food Services – can be instrumental in helping to bring local, sustainably-grown foods to the hospital's menu and when planning/implementing a Farmers' Market
- Public Relations – important to keep in the loop to recognize and publicize great work
- Nursing and Professional Development – a good place to help to bring speakers into the hospital to educate on environmental health and sustainability related to health care. Nursing "grand rounds", lunch-time talks, and other venues can provide great opportunities to have compelling speakers.

- **GREEN TEAMS** – critical organizational structures in which sustainability and environmental health can be discussed and addressed.

Some hospitals have made institutional commitments to environmental health and sustainability, even including it in their core values statement.

## OCCUPATIONAL HEALTH

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### INTRODUCTION TO OCCUPATIONAL HEALTH

The discipline of occupational health and safety focuses on promoting safe and healthful working conditions that protect workers, the community, and the environment. The emphasis is on the whole person, including social, mental, and physical well-being. Occupational health and safety interventions span policies, systems, and personal-level approaches. One specialty area of occupational health is industrial hygiene, defined as “the science and art devoted to the anticipation, recognition, evaluation, and control of those environmental factors or stresses arising in or from the workplace that may cause sickness, impaired health and well-being, or significant discomfort among workers or among the citizens of the community” (American Industrial Hygiene Association [AIHA], 2018).

A major emphasis of occupational health and industrial hygiene is primary prevention, which involves implementing health promotion and health protection measures to prevent diseases and injuries from occurring. For example, replacing toxic chemicals used in an industrial or process with a nontoxic alternative can protect workers, family members, and the community from developing health problems and protect the environment from contamination. Another example of primary prevention is giving the influenza vaccine, as this intervention protects people from getting influenza.

Occupational health also focuses on secondary and tertiary prevention. Secondary prevention involves detecting and treating diseases or injuries early at a time when they may be more treatable or less severe. Secondary prevention often involves screening to detect an asymptomatic condition, such as conducting blood pressure screenings and intervening early. Tertiary prevention involves actions to prevent a condition from getting worse, preventing complications, or preventing disability. Examples of tertiary prevention services or interventions are rehabilitation services, case management, and/or behavior change strategies, such as motivational interviewing and health coaching.

### OCCUPATIONAL HEALTH AND THE 3 PS: PEOPLE, PROFIT, AND PLANET

The concept of the Triple Bottom Line is important to occupational health. Triple Bottom Line or the 3 Ps refers to the people, profits, and the planet (University of Wisconsin, 2018). Entities that adopt the 3 P model exhibit corporate social responsibility rather than focus

heavily on profits. This approach may involve a range of strategies, such as reducing risks to employees, reducing emissions, protecting the planet, and encouraging or incentivizing employees to volunteer to help important causes of initiatives. In the context of occupational health and safety, employers and employees who apply the triple bottom line philosophy focus on sustainability and the effect of business operations on the community and environment. These organizations may adopt eco-innovation and implement sustainable or “green” practices that protect workers, the public, and the earth.

One occupational health and safety expert wrote that: “The health and safety function must be given the same level of importance and accountability as the production function” (Plog & Quinlan, 2012) and aligns with the concept of the 3 Ps. This concept challenges occupational health and safety professionals to work within their respective organizations to promote health and safety among workers and the greater community as part of the overall mission of the organization.

### INDUSTRIAL HYGIENE: PROTECT WORKERS, FAMILIES, COMMUNITY AND THE ENVIRONMENT

As stated above, industrial hygiene focuses on anticipating, recognizing, evaluating and controlling factors in the environment that create health problems “among workers or among the citizens of the community” (Plog & Quinlan, 2012, p. 3). Industrial hygiene focuses on promoting a healthy workplace and processes that protect health, and considers the immediate, short-term, and long-term health effects of hazards. An important and perhaps overlooked part of the definition of industrial hygiene is: “among citizens of the community” (AIHA, 2018). This phrase is critical because it highlights the role of occupational health professionals, including industrial hygienists, in not only protecting the health and safety of workers, but also protecting populations beyond the organization. This requires employers to implement environmentally healthy practices to protect the community and the earth from health hazards, such as toxic spills, water contamination and other sources of pollution, and climate change.

### IMPORTANCE OF OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE

Workplace illnesses and injuries are costly to society, in dollars, pain, suffering, and deaths. The United States Department of Labor (USDOL, n.d.) estimates that “employers pay almost \$1 billion per week for direct workers’ compensation costs alone.” During 2016, there were nearly 2.9 million reported nonfatal workplace injuries and illnesses in the United States (U.S.); this included approximately 892,300 severe cases that

contributed to absenteeism (Bureau of Labor Statistics [BLS], 2017). In 2016, “5,190 workers died from a work-related injury in the U.S.” (BLS, 2017). On a global level, “an estimated 24% of the global burden of disease and 23% of all deaths can be attributed to environmental factors (Stanhope & Lancaster, 2016, p. 218).”

It is important to emphasize that most occupational illnesses and injuries are preventable. Therefore, occupational health and safety programs and professionals offer substantial benefits to workers, employers, and society by reducing workplace injuries and illnesses, related deaths, suffering, and costs.

Pollution created by industry and other businesses, including health services organizations, also contributes significantly to health problems, deaths, environmental destruction, and costs associated with clean-up efforts (Sacramento Metropolitan Air Quality Management District, 2018). For example, “air pollution was linked to 6.5 million deaths in 2015, water pollution was linked to 1.8 million deaths and workplace pollution was linked to nearly one million deaths (Sifferlin, 2017).” Watch a brief online video about air pollution and deaths at: <http://time.com/4989641/water-air-pollution-deaths/>.

## OCCUPATIONAL HEALTH AND THE PRECAUTIONARY PRINCIPLE

It is important for occupational health and safety professions to apply the Precautionary Principle to promote and protect health and safety of workers and the community. This principle urges that when there is evidence to suggest potential harm from an activity, substance or other exposure, there is a social responsibility to protect workers and the public from exposure to harm, even if the cause and effect relationships are not fully determined based on available scientific evidence. The Precautionary Principle involves “taking preventive action in the face of uncertainty; shifting the burden of proof to the proponents of an activity; exploring a wide range of alternatives to possibly harmful actions; and increasing public participation in decision making (Kriebel et al., 2001, p. 871).”

## HIERARCHY OF CONTROLS

In the field of industrial hygiene, efforts to protect from exposures to occupational hazards are classified in a hierarchy of controls that are arranged based on level of effectiveness (National Institute for Occupational Safety and Health [NIOSH], 2018a). Often this hierarchy of controls includes three classifications: engineering controls, administrative controls, and personal protective equipment. In some models, engineering controls may also include two higher-level tiers, elimination and substitution.

For example, NIOSH (2018a) has classified the “Hierarchy of Controls” as: elimination, substitution, engineering controls, administrative controls, and personal protective equipment.

Engineering controls are considered to be the first strategy to use as they involve removing, replacing or reducing the hazards. This approach not only protects workers but also may better protect the community and environment if an engineering approach involves substituting use of a toxic material with a non-toxic material. In this description, elimination and substitution are included as part of engineering controls. Engineering controls may be considered upstream preventive approaches and are likely to be more effective than relying on personal behavior changes.

Administrative controls are generally considered to be the second strategy to use. This may involve changing the work processes to limit worker exposure to some type of hazard or health threat. A few examples of administrative control strategies are to pace the work processes to reduce exposure, and to distribute work involving exposure among workers.

Personal protective equipment (PPE) is generally considered to be the third line of defense. Personal protective equipment may include uses of gloves, eyewear, helmets, ear plugs, and other types of safety equipment that protects the worker from exposures.

Read more about the hierarchy of controls at the NIOSH website at: <https://www.cdc.gov/niosh/topics/hierarchy/default.html>.

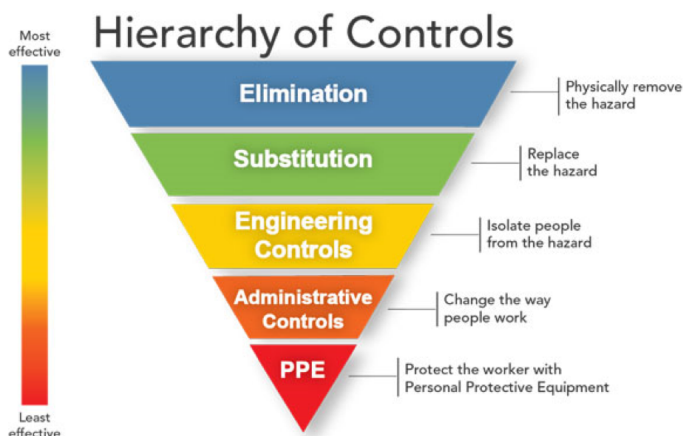


Figure 1: NIOSH, 2018a; <https://www.cdc.gov/niosh/topics/hierarchy/default.html>

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## SELECT HEALTH PROBLEMS ASSOCIATED WITH OCCUPATIONAL EXPOSURES

Workplace illnesses and injuries can affect any part of the body. The most common problems vary by type of employment setting and role. However, some commonly occurring occupational injuries and illnesses are: allergic and irritant dermatitis, asthma, chronic obstructive pulmonary disease (COPD), fertility and pregnancy abnormalities, hearing loss, infectious diseases, low back disorders, musculoskeletal disorders of the upper extremities, and traumatic injuries (NIOSH, 2014). Some details are presented below for occupational skin disorders, the respiratory system, ears, and eyes.

### OCCUPATIONAL SKIN DISORDERS

Two major types of skin problems that may occur in occupational settings are dermatosis and dermatitis. Dermatitis is a general term for “any abnormal condition of the skin (Plog & Quinlan, 2012, p. 60). Dermatitis is more specific and is limited to inflammatory conditions of the skin, such as contact dermatitis. Inflammation generally refers to a local reaction that may include redness, swelling, warmth and pain in reaction to some type of irritant, infection, injury or toxic exposure.

#### Direct causes of occupational skin disease

Occupational skin diseases are caused by many factors, most preventable. The common causes of occupational skin disease are: chemical, mechanical, physical, biological, and botanical. Some chemicals may be considered irritants, some are sensitizers, and some chemicals are classified as both. Mechanical injuries can be caused by friction, pressure, sharp objects or external forces. Physical causes of skin disorders include heat, cold and radiation. Sunlight is one source of skin-damaging radiation for people who work outside. Biological hazards that can affect the skin are bacteria, viruses, fungi, and parasites. Botanical hazards are some plants and wood, such as poison oak and poison ivy.

### THE RESPIRATORY SYSTEM

The respiratory system can be exposed to many different types of unhealthy conditions at the workplace and in other settings. Several examples are emphysema, chronic bronchitis, and pneumoconiosis. Emphysema is a condition involving over-inflation of the alveoli, which become damaged and enlarged, making it difficult to breathe. Emphysema can be caused by exposures such as coal dust, cadmium fumes, and cigarette smoke. Chronic bronchitis is a persistent inflammation of the bronchi. The most common cause of bronchitis is smoking; however, it can also be caused by occupational exposures, such as dusts,

vapors, gases or fumes. Pneumoconiosis is a general term for various pulmonary disorders that occur from dust inhalation, such as silicosis and asbestosis. The inhalation of asbestos, for example, can lead to scarring or fibrosis in the lungs and can make lungs less resilient, thereby reducing the exchange of gas in the lungs. Asbestos exposure has been linked to severe respiratory diseases including asbestosis and, mesothelioma (lung cancer) (U.S. Department of Health and Human Services, 2016).

#### Inhaled contaminants

The effect that inhaled air contaminants have on the lungs and body depend on the size, solubility, and chemical reactivity of these contaminants. The size of particles affects where they may be deposited in the airway. Inhaled contaminants that adversely affect the lungs fall into three general categories: aerosols and dusts that may produce tissue reaction and/or disease; toxic gases that may injury tissue directly; and toxic aerosols or gases that enter the lungs, are absorbed into the bloodstream, are carried to other organs, or adversely affect the oxygen-carrying capacity of the blood.

### THE EARS

“Occupational hearing loss is one of the most common work-related illnesses in the United States (NIOSH, 2018b).” Approximately 22 million United States (U.S.) workers are exposed to hazardous noise levels at work each year; and more than 30 million workers are exposed to chemicals, some of which are ototoxic, harmful to the ear.

#### Noise levels of various workplace sounds.

The NIOSH has provided a list of sources of sounds in various workplaces. This “Noise Meter” provides sound levels, in decibels, for more than a dozen workplace sounds. Review this list at: [https://www.cdc.gov/niosh/topics/noise/noisemeter\\_html/old/hp0.html](https://www.cdc.gov/niosh/topics/noise/noisemeter_html/old/hp0.html)

#### Effects of noise exposure

Noise exposure can cause temporary or permanent hearing loss and may lead to other health problems, such as high blood pressure and sleep disturbances. Noise exposure can even be harmful to a pregnancy, increasing the risk for preterm births and low birthweight infants. Ears generally can recover from brief exposures to intense sounds, however, more prolonged exposure to high decibel levels of noise can gradually damage the cochlear hair cells of the inner ear (Plog & Quinlan, 2012, p. 97), and this can result in hearing loss across the sound frequency levels. For more information about noise, see the noise chapter in Unit III: Environmental Health Sciences.

The eyes are at risk for physical injuries in some workplaces. Examples of these risks are being hit by blunt objects, cut by sharp objects, damaged by foreign bodies, burned by heat and/or chemicals, or damaged by radiation. The most common type of physical injury to the eye involves foreign bodies. Workers can also be exposed to chemicals that damage the eye by accidental splashing, mists, vapors, and gases. The degree of injury can range from a minor irritation, vision loss, and systemic poisoning. Chemical burns may be alkali burns, acid burns, or irritants. The most dangerous chemical burns are from alkali, such as ammonia hydroxide, fertilizers, lye, and lime. Laser lights are another hazard to the eyes, and especially the macula, as well as sunlight can damage the eyes.

Eye protective equipment may be needed in various work settings. And, for outside work, the use of sunglasses can reduce the risk of glaucoma, cataracts, and macular degeneration. For more information about eye and face protection, see: <https://www.osha.gov/SLTC/eyefaceprotection/hazards.html>.

## CATEGORIES OF OCCUPATIONAL HAZARDS

“A hazard is a situation that poses a level of potential threat or risk, to life, health, property, or environment” (Breeding, 2011). The Occupational Safety and Health Administration (OSHA) has classified hazards as: safety, biological, physical, ergonomic, chemical and dust, and work organization (OSHA, n.d.-a). Review some examples of each type of hazard at: [https://www.osha.gov/dte/grant\\_materials/fy10/sh-20839-10/circle\\_chart.pdf](https://www.osha.gov/dte/grant_materials/fy10/sh-20839-10/circle_chart.pdf). A similar classification of occupational hazards is: physical, chemical, biological, radiological, ergonomic, and behavioral (Breeding, 2011).

### Safety Hazards

Safety hazards are commonly occurring in many occupational settings. They are unsafe conditions that increase the risk for injuries, illnesses and even death (OSHA, n.d.-a). Some examples of these hazards are spills on floors that can cause workers to slip and fall, tripping hazards, such as power cords or clutter, moving parts in machinery, electrical hazards, and confined spaces. For prevention tips about slips, trips, and falls in work settings, review the Canadian Centre for Occupational Health and Safety (CCOHS, 2018a) website at: [https://www.ccohs.ca/oshanswers/safety\\_haz/falls.html](https://www.ccohs.ca/oshanswers/safety_haz/falls.html). For information about working in confined spaces, hazards, and hazard control, review the Canadian Centre for Occupational Health and Safety (CCOHS, 2018b) website at: [https://www.ccohs.ca/oshanswers/hsprograms/confinedspace\\_intro.html](https://www.ccohs.ca/oshanswers/hsprograms/confinedspace_intro.html).

### Biological Hazards

Biological hazards include infectious microbiologic agents, such as bacteria and viruses, blood and other body fluids, biologic allergens, plants, insect bites, molds, and other biohazardous materials. An estimated 190 biologic agents pose health risks in the workplace. These hazards pose various health risks, including infectious, allergenic, toxic, and carcinogenic conditions. Employees that work in agricultural, medical, health, and laboratory settings are likely to have the highest levels of risk for these hazards; however, exposures are not restricted to these settings.

### Physical Hazards

Physical hazards in the work environment include ionizing and nonionizing radiation, exposure to sunlight and ultraviolet radiation, hot and cold temperatures, and loud noise.

#### *Ionizing radiation*

Ionizing radiation refers to “particles, charged or uncharged, that are energetic enough to knock electrons out of the material that the radiation is passing through” (Plog & Quinlan, 2012, p. 261). Producers or sources of ionizing radiation are the sun, radioactive materials, radiation-producing machines, the cosmos, and nuclear reactors. Radioactive materials are unstable forms of elements that emit ionizing radiation as they decay. Some examples of radioactive elements are: plutonium, uranium, curium, actinium, and thorium (Helmenstine, 2017). Radioactive materials may be naturally occurring, extracted by people, or artificially produced. Some types of machines can produce radiation when operated, and may be referred to as radiation-producing machines (RPMs). Examples of these machines are x-ray machines, linear accelerators, and electron microscopes. Nuclear reactors may be used to produce power or conduct research. Nuclear reactors produce ionizing radiation from several sources: fuel rods, neutron production, activation, and fission fragments. Some above ground nuclear weapon testing was conducted prior to the Limited Test Ban Treaty (1963), contributing to the presence of radioactive substances in our environment.

#### *Human health effects of radiation*

Ionizing radiation can cause chemical changes in cells and damage them. Some cells may die or become abnormal, either temporarily or permanently. By damaging the genetic material (DNA) contained in the body’s cells, radiation can cause cancer (Environmental Protection Agency [EPA], 2018).” For more information about the health effects of radiation, a brief summary is provided by

the Centers for Disease Control and Prevention (CDC, 2015) at: <https://www.cdc.gov/nceh/radiation/health.html>.

Health effects of radiation may be classified as deterministic effects or stochastic effects. Deterministic effects are those that occur for everyone when the exposure reaches a certain threshold level. That threshold level may vary by individual. Stochastic effects are those in which the risk of developing a particular condition or disease increases with an increase in exposure to the agent, but where only a fraction of those exposed developed the health effect (Plog & Quinlan, 2012, p. 274).” For example, leukemia is a stochastic effect of extensive exposure to x-rays by clinicians who do not use protective equipment.

### *Nonionizing radiation*

Non-ionizing radiation is electromagnetic radiation that is lower energy radiation, and has a lower frequency. Nonionizing radiation often generates heat; for example, a microwave heats food and water quickly. Examples of non-ionizing radiation are microwaves, radio waves, infrared radiation from heat lamps, and extremely low frequency (ELF) radiation. Electromagnetic fields associated with electric power lines and other sources have been the focus of epidemiological studies in occupationally and community-based settings.

### *Potential health effects of nonionizing radiation*

Exposure to extremely low frequency (ELF) electric and magnetic fields, such as from power lines, appliances, and electrical substations, has been shown, among children, to be associated with a higher risk of health problems, such as leukemia (NIEHS, 2018). The International Agency for Research on Cancer (IARC), a component of the World Health Organization, classified extremely low frequency electromagnetic fields as “possibly carcinogenic to humans” primarily based on studies of childhood leukemia (National Cancer Institute [NCI], 2016). Exposure to static magnetic fields has been shown to be associated with nausea, metallic taste in the mouth, dizziness, flashes of light in the eyes when the head is moved, and effects on the circadian rhythm (Plog & Quinlan, 2012, p. 294).

### *Thermal Stress*

Thermal stress includes excessively high temperatures and cold stress. These exposures may occur for people who work outdoors, or work near ovens, freezers, or other environments with temperature extremes.

### *Heat stress and heat-related health problems*

People who are exposed to heat while working may experience heat-related illnesses (OSHA, n.d.-b). Some

common symptoms of heat stress are elevated body temperature and heart rate, and increased sweating. There are at least six different types of heat-related disorders, including heat stroke, heat exhaustion, dehydration, heat syncope, heat cramps, and heat rash. Heat stroke is the most serious heat-related illness. If it is not addressed, it can lead to seizures or becoming unconscious and in more severe cases, permanent disability and death. Heat exhaustion is a heat-related illness that is milder than heat stroke. Heat cramps are muscle cramps that occur from the losses of fluid and electrolytes from sweating.

### *Cold stress*

The body does not have the same types of physiological adaptive mechanisms for cold stress as it does for heat stress (sweating). One response to cold from the body is shivering; however, this is not a great protective mechanism but indicates that a person may have hypothermia. Hypothermia can progress and cause central nervous system depression, organ failure, and death.

## Ergonomic Hazards

Ergonomics has been defined as the “scientific study of people at work (NIOSH, 2018d).” A more detailed definition of ergonomics is “the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance” (International Ergonomics Association, 2018). The goals of ergonomics are to make work safe, prevent injuries to soft tissue, and prevent “musculoskeletal disorders (MSDs) caused by sudden or sustained exposure to force, vibration, repetitive motion, and awkward posture” (NIOSH, 2018d), and optimize the well-being of workers.

### *Strategies applied in ergonomics*

Occupational health and safety workers often work to design or redesign work spaces, tasks, displays, lighting, tools, and equipment to meet the needs of employees’ physical capabilities and limitations (NIOSH, 2018). This may occur in industrial settings and office-based settings. In some cases, this may involve matching people with the tasks and roles that are a good fit. This may consider both human capacity for mental workload and physical workload. Efforts may include engineering approaches, administrative approaches, and protective equipment. Watch the following brief video on “Workplace Ergonomics” (Montana State Fund, 2014): <https://www.youtube.com/watch?v=QeDUCXfzI6U>.

“Chemical hazards are present when a worker is exposed to any chemical preparation in the workplace in any form,” solid, liquid or gas (OSHA, n.d.-a). Some examples of hazardous chemicals are pesticides, cleaning products, asbestos, particulate matter, vapors, fumes, and solvents. For information about specific chemical profiles, review the Canadian Centre for Occupational Health and Safety (CCOHS, 2018c) website at: [https://www.ccohs.ca/oshanswers/chemicals/chem\\_profiles/](https://www.ccohs.ca/oshanswers/chemicals/chem_profiles/). Another source of chemical information is the OSHA occupational chemical database: <https://www.osha.gov/chemicaldata/>.

Industrial toxicology and toxins. Industrial toxicology focuses on harmful properties of substances that are encountered in the workplace. Some of these toxins may also be encountered in homes and in the community. “A toxic effect is any reversible or irreversible harmful effect on the body as a result of contact with a substance via the respiratory tract, skin, eye, mouth, or other route” (Plog & Quinlan, 2012, p. 123). Toxicity refers to the capacity of a substance to cause harm. It is not really a “property” of a substance but a manifestation of it. Toxicity generally depends on the quantity or dose of the substance. Some substances, such as some minerals and vitamins are important to health in certain quantities, yet can be toxic if larger amounts than necessary are taken.

#### *Routes of entry into the body*

The route of entry of a substance into the body can affect whether a harmful effect occurs. Substances may enter the body through the skin, respiratory tract, gastrointestinal tract, injection, or multiple routes. Inhalation is a common route of entry for industrial exposures. Smaller particles are more likely to reach the alveoli; and some gases and vapors may be absorbed into the bloodstream from the lungs. Skin absorption is a second possible route of entry for substances. Absorption can vary based on the type and properties of the substance, environmental temperature, skin pH, presence of perspiration, area of the body and thickness of the skin, and presence of skin damage, such as abrasion dermatitis. Ingestion is believed to be a relatively uncommon route of entry in the workplace; however, this can occur when workers eat or smoke in areas where substances are in use or if proper hand washing is not done. For example, in a study of pesticide protective behaviors, consistent glove use was observed among 39% of farm workers, and hand washing before eating occurred among only 17% of workers (Walton, et al., 2016). These behaviors are likely to result in inadvertent ingestion of toxic pesticides. Injection is a route of entry in some industries, such as health services, which can result in transmission of blood-borne pathogens and infection.

Table I. List of Five Sets of Exposure Guidelines

| Acronym | Guideline Name                                 | Source                                                                                                                                              |
|---------|------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| PEL     | Permissible Exposure Limit                     | Occupational Safety and Health Administration (OSHA); United States; Legal exposure limits                                                          |
| TLV®    | Threshold Value Limit®                         | American Conference of Governmental Industrial Hygienists (ACGIH®); United States                                                                   |
| STEL    | Short-term exposure limit                      | American Conference of Governmental Industrial Hygienists (ACGIH®); United States; for some gases and vapors                                        |
| REL     | Recommended Exposure Limit                     | National Institute for Occupational Safety and Health (NIOSH); United States                                                                        |
| MAK     | Maximum Concentrations Values in the Workplace | DFG (German Research Foundation) Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area (MAK-Commission); Europe |

#### *Effects of exposure to air and other contaminants*

The effects of exposure to air contaminants or air pollution can be classified as irritants, allergens, systemic toxins, or site-specific or organ-specific toxins (Plog & Quinlan, 2012, p. 129). Some toxic substances can selectively target or affect specific organs in the body, such as the central nervous system, cardiovascular system, and respiratory system, while others may affect multiple organs. For example, evidence is growing to show an association between exposure to some types of pesticides and development of Parkinson’s disease (Brouwer et al., 2017).

However, pesticides are also known to affect other organs and systems of the body. For example, acute illnesses related to pesticide exposures may resemble acute upper respiratory track illnesses, conjunctivitis, and gastrointestinal illnesses (Alarcon et al., 2005). Symptoms of pesticide poisoning vary with the specific type(s) of pesticide exposures, and may include coughing, shortness of breath, nausea, vomiting, dizziness, muscular weakness,

muscle twitching, tingling sensations, headaches, and eye, nose, throat and skin irritation (Alarcon et al., 2005; EPA, 2008; NIOSH, 2007; Sanborn et al., 2007). High severity acute pesticide-related illnesses may include seizures, pulmonary edema, and damage to the kidneys and central nervous system (Alarcon et al., 2005; EPA, 2008). In addition, there is growing evidence that pesticide exposure is associated with chronic health effects such as asthma (Hoppin et al., 2008), cancer, damage to the liver, central nervous system dysfunction, immune system problems, and reproductive problems (Baldi et al., 2003; Cooper & Jones, 2008; EPA, 2008; Kamel & Hoppin, 2004; Kamel et al., 2005; Landrigan et al., 2005; Landrigan et al., 1999; NIOSH, 2007; Sanborn et al., 2007; Silver, 2006). Exposure to pesticides during childhood has been linked to an increased risk of leukemia, Hodgkin lymphoma, and renal, hepatic, soft tissue, bone and brain tumors (Belson, Kingsley, & Holmes, 2007; Carozza, Li, Elgethum, & Whitworth, 2008; Shim, Mlynarek, & van Wijngaarden, 2009). Prenatal pesticide exposure is associated with a number of health problems in their exposed children, including: neurologic abnormalities, autism (Colborn, 2006), attention deficit disorder/attention deficit hyperactivity disorder (ADD/ADHD) (Colborn, 2006), birth defects, altered fetal growth, fetal death, elevated blood pressure, brain and nervous system cancers (TEDE, 2007), leukemias, lymphomas, and Ewing's sarcoma (Buka, Koranteng, & Osornio Vargas, 2007; Colborn, 1995; Grandjean, Harari, Barr, & Debes, 2006; Roberts et al., 2007; Sanborn et al., 2007; Shim, Mlynarek, & van Wijngaarden, 2009; Sanborn et al., 2007; Shirangi, Fritsch, Holman, & Bower, 2009).

The effects that toxins have on the body are likely to depend on the point of exposure or entry into the body. Some gases and vapors can act as asphyxiants, reducing the body's access to oxygen. Some chemicals can burn the skin and mucous membranes, such as strong acids and bases. One example of a highly toxic acid is hydrogen sulfide (H<sub>2</sub>S). The health effects of H<sub>2</sub>S generally result from inhalation and vary based on the quantity and duration of exposure. Examples of symptoms and effects at lower exposure levels are nausea, headache, fatigue, loss of appetite, airway problems, and dizziness; higher exposure levels can lead to staggering, collapse, unconsciousness, and death (OSHA, n.d.-c).

Read about the health effects and control strategies at this OSHA website: <https://www.osha.gov/hydrogen-sulfide>.

### *Gases, vapors, and solvents*

Everyone can be exposed to potentially harmful chemicals. These exposures occur at work, in our homes, and in our communities. Many hazardous chemicals are commonly

used in homes, such as air fresheners, scented and other cleaning products, or having clothes dry cleaned with solvents. And, thousands of chemicals and chemical compounds are in use in work settings. These substances may occur in the form of gases, vapors, fumes, dusts or mists. "A gas is a formless liquid that completely fills its container and exerts an equal pressure in all directions" (Plog & Quinlan, 2012, p. 150). A vapor is a substance that is liquid at normal temperature and pressure yet some of the vapor part is diffused or suspended in the air. A solvent is a liquid in which a solute, which may have been a solid, gas, or liquid, is dissolved or suspended in the solvent. A solvent may also be described as a medium for a reaction. Common examples of solvents are water, nail polish remover, and turpentine.

### *Particulate matter*

Particulate matter (PM), also known as particle pollution (Environmental Protection Agency [EPA], 2017), is a "mixture of solid particles and liquid droplets found in the air (EPA, 2018)." Inhalation is the most important exposure route for most particulate matter. After being inhaled, the particles can affect the heart and lungs and cause serious health effects (EPA, 2017). One relatively new PM concern is nanotechnology and the production of engineered nanoparticles (ENPs) that are very small in at least two dimensions. The types of PM are dusts, mists, fumes, biologic agents, and smoke. Several examples of the most widely used and pervasive PM types are: asbestos, cotton, diesel exhaust, lead, pesticides, and wood dust. Engineered nanoparticles may be introducing relatively new health risks.

### *Routes of exposure for particulate matter*

Inhalation is the most important exposure route for most PM. Once particles enter the respiratory tract, they may directly damage the lung, persist in the lung tissue and cause chronic health problems, be dissolved and absorbed by the body to cause systemic effects, or may be cleared from the lungs and swallowed, and then be absorbed by the digestive tract. It is also possible that some particles may be transported from the nasal mucosa to the central nervous system. Other routes of exposure for some types of PM are ingestion and skin contact. Skin contact with some particulates can cause burns or cancer.

### *Leaf blowers and particulate matter*

One example of a common home and occupational hazard occurs in lawn care, the use of leaf blowers. Leaf blowers blast air at high speeds, sending many contaminants and particulates in the air, such as fungi, insecticides, herbicides, spores, heavy metals, and other particulate matter (PM).

One leaf blower used for an hour sweeps up about five pounds of PM into the air that takes hours to settle. This contamination poses many health hazards, including the risk for allergic reactions, infections such as fungal lung infections, and toxic effects.

### *Biological reactions to particulate matter*

Exposure to PM can induce biological responses ranging from acute to chronic, local to systemic, and mild to life threatening (Plog & Quinlan, 2012, p. 172). Some examples of biological reactions from inhaled PM are: irritation of the airways, breathing difficulties, pulmonary edema, bronchitis, allergic sensitization, fibrosis or scarring of lung tissue, emphysema, systemic toxicity, lymphatic toxicity, oncogenesis, infection, and metal fume fever. Workers may also experience adverse health effects from other routes of exposure. Pneumoconioses are a group of interstitial lung diseases caused by the inhalation of certain dusts and the lung tissue's reaction to the dust. The common types of pneumoconiosis are asbestosis, silicosis, and coal workers' pneumoconiosis (CWP). These diseases are caused by inhaling particulates, including asbestos fibers, silica dust, and coal mine dust (NIOSH, 2017). For more information about air pollution see the chapter on air in UNIT III: Environmental Health Sciences.

### *Engineered nanoparticles*

Engineered nanoparticles (ENPs) are one type of product from nanotechnology, which involves manipulating matter to form structures that are very small. Nanoparticles need to be intentionally engineered to be ENPs. Nanoparticles have not been used long enough to study and understand the health effects of exposure to these small particles. There is evidence to suggest that some materials that are not highly toxic on the macro-scale may be highly toxic on the nano-scale. Epidemiologic and experimental studies have demonstrated that combustion-derived nanoparticles (CDNP), often found in air pollution, contribute significantly to pulmonary and cardiovascular disease and deaths. It can be expected that ENPs will mirror the adverse health effects associated with CDNP.

### *Exposure routes and distribution of nanoparticles*

Nanoparticle exposure can occur through inhalation, ingestion, and skin contact. Some exposures through the respiratory and digestive tracts may cross into other areas of the body and lead to exposure of other organs and tissues. There is some evidence that several engineered nanoparticles may enter the brain through nasal mucosa and olfactory neuron axons; others may enter the brain through the bloodstream. There is conflicting evidence

about whether nanoparticles cross the placental barrier and the impact on the developing fetus.

## Work Organization Hazards

Work organization hazards include stressors, such as workload demands, intensity and/or pace, workplace violence, control over work, social relationships and support, and sexual harassment (OSHA, n.d.-a).

### *Workplace bullying and incivility*

Workplace incivility and bullying are occupational health and public health issues. Sometimes the two terms are used interchangeably. Some people distinguish the two with incivility being considered less intense and perhaps the precursor of bullying. Incivility may be considered: "low-intensity deviant behavior with ambiguous intent to harm the target, in violation of workplace norms for mutual respect (Longo, 2017)." Bullying may be defined as "behaviors intended to degrade or humiliate another and that continue over a period of time (Longo, 2017)." Examples of bullying are threatening language or behavior, constant and unreasonable criticism, and deliberate undermining of activities.

Bullying and incivility are common problems in many organizations, including health services organizations. It is a challenge to quantify the problem of bullying; it often goes unreported (Thompson, 2013). However, the literature suggests bullying is fairly common in nursing (Thompson, 2013; Vessey et al., 2009; Wilson, 2016). One large international study (N=2,000) indicated that 80% of participating nurses reported that they witnessed bullying in the workplace (Thompson, 2013b). Of these, 51% were nurse-to-nurse bullying (Thompson, 2013). A survey conducted in 2008, which included every region of the United States and 17 other countries, concluded that 75% of healthcare workers experience violence in forms other than physical violence, such as bullying, intimidation, criticism, and outbursts of anger (Hader, 2008). Of those subjected, 75% experienced criticism from their supervisors, colleagues, and physicians; 51.9% experienced verbal abuse directly from their coworkers (Hader, 2008).

## OCCUPATIONAL AND ENVIRONMENTAL REGULATORY AGENCIES AND LAWS

### *Federal Regulatory Agencies*

Several federal agencies oversee occupational health and/or environmental health, including:

- Occupational Safety and Health Administration: created in 1971

- National Institute of Occupational Safety and Health (NIOSH): established by the Occupational Safety and Health Act (OSHAct); it is housed within the Centers for Disease Control and Prevention (CDC)
- Environmental Protection Agency (EPA)

The Occupational Safety and Health Administration (OSHA) was created by the Occupational Safety and Health Act (OSHAct) of 1970. The OSHA is charged with helping employers to achieve health and safety goals by enforcing standards, through education, training and technical assistance, and creating partnerships and consulting with employers, employees, and organizations regarding preventing injuries and illnesses (Plog & Quinlan, 2012).

### Occupational Safety and Health Act

The first phrase of the OSHAct is: “To assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the Act; by assisting and encouraging the States in their efforts to assure safe and healthful working conditions; by providing for research, information, education, and training in the field of occupational safety and health; and for other purposes (OSHA, 2004). It emphasizes the goal of achieving safe and healthy working conditions.

The OSHAct specifies two duties for employers. One is to provide employees with work settings that are “free from recognized hazards that are causing or are likely to cause death or serious harm to their employees” (Plog & Quinlan, 2012, p. 7). The second duty is that employers must comply with all standards under OSHAct. To learn more about OSHAct, browse through the Act at: <https://www.osha.gov/laws-regs/oshact/toc>.

### Federal Regulations and Governmental Standards for Toxic Substances

Two major federal regulations for toxic substances are the OSHAct and the Toxic Substances Control Act of 1976. The Occupational Safety and Health Administration (OSHA) has adopted Permissible Exposure Limits (PELs) for more than 400 substances (Plog & Quinlan, 2012). This is a very small number out of the approximately 84,000 chemicals that may be in use in businesses, based on the Environmental Protection Agency’s inventory (U.S., Government Accounting Office, 2013).

The OSHA has the authority to develop standards that employers must follow to protect the health and safety of workers. However, these standards are developed using a “very extensive and lengthy process that includes

substantial public engagement, notice, and comment. The agency must show that a significant risk to workers exists and that there are feasible measures employers can take to protect their workers” (Plog & Quinlan, 2012, p. 810). The stages and steps of “The OSHA Rulemaking Process” are outlined in a one-page online document: [https://www.osha.gov/OSHA\\_FlowChart.pdf](https://www.osha.gov/OSHA_FlowChart.pdf)

### Legal requirements for OSHA standards

There are six legal requirements for OSHA standards:

- “Each standard must substantially reduce a significant risk of material harm” (Plog & Quinlan, 2012, p. 811)
- Technologically feasible: “protective measures being required already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be developed” (Plog & Quinlan, 2012, p. 811)
- Economically feasible: not adversely affect long-term profitability or competitiveness
- Address a significant risk; and standards must protect to a high degree
- Cost-effective measures
- Must have substantial evidence to support the standards

These legal requirements substantially limit the ability to create protective standards and do not adhere to the precautionary principle.

### EXPOSURE GUIDELINES

Different governmental agencies and professional organizations have established exposure guidelines for various chemicals or substances. The acronyms, names and source of several of these guidelines are listed in Table I.

Threshold limit values: The American Congress of Governmental Industrial Hygienists (ACGIH) recommends Threshold Limit Values (TLVs®). These are voluntary “exposure guidelines established for airborne concentrations of many chemical compounds (Plog & Quinlan, 2012, p. 25).” The TLVs are intended to protect most but not all workers from adverse effects if exposed day-after-day. However, this is not indicating that the levels are safe; and they do not consider cancer and reproductive health risks.

European Maximum Concentration Values in the Workplace (MAKs) are more likely than U.S. standards to be based on health effects and are often developed using an approach called no observed adverse effect (NOAEL) of the most sensitive endpoint.

## LIMITATIONS OF ENVIRONMENTAL HEALTH AND SAFETY REGULATIONS AND GUIDELINES

In general, environmental and occupational regulations and guidelines are not sufficient for protecting workers, the community, or the environment. As noted above, only about 400 of approximately 84,000 substances or chemicals have established PELs (Plog & Quinlan, 2012; Government Accounting Office, 2013). Additionally, there are substantial limitations for the PELs that do exist that directly relate to the legal requirements and processes for standard development and approval. The requirements for standards to be technically feasible for industry to comply with, economically feasible and cost-effective, and not threaten long-term profitability or competitive structure undermine the ability to protect the health and safety of workers and the community. As a result, adverse health effects can occur from exposure to substances that are at or below the PELs.

The requirement to have substantial evidence to support the standards can be challenging to meet because of limitations in research funding and methodological challenges in conducting occupational and environmental studies. One challenge is that epidemiologic research on health effects of many exposures may take decades of following and monitoring exposed persons to assess long-term health outcomes. Second, there may not be sufficient funding or human resources to complete all the studies that are needed to assess the health and safety of all potentially harmful exposures. Third, epidemiologic investigations are complex because people are often exposed to many toxic exposures during their lifetime; therefore, it may be difficult to find true unexposed control groups that have not been exposed to toxins with similar health effects of the exposure being studied.

Several factors can affect the response to a toxic exposure, including age, body size, other exposures, overall health status, and the timing of an exposure in a lifespan. Very young children, whose systems are immature, are more vulnerable to exposures and the adverse effects of environmental hazards. Children are especially vulnerable to the adverse effects of environmental hazards because of their developmental stages, higher metabolic rates, immature organ systems, and brains that are not fully developed. Because of their potential for a longer remaining life expectancy than for adults, there is greater potential for children to develop environmentally triggered diseases over their lifespan. Yet, many environmental and occupational studies are based on effects among healthy adult males. Therefore, legally acceptable levels of toxins may be released into

communities and the environment, exposing more vulnerable populations.

## USE OF STANDARDS AND GUIDELINES BY OCCUPATIONAL HEALTH PROFESSIONALS

Occupational health and safety professionals are responsible for promoting safe and healthful working conditions that protect workers, the community, and the environment. Environmental and occupational standards are not sufficient for meeting this obligation. Therefore, occupational health and safety professionals should consider PELs and TLVs® as minimally acceptable protections. Nurses apply evidence-based guidelines, including the European standards, and supplement these guidelines with published scientific literature on the health effects of environmental and occupational exposures. Using all available information, the Precautionary Principle should be applied.

## INTRODUCTION TO THE OCCUPATIONAL HEALTH AND SAFETY TEAM

In a specific workplace, there may be multiple types of occupational health professionals that collaborate to promote health and safety. However, in some workplaces, multiple roles are handled by the same person. Four major occupational health roles are: occupational health nurse, occupational and environmental physician, industrial hygienist, and safety professional.

### Occupational Health Nurse

Occupational health nursing “focuses on the promotion, protection, and restoration of workers’ health within the context of a safe and healthy work environment (Plog & Quinlan, 2012, p. 4).” Occupational health nurses work to prevent work-related injuries and illnesses, prevent disabilities, and help workers optimize their health status. The occupational health nurse (OHN) may be involved in providing direct care services, however, the major focus should be on primary prevention. Another OHN role is to use a case management approach to help injured workers navigate the care delivery system and return to work appropriately and on a timely basis; this is considered to be tertiary prevention. The OHN often serves in multiple roles, clinician, educator, manager, and consultant.

### *Nurses’ roles in environmental health*

Nurses have a history of promoting environmental health, going back to early landmark efforts of Florence Nightingale and Lilian Wald. In addition, nurses are increasingly being called to take action to apply environmental health concepts to all areas of nursing practice, including occupational health, through the

professional Scope and Standards of Practice for Nursing (American Nurses Association [ANA], 2020, ANA, 2010; ANA, 2007). There are several sets of standards of practice for nursing that are important to environmental health; one that focuses specifically on environmental health is the ANA's Principles of Environmental Health for Nursing Practice with Implementation Strategies (ANA, 2007).

### Occupational and Environmental Health Physician

The primary goal of an occupational and environmental health or medical physician is to prevent occupational illness. To effectively participate in the process of creating a safe and healthy work environment, the occupational medicine physician must understand the jobs, work processes, and materials used in the organization, the potential hazards and risks, and strategies to reduce risks. When occupational injuries or illnesses occur, the occupational medicine physician may be involved with working with the employee to restore health. Occupational physicians may also conduct occupational health histories of employees, be involved in preplacement physical examinations, perform fitness for duty (FFD) evaluations, and conduct return-to-work evaluations.

The occupational medicine physician may work in a range of settings, such as within an occupational health and safety department of an organization or corporate medical department, in a multispecialty group practice or hospital-based program, freestanding occupational health clinic, consulting firm, academic occupational medicine department, environmental agency, government agency, union, or other settings.

### Industrial Hygienist

"Industrial hygienists are occupational health professionals who are concerned primarily with the control of environmental stresses or occupational health hazards that arise as a result of or during the course of work" (Plog & Quinlan, 2012, p. 3). This definition highlights the important role that industrial hygienists have in protecting workers and the health of the community. Industrial hygienists consider effects of hazards or exposures quite broadly, focusing on life, health, pain or discomfort, and effects on the aging process. They often need to be generalists, having a broad scope of knowledge and skills.

Industrial hygienists may work as part of a team that may include physicians, nurses, safety professionals, toxicologists, epidemiologists, educators and/or other professionals. In addition, industrial hygienists may supervise occupational safety and health technologists,

also called industrial hygiene technicians, who may function in more limited technical areas.

### Safety Professional

A safety professional is defined as "a person engaged in the prevention of accidents, incidents, and events that harm people, property, or the environment" (Plog & Quinlan, 2012, p. 728). Although safety in an organization generally requires a multidisciplinary effort involving several members of the occupational health and safety team, the safety professional specifically focuses on identifying and evaluating potential hazards in the workplace and making recommendations for administrative and engineering controls to eliminate or reduce the risk posed by hazards. The discipline applies knowledge of "physics, chemistry, biology, physiology, statistics, mathematics, computer science, engineering mechanics, industrial processes, business, communication, and psychology" (Plog & Quinlan, 2012, p. 726).

### GREENING OF INDUSTRIES

A major emphasis in occupational health and industrial hygiene is primary prevention, which involves implementing health promotion and health protection measures in the workplace to prevent diseases and injuries from occurring. By implementing effective evidence-based health promotion activities and keeping people healthier, occupational health professionals can reduce absenteeism at work, help keep people out of the hospital, and reduce the excessive environmental waste associated with hospital-based services. In addition, the implementation of "green" or environmental sustainability practices or initiatives in businesses or industries is consistent with a primary prevention approach.

Environmental sustainability involves a wide range of interventions or strategies, including:

- Implement healthy landscaping without use of pesticides, minimizing water use, and avoiding use of motorized equipment, such as leaf blowers or lawn mowers
- Provide access to public transportation, safe walking and bicycle paths and other alternatives
- Provide a connection with nature
- Use eco-friendly building materials
- Reduce use, reuse, reduce use, and rot or compost
- Conserve energy and water
- Work toward carbon neutrality

## Unit IV: Practice Settings

- Minimally use toxic chemicals; substitute for healthier alternatives
- Provide access to and promote purchase and consumption of healthy, organically and sustainably grown, and local foods

The benefits to individuals and society of going green are immense, and include:

- Protecting infants from reproductive abnormalities and developmental damage
- Preventing human cancers, infertility, and other health problems
- Reducing the need for landfills
- Reducing organizational costs and clean-up costs for society
- Reducing emissions of dioxins and other toxins into the atmosphere
- Other benefits

Environmental sustainability is healthier, often cost effective, and is consistent with the health professionals' ethical principle of "First Do No Harm."

### Greening of Health Care

Some health services organizations are working on "green" or environmentally friendly initiatives. Some organizations have launched green teams and developed sustainability departments. The Preface of the book *Greening Health Care* (Gerwig, 2015) briefly describes an exemplar hospital that is environmentally sustainable in terms of size, healthy landscaping, access to public transportation, connection with nature, eco-friendly building materials, recycling, conservation of energy and water, carbon neutrality, minimal use of toxic chemicals, and other strategies. These strategies are more in line with "health" than many or most sick care organizations. In addition, in the Preface the author mentions that "the best thing we can do for the environment is to reduce our own health risks, or if we are healthy to stay that way" (Gerwig, 2015, p. ix). It is true that most health problems are preventable; and if we change the focus of health services to a greater emphasis on evidence-based strategies to promote health, that should lead to a decrease in the need for sick care services that are financially costly, burdensome to patients and their families, and generally do significant harm to the environment. Any type of industry can implement wellness initiatives that may benefit the employees and the bottom

line of the company, while helping to reduce use of sick care services.

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## HEALTHY FOOD IN HOSPITALS

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## HISTORICAL INSIGHT TO HOSPITAL FOOD

Cultures, religion, and medicine have historically been linked to the earliest known archaic hospitals where monks, soldiers, porters' wives and then nurses prepared the food. Food for the sick in the 1700s consisted of the three Bs; bread, beef, and beer, although alcohol in diets declined in the 1800s. Fruits and vegetables, other than potatoes, were hardly ever a food option whereas the food for the sick traditionally depended on the donations and generosity of family and friends.

The practice of nurses preparing and serving food to the sick was called "Invalid Cookery," in which a few hours were spent training the nurses to prepare the food. Clinical nursing duties in the nutritional care of their patients is clearly defined as Duty #10 in the Lady Probationers Handbook as..."to be competent to cook gruel, arrow bread, egg flip, puddings and drinks for the sick" ... (Englert, Crocker & Stotts, 1986, p.522). Several prestigious "Cookery Schools" started in the 1870s which had a significant impact on the nutrition content taught in schools of nursing. In 1893 the Women's Hospital of Philadelphia, the first nurse training school in the county included instruction in foods and methods of cookery (Englert et al., 1986). Student nurses were assigned to work in the kitchen for a month to learn dishwashing, cleaning and the art of preparing food for the sick. It is believed that the word "dietitian" most likely originated during this time, although the exact origin is unknown.

In the 1900s, the development of nutritional science diets was more carefully considered and the health profession began to recognize the importance of providing special diets specific to patients with certain diseases. During this time in 1901, Adelaide Nutting, the Superintendent of Nurses at John Hopkins Hospital, voiced the need to implement a separate program in dietetics. Shortly thereafter, the Department of Public Charities in New York City implemented a dietetic program which sparked the formation of the American Dietetic Association (ADA) and the establishment of the profession of dietetics in 1917 (Englert et al., 1986).

During the early period of dietetics, nursing curriculum related to nutrition evolved from the Diet Kitchen Course

comprising approximately 15 hours in the topics of food, its source, composition and usage in the body, diet in diseases and infant feeding and expanded to approximately 100 hours of content over a three-year period. In 1949, the National League for Nursing (NLN) recognized the importance of nutrition by introducing a nursing achievement test in "Diet Therapy and Applied Nutrition" (Englert et al., 1986). The didactic areas related to nutrition were broken down into three separate sections of food, nutrition and diet therapy. In addition at this time, nurses willingly released their duties of food service preparation to the dietary department. Soon after the directors of nursing schools then invited the dietitian to teach the nutrition-related learning activities. To differentiate the roles, the dietitian's role was to plan and order the patient's meals and the nutritional well-being of the patient was the responsibility of the nurse.

In the 1960s the nursing curriculum changed from the medical to the conceptual model in which the content of nutrition was taught as a continuous "thread" through the curriculum. This curricula change prompted the State Boards of Nursing to eliminate the specific number of required hours in nutrition. Approximately 10% of the State Board Nursing exam consisted of nutrition-related questions in 1972, and was decreased to only 5% in 1982, currently it is difficult to determine the exact percentage dedicated to nutrition since this topic meshes with other subjects in the National Council Licensure Examination (Englert et al., 1986). Currently nursing program curriculum vary, making it difficult to standardize nutrition content into curriculum though five major strategies are employed:

- 1) Nutrition is taught as a separate subject;
- 2) Nutrition is included as an integral part of nursing courses;
- 3) Nutrition is covered in patient-oriented situations, conferences or during studies of special patients;
- 4) Nutrition is taught as a science course for nurses;
- 5) Nutrition is taught as a combination of strategies (Englert et al., 1986, p. 527).

If optimal nursing care is to be provided to all patients, then the importance of nutrition should be examined.

## NUTRITIONAL INSIGHTS CENTERED AROUND ETHICS

Hospitals are fortunate to have a variety of members on a healthcare team; each member has a unique role in nutrition care for patients. Physicians hold the ultimate responsibility for meeting the patients' healthcare needs,

including nutrition, since they are responsible for prescribing the diet order. Physicians perform comprehensive nutrition assessments, order diet counseling and review data on food intake. Not all facilities employ dietitians, and it may be possible if a dietitian is employed by a facility, they may not be able to complete a patient consult without a specific order or trigger to provide nutritional assessment and medical nutrition therapy. Nurses spend a majority of their time with the patients and are on the frontline ready to assess and identify patients' nutritional needs, although they are not permitted to order a patient's diet without consulting with a physician first. Nurses are busy with many responsibilities centered around medication administration and providing essential patient maintenance, however most often it is the nurse who evaluates the patient's nutritional deficiencies that places the patient at risk for inadequate energy to heal, maintain an immune system and skin integrity, absorb/use medications appropriately and support organ function. There is an increase in the risk of malnutrition in adult hospitalized patients, foremost it has been established that nutritional education for nurses must improve (Boarz et al., 2013; Tappenden et al., 2013). Patient nutrition education is a vital piece of healthcare, nutrition education is to be initiated by the physician and dietitian then reinforced by the nurse, although in reality this may not happen due to various reasons, including time constraints, shortened length of stay and knowledge deficit. Tappenden et al., (2013) offers the following recommendations to drive nutritional improvement:

- 1) Create an institutional culture where all stakeholders value nutrition;
- 2) Redefine healthcare clinicians' roles to include nutritional care;
- 3) Recognize and diagnose all malnourished patients and those at risk;
- 4) Rapidly implement comprehensive nutrition interventions and continued monitoring;
- 5) Communicate nutritional care plans; and
- 6) Develop a comprehensive discharge nutrition care and education plan (p. 147).

The transformation of hospitals evolved from financial incentives for keeping beds filled to present incentives for preventing readmissions and promoting wellness. In the United States, healthcare delivery driven by policy is steering the focus on cost, quality, and transparency of care. These changes have promoted the return to re-examining the role of nutrition as a critical component to

patient recovery and wellness. Hospitals have a moral obligation to provide a variety of healthy foods since many leading causes of death including obesity, diabetes, heart disease, and cancer, are diet related. Also, it is clear that healthcare workers are aware that foods high in fats and sugars are considered damaging to health and result in increased morbidity and mortality rates. Simply put, serving unhealthy food to patients, staff and visitors is unethical. In a sustainable hospital the fundamental science of providing healthy foods to patients, staff and visitors is embraced by role modeling contagious healthy behaviors such as banning sugar-sweetened beverages, and minimizing the availability of candies, chips, fries, refined grains and cured/preserved meats. Providing wholesome nutrition in hospitals is morally sound, and hospitals should offer food that is beneficial to the planet such as serving dairy products and meats without antibiotics, offering meatless alternatives or meatless days, and choosing food grown by local farmers. By making these simple menu changes, it can have a positive impact on human health and the environment which is good for all.

### THE CONNECTION BETWEEN FOOD, HEALTH AND THE ENVIRONMENT

According to the World Health Organization (WHO, 2018), by the year 2020, chronic diseases will account for almost 75% of all deaths worldwide. In the United States, the majority of the nation's 3.3 trillion health care dollars are spent on managing chronic diseases such as diabetes, obesity and heart disease (Center for Disease Control, 2018). Poor eating patterns can be held accountable for these trends. While efforts have been employed to change food consumption patterns in the United States such as banning trans fats (Assaf, 2014) or taxing sugar-sweetened beverages (Mariner and Annas, 2013), these types of initiatives are not holding ground, and the number of food-related diseases is continuing to rise. Additionally, the over-consumption of foods in the United States is not only impacting the health of its people but also the health of our planet. This cycle of activity does not provide a sustainable, healthy environment in which one can live.

According to the United States Department of Agriculture (USDA, 2014), there is strong evidence that new dietary patterns, such as eating more plant-based meals and reducing the consumption of red meat can reduce not only the incidence of chronic disease but also decrease the footprint of food consumption on the environment. Healthcare organizations have responded to this evidence and are actively promoting healthy, environmentally friendly, nutritional offerings for patients, employees, and communities (Healthier Hospitals Initiative, 2012). Hospital systems are incorporating innovative

environmental nutrition concepts into daily operations with the goal of providing optimal care to the communities in which they serve.

The traditional discipline of nutrition focuses on the biochemical components of food such as calories, vitamins, and fats and individual food consumption, while the relatively new discipline of environmental nutrition addresses social, political, economic and environmental factors in defining healthy foods (Sabate, Harwatt, & Soret, 2016). Leveraging both nutritional approaches is necessary to promote positive, healthy behaviors. Understanding the intersection of the food supply, health and the physical environment otherwise known as the health-environment-diet trilemma is of great importance for public and environmental health (Sabate et al., 2016). Shifting to healthier diets can reduce diet-related diseases and improve environmental outcomes. The impact of food systems from farm to processing, storage, consumption, and waste is impacting climate change, which is known to have effects on human health. Identifying ways of reducing food waste should be a priority of all healthcare systems. Hospitals can get support from such organizations such as Practice Green Health's program called The Healthy Hospital's Initiative (HHI). The organization provides tools for hospitals to reach sustainable goals around healthier food, the reduction of waste, ideas for less energy consumption and smarter purchasing power.

One suggestion from HHI to reduce the carbon footprint is for hospitals to explore new procurement methods for securing food by partnering with local farmers. Leveraging sustainable-local resources reduces the number of greenhouse gases from vehicle transport as food can travel up to 1,500 miles to reach its final destination (Xuereb, 2006). However, hospital operations need to be aware that some barriers will need to be addressed when considering this option, such as the reliability of supply, the timing of supply, and geographic locations subject to seasonal changes. Despite the challenges, incorporating environmentally-supported concepts must be considered.

Additionally, modifications of food sources may relieve some of the food production burdens on the environment, whereas approximately 14.5% of the world's greenhouse gas emissions (GHG) is from farming of livestock (Stoll-Kleemann and Schmidt, 2017). Trends are shifting toward plant-based meals to reduce the environmental burden of meat-based meals, and they offer similar or better nutritional value and have shown to improve health (Evans, Magee, Dickman, Sutter, & Sutter, 2017). In June of 2017, the American Medical Association passed a [Healthy Food Options in Hospitals](#) resolution that calls on hospitals to improve the health of patients, staff, and visitors.

### On-Trend: Hospital Based Farmer's Markets

Hospitals are becoming more innovative in the promotion of healthy foods. One such approach is establishing hospital-based farmers' markets for patients, visitors, employees and the community. The benefit of having on the ground farmer's markets can serve a variety of purposes from the basic provision of healthier foods to leveraging new methods in which to provide nutritional educational opportunities.

Interested in establishing a hospital-based farmers market at your hospital? Visit [Health Care Without Harm](#) for a step-by-step guide on how to host a farmer's market.

Additionally, August 2018, [California State Bill 1138](#) mandated that all hospital systems must offer at least one plant-based option at every meal. With each small initiative, hospitals can pledge to rethink food leveraging to the environmental nutrition approach which can encourage people to live healthy lives, plus maintain planetary survival.

### THE ROLE OF HOSPITALS AND HEALTH PROFESSIONALS IN HEALTHIER FOOD

There is a remarkable opportunity for all healthcare providers to educate patients and communities about sustainable eating to achieve optimal health and wellness. With a focus on environmental nutrition and dietary trends, the first ingredient is education. As nutrition and food service-lines are infusing new concepts and ideas into menu choices, there is often a lack of support from other disciplines due to a knowledge deficit for the changes. Therefore, establishing a baseline understanding of nutrition, sustainability, and the environment should be provided to all stakeholders. Steps can also be taken to improve personal awareness by participating in educational programs to learn about plant-based nutritional approaches and in turn apply the knowledge gained to patient care (Evan et al., 2017). Establishing a partnership between the healthcare providers and nutritional services is critical to close communication gaps, clarify roles, and foster effective use of resources and knowledge for continuous improvement in achieving patient health and wellness. It is anticipated with a better understanding of sustainable food practices, support for these new initiatives will increase.

Health care providers can also engage in research to further examine the impact of food production on the health of patients and the planet and advocating for public

policies that promote better sustainable farming practices. Finally, health care facilities should consider joining organizations that support plant-based diets such as the [Nurses Nutrition Network](#) or [Practice Green Health](#) to obtain step-by-step guides on how to move the dial on sustainable food practices. For more about the environmental impacts of food and food production please go to the food and agriculture chapter in Unit V: Sustainable Communities.

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## CONCERNS OF CLEANING PRODUCTS ON OUR HEALTH AND SAFER STRATEGIES

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From the very beginning of our journey to become a nurse, the importance of cleanliness in the prevention of the transmission of diseases began with handwashing and keeping our patient's care area clean. In this effort to protect our families and patients from illness by cleaning our homes and workplace, we also may be exposed to potentially toxic substances. Cleaning products, including those we use to disinfect our hands, have been associated with a variety of health effects, including headache, irritation of the airway (mouth, nose, throat), skin and eye irritation, and even death related to accidental ingestion.

### HOW TO CHOOSE PRODUCTS FOR CLEANING OUR HOMES

It is critically important that cleaning products remain in their original packaging with the original label, including warning symbols, and are properly stored and sealed appropriately. If a product is transferred to another container, it should be labeled with the ingredients and the dilution/concentration, if appropriate. This will help users know the chemicals inside, as well as the hazards associated with using the product. Another important consideration is the prevalence of concentrated products which should be only diluted according to the manufacturer's instructions. At times, products may be used at a stronger concentration with the thought "less is more" or "the stronger the better" and expose the user to a higher exposure to chemicals. The Environmental Protection Agency (EPA) recommends using a hazardous materials identification system which uses pictograms, hazard statements, and signal words to communicate hazard information (EPA.gov (a), nd).

At the very least, product labels that use the words "Caution", "Warning", "Danger" or "Poison" should be avoided at all cost. The Ecology Center (EC) goes a step further by recommending purchasing products that require no warning signal words (Ecology Center, 2019). The word "Danger" on a label, signifies a highly toxic product, where just a few drops may be lethal. "Warning" on a label denotes a moderately toxic product, from which a lethal dose can be the result of a teaspoon to a tablespoon. Labels with the word "Caution" have a lower toxicity, with lethal dose coming from an ounce to a pint and have a varying degree of safety. The EC also recommends avoiding products labeled as flammable, which likely contain volatile organic compounds (VOCs), many of which are linked to health effects such as cancer.

Products that contain the word "corrosive" should be avoided as they may cause permanent damage to eyes and skin with exposure (Ecology Center, 2019).

The Environmental Working Group (EWG) suggests avoiding antibacterial cleaners, air fresheners, and drain cleaners (EWG (a), 2019). Per the EWG, antibacterial cleaners contain pesticides and do not provide added protection against illness. Air fresheners contain undisclosed and often untested chemicals such as fragrances. Drain cleaners often contain harmful chemicals which can be hazardous if misused, or poisoning due to swallowing, inhaling, or touching the chemicals. Children are more at risk to the effects of even small amounts of certain drugs and chemicals (Mayo Clinic, 2019). It is suggested to look for a safer product, especially if the label for the product you are considering requires multiple pieces of personal protective equipment (EPA (a), nd).

EWG's Guide to Healthy Cleaning (EWG(a), 2019) is an excellent resource to review cleaning products for environmental and health concerns. EWG rates each product with a score from A (few or no known suspected hazards to health or the environment with good ingredient disclosure) to F (potentially significant hazards to health or the environment or poor ingredient disclosure). Consumers can review the list of ingredients, label information, warnings and directions, as well as information for health concerns including asthma and respiratory, skin allergies and irritation, developmental and reproductive toxicity, cancer, and environmental concerns for each of over 2,500 products.

For example, some hand soap/sanitizer may include triclosan which is linked to endocrine disruption, allergies and immunotoxicity, skin, eye, or lung irritation, organ system toxicity and suspected to be an environmental toxin (EWG (a), 2019). A simple safer strategy would be to avoid products with triclosan. The EWG site enables the savvy consumer to be able to review a product, compare information with other products and find safer alternatives all while in the product aisle. For example, the EWG suggests avoiding products that contain ammonia, 2-butoxyethanol, chlorine bleach, ethanolamines, "active ingredients" such as ADBAC, benzalkonium chloride, and ingredients with names including "monium chloride" or triclosan. EWG provides a wallet-friendly resource that can be taken shopping as you evaluate available products for cleaning: <https://static.ewg.org/ewg-tip-sheets/EWG-Cleaners-WalletGuide.pdf>. Another resource for the comparison of cleaning products, the ingredients and effects, and a safer alternative, is Clean Water Action's (2019) Green Cleaning Guide; This resource can be found

at <https://www.cleanwateraction.org/features/green-cleaning-guide>.

There are many safer, less hazardous cleaning product lines available such as Seventh Generation and Mrs. Meyers, but these may also be costly and out of reach for some households.

The EWG and Clean Water Actions websites offer recipes for safer home-made cleaning products using a few simple inexpensive ingredients, such as vinegar, castile soap, baking soda, hydrogen peroxide, lemon juice, and washing soda. For example, white vinegar can be used as a deodorizer and fabric softener, as well as used to clean windows, microwaves, and toilets, cut grease and make chrome shine—all for a few pennies! A soft scrub for bathroom surfaces can be made from making a paste from baking soda and a bit of liquid soap. Utilizing green cleaning practices can improve indoor air quality, reduce health risks associated with exposure for ourselves, our families and animals. Creating your own cleaning supplies and reusing dispensing containers such as spray bottles will also help minimize plastic waste entering the waste stream. Women's Voices for the Earth (2019) is another resource for cleaning recipes. Link to the resource: <https://www.womensvoices.org/take-action-with-womens-voices/green-cleaning-parties/green-cleaning-recipes/>.

## HAND SOAP

As nurses we promote hand washing to prevent the transmission of diseases. It is very possible that there are toxic chemicals in the very products we are using to protect our health.

For example, hand soap may contain chemicals linked to irritation, cancer, endocrine disruption, organ system toxicity, and neurotoxicity. Reading the list of ingredients on product labels will help identify the safety of a product. In the healthcare environment, it is vitally important that nurses have a seat at the table on committees that evaluate products prior to purchasing to help identify safer products for use not only by patients, but the community and members of the healthcare team.

## LAUNDRY PRODUCTS

We protect our families from everyday dirt and grime by keeping everything in our homes clean, including our clothing. It seems impossible that something we use every day to help protect our families, maybe harmful to them and/or the environment. For example, manufacturers of laundry detergents may use phosphates to prevent dirt from resettling on fabrics and as a water softener. As the waste water enters streams and rivers, these phosphates feed algae, causing an “algae bloom,” an overgrowth of

algae which chokes out other plants and marine life (EPA, 2019). Reading labels for the phosphate content is a start in choosing a safer laundry detergent.

Laundry pods are one of the newest laundry products on the market. Many are colorful with attractive designs. Laundry pods have been linked to over 56,000 calls to poison control centers due to exposure or ingestion by children and adults with dementia (Consumer Reports, 2019). It is anticipated that incidences of unintentional child poisoning may increase with the current trend of concentrated products, attractive packaging, and convenient forms such as laundry pods (Schwebel, Evans, Hoeffler, Marlenga, Nguyen, Jovanov, Meltzer, & Sheares, 2017). There are safer alternatives for laundry, including homemade liquid and powder laundry detergents utilizing a few simple ingredients such as borax or washing soda: <https://thefrugalgirls.com/2010/08/homemade-liquid-laundry-detergent.html>.

Drying clothes outside on a clothesline or drying rack has many benefits including no need for dryer sheets (think of the fragrances!), less wear and tear to clothing from the dryer tumble, conserving energy and resources, and having that “clean, outdoor fresh” smell. Another benefit to drying clothes outside is that sunlight can help bleach and disinfect clothing.

A clothes dryer is recognized as the second highest user of electricity in a household behind a central air conditioner or heat pump (Oasis Energy, 2017) and utilizes approximately six percent of an average home's energy use (National Park Service, 2018). It is estimated that a small load of laundry costs \$0.36 to dry (The Simple Dollar, 2019), which can add to a significant amount of money over a year and multiple loads of laundry—let alone the cost and maintenance of a dryer. An Energy Use Calculator can be helpful in assessing the energy usage of household appliances and calculate the cost of usage of each appliance. One energy calculator is available at: <https://oasisenergy.com/appliance-electricity-usage>. According to the EPA, if all clothes washers and dryers in the U.S. were Energy Star certified, more than 19 billion pounds of carbon pollution would be prevented and more than \$4 billion would be saved in energy costs (EPA (b), nd.).

## FRAGRANCES

Clean homes should have no odor. Marketing and advertising has convinced us that a clean home smells like “Mountain Air” or a “Spring Meadow.” As discussed earlier in this text, the word “fragrance” often is a combination of many ingredients, but are not listed specifically on the label making it difficult for the consumer to choose

products. According to the Environmental Working Group's Campaign for Safe Cosmetics (2019), fragrances are linked to health problems such as cancer, reproductive and developmental toxicity, allergies and sensitivities. A safer solution would be to read labels and avoid a product that gives no information other than the word "fragrance."

Essential oils, such as camphor, peppermint, wintergreen, and lavender may be used with caution to add a natural scent, but may not be the safest solution. Essential oils are unregulated and it is difficult to know the specific ingredients of each product. Essential oils should be stored away from children due to the concern of skin irritation, absorption through the skin or ingestion, allergic reactions, and poisoning (Poison Control, 2019). For example, the Poison Control organization cites a case of a 22-month old who was admitted with a seizure and respiratory depression which was linked with an ingestion of camphor which had been placed in the home for roach control. Camphor may also be used as a moth repellent and found in some skin preparations used to relieve pain, irritation, and itching. It is recommended to contact Poison Control immediately for an ingestion of an essential oil or a product containing an essential oil.

As nurses keep our homes and places of work clean to maintain the health and safety of our patients, our communities, and our families. We can build on this effort by evaluating each product we use not only for appropriateness for the task at hand, but also for safety. As well, we need to be part of the decision in the choices of the products utilized in our everyday life, at home, our community and our place of work.

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**ENVIRONMENTAL HEALTH LITERACY**

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The goal of Environmental Health Literacy (EHL) is for individuals, families, and communities to understand and “act on health-related information about environmental hazards” (Hoover, 2019, pg. 5). To prevent illnesses and injuries from environmental exposures, it is important that the risks related to environmental factors are known and that individuals, families and communities are aware of approaches that can address, reduce, and eliminate these risks and the environmental exposures (Finn & O’Fallon, 2017). EHL draws from the disciplines of health communication, health literacy, risk communication, and participatory communication (Hoover, 2019). Health communication is focused on developing clear, understandable information so that individuals/families/communities can make evidenced-based decisions about their health. Health literacy addresses the ability to understand basic health information. EHL extends the ideas of health communication and health literacy to include an understanding of the science related to environmental hazards and the importance of working collaboratively to address hazards. The purpose of risk communication is to provide individuals with “information they need to make informed, independent judgements about risks to health, safety, and the environment” (Morgan, Fischhoff, Bostrom & Atman, 2002). The information must be accurate, understandable, and from trustworthy sources. In risk communication, those creating communication initiatives must know the purpose of the communication, the knowledge level of the audience, and the social/cultural factors that may influence how the communication is interpreted. Participatory communication, on the other hand, involves multidirectional discussions with community members, stakeholders, scientists and others that is collaborative, culturally appropriate and goal oriented (Hoover, 2019). EHL combines these approaches to enable individuals, families, and communities to understand the health impacts of environmental hazards and identify actions steps to address those hazards.

**ENVIRONMENTAL HEALTH LITERACY EXAMPLES**

EHL has historical roots in natural and human-made disasters such as Hurricane Katrina, Love Canal, the Chernobyl and Fukushima nuclear accidents, and the Deepwater Horizon oil spill. News stories broadcast on television, radio, and via social media provided information about these environmental disasters and increased the

public’s knowledge and awareness of the risks of environmental hazards (Finn & O’Fallon 2017).

The critical need for safe drinking water has highlighted when lead was found to be present in the Flint, Michigan water supply. In 2014, the city of Flint stopped taking water from Lake Huron, and instead took water from the Flint River. The city failed to implement the appropriate required corrosion-control treatments required by the Environmental Protection Agency (EPA). These and other failures resulted in very high concentrations of lead in water of about one-quarter of the homes. Blood lead concentrations in children increased, especially in the communities where most residents live below the poverty-line (Bellinger, 2016; Butler, Schammeli, & Benson, 2016). Although mistrust of government officials and academics who did not respond to requests for information was high, many community residents continued to actively seek out information about lead levels and their water and the health impacts of these high lead levels until the problem was addressed (Carrera, Kye, Bailey, et al, 2019; McQuaid, 2016). The short video “Without these whistleblowers, we may never have known the full extent of the Flint Water Crises” highlights the persistent efforts of a Flint, Michigan mother and a scientist from Virginia Tech University to expose the high lead levels in the Flint water <https://www.youtube.com/watch?v=loQo6PBmZi0>.

Water quality is also an issue for American Indian/Alaskan Native communities. Members of the Apsáalooke (Crow Indian) tribe noticed that stomach and lung cancers were occurring at higher rates for tribal members living on or near the reservation than for those living further away. A working group, the Crow Environmental Health Steering Committee, was formed to address the problem. This committee included a county commissioner, a construction manager, and tribal members. Partnerships were formed with a local community college and a state university to test the well water. The committee began an educational campaign on how to decontaminate wells contaminated with bacteria. In addition, the committee determined that if children were better educated regarding environmental hazards, they could be agents of change. A hands-on educational program was developed for school-aged Apsáalooke children to increase their EHL regarding water quality and its health impacts. Children were involved in testing well-water and in reporting results back to their community (Simmonds, Margetts, & Rudd, 2019).

Youth were also involved in an EHL and leadership skills training in California. The focus of this effort was on exposure to endocrine disrupting chemicals in products

used by Latina girls. The Health and Environmental Research in Make-up of Salinas Adolescents (HERMOSA) study included 15 youth who collected data from 100 adolescent Latinas that included interviews and urine samples. The 15 youth provided education to the community about endocrine disrupting chemicals in cosmetics and distributed low-chemical replacement products. Participants learned about the results of the study in a community forum, and additional information about endocrine disrupting chemicals was provided. Findings of the study were also presented in the media and social media. The 15 youth investigators indicated they learned a great deal about research and about chemicals they could be exposed to in their beauty products (Madrigal, Minkler, Parra, et al., 2016).

### **ENVIRONMENTAL HEALTH LITERACY AND NURSING'S ROLE**

Brown, Clark, Zimmerman, Valenti, and Miller (2019) identified five stages of EHL awareness that are important for health professionals, including nurses.

- Level 1. Knowledge and understanding about the effects of environmental exposures on human health.
- Level 2. Communicating and providing information to patients about their environmental exposure risks and referring to experts when needed.
- Level 3. Communicating and engaging with community groups about environmental risks and collaboratively strategizing about how to address those risks.
- Level 4. Participating in professional organizations and advocating for environmental health issues. Serving on committees of professional organizations that are addressing environmental health issues or starting such a committee can help to increase nurses EHL as well as impact the policies of the professional organization.
- Level 5. Advocating for environmental health issues at work and/or with legislative or regulatory bodies. In healthcare institutions nurses can work to make the environment safer for patients and for workers. Nurses can inform policy makers about environmental hazards and become a member of an advisory or regulatory board to advocate for EHL.

There are many ways in which nurses can communicate environmental health information. For example, brochures and fact sheets can be prepared as can lectures. Studies concerning communication of environmental information have shown that: (1) those who were well-informed about the topic were more likely to accept the knowledge, (2) those participating in classroom-type lectures were more likely to retain the information than those given

brochures, and (3) booklets tend to result in more knowledge retained than fact sheets (Lewis, Yost, etc. 2010). Digital communication strategies have shown potential in increasing EHL. Blogging, smartphone applications, and use of other social media platforms can impact environmental health awareness and knowledge. Smartphone notifications of poor air quality days are a common example of alerting residents to environmental exposures. Caution is needed to assure that the digital information provided is accurate, clear, timely, easily obtainable, interesting, visual, and interactive when possible (Kreps, Wrights, & Burke-Garcia, 2019).

### **CONCLUSION**

Environmental health literacy combines the understanding of the link between environmental exposures and the health impacts of those exposures (Finn & O'Fallon, 2017). Nurses have a dual responsibility to learn about the potential and actual environmental exposures of their patients, co-workers, the community, and themselves. Becoming literate in environmental health is a responsibility of all nurses, as is providing effective communication about environmental risks to patients, families, and communities and working with these constituents to effectively address environmental hazards. Environmental health literacy, a growing discipline, combines strategies from health communication, health literacy, risk communication, and participatory communication to assure individuals, families, and communities understand the risks of environmental exposures and develop and implement effective strategies to eliminate environmental health risks.

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## ENVIRONMENTAL NURSING IN LATIN AMERICA

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Since the origins of care, health was directly related to the environment because man had to learn to protect himself from extreme changes in climate, to use plants to treat diseases, to make stone tools and later from other materials, to hunt and fish, and to use the byproducts of animals (1) in short, he learned to use the resources of nature for his survival; however, as a consequence of human actions, problems have been generated such as global warming, greenhouse effect, desertification, acid rain, depletion of natural resources, disappearance of species and the accumulation of toxic and radioactive waste in soil, water and air, generating environmental risk factors that affect the health of human beings (1).

An aggravating factor is that in the last 100 years the population of the earth has quadrupled to 7 billion people, of which most have been concentrated in urban areas, with the Latin American and Caribbean Region being the most urbanized in the world, with 77% of the population living in cities, a figure that is expected to reach 85% by 2030. Cities can offer better opportunities and working conditions, but generate unplanned and unchecked growth, road insecurity and the streets, housing deficit, aging, inefficient public services infrastructure, increasing inequalities in access to health goods and services (2), greater energy consumption and greater transport needs and therefore greater emission of gases into the atmosphere.

On the other hand, in America, there are diverse ecosystems and large reserves, which are vulnerable to deforestation, the conversion of natural habitat for agricultural or livestock use or urban expansion; the alteration of surface waters through the construction of dams, irrigation, and diversion of the current; as well as the loss of biodiversity that can result from overexploitation for fishing or the introduction of invasive species (2).

Latin America is one of the regions with the highest risk of diseases of environmental origin, considering the susceptibility related to social and environmental determinants. According to the World Health Organization in the Region (except Chile) per capita deaths attributable to the environment are related in their

order to noncommunicable diseases, injuries and in a smaller proportion due to infections, parasites and neonatal and nutritional diseases (3). This region, like the rest of the world, has been subject to numerous extreme natural events and disasters, related to the effects of climate change, which aggravate the health situation of the most vulnerable populations.

### WHAT CAN WE DO IN NURSING TO HELP MINIMIZE THIS PROBLEM?

Nursing professional practice involves the inclusion of ethics and environmental bioethics in the actions performed in each of the performance areas. Several authors in Latin America have made reference to the importance of resorting to the ethics of care, in such a way that resources are used in an organized manner, so that the environment can recover and continue to be self-sufficient. (4) Some of the reflections in relation to the subject are:

- Nursing, by adopting ecosystemic actions in its daily work, advocates for integral attention to the human being and, therefore, has the opportunity to put into practice environmental, ecological, physical, psychological, spiritual and social actions, creating thus possibilities of a complete and interactive attention (5).
- Quality of life and health are closely related to aspects of the ecosystem (6).
- The environmental issue should be part of the debates on education, because this debate favors the reflection of people about what is ecologically healthy, for which nursing should integrate environmental education into its work (7)
- Nursing should be strengthened as a discipline to respond to the needs of nursing research and care education, in line with the trends of globalization in the contemporary world, as well as the drastic impacts on human and environmental health (8).
- The nurse can be an environmental educator and act in this space, favoring reflection on the actions that affect the environment and the risk to the community (9).
- It is necessary to take up the legacy of Florence Nightingale as a way of valuing the environmental dimension as essential for the health assistance process, both in terms of promoting health and quality of life, and minimizing the environmental impact from the health work process. The ethical reflection and the educational approach are fundamental in this process. (10)
- Nursing commitment to globalization is and its impact on individual and collective health is to reflect on its

effects on care, with the intention of contributing to health for all; analyzes the importance of recognizing plurality as a way of producing knowledge in nursing and health, as well as the necessary union between reason and emotion. Finally, Do Prado discusses the challenges of education for the construction of an ethical subject, capable of printing the transformations that nursing care requires and desires for Latin America. (11).

- The nursing professional is an important actor in the promotion of health, especially in the environmental health of children and for this it requires interventions aimed at promoting behaviors that favor the environment and that minimize the risk of exposure to environmental risk factors (12)

As was done by the International Council of Nurses (ICN) and the American Nurses Association, in Latin America, some of the associations or colleges of nursing professionals included in their codes of ethics the issue of environmental health, as follows:

- Argentina, Brazil, Uruguay and Paraguay: the Declaration of Ethical Principles, article 7 establishes that the nursing professional has the responsibility of maintaining the natural environment and protecting it from contamination, degradation, destruction and abandonment(13).
- Colombia: the Code of Ethics of Nursing, article 27 states that the nursing professional should refrain from promoting the use of products that he knows hurt human beings or the environment (14).
- Chile: The Code of Ethics of the Nurses' Association of Chile, in section 7.1, establishes that the nursing professional should be informed about the studies and action plans to detect the harmful consequences that the environment exerts on men, as well as the plans for the conservation of natural resources (15).
- Costa Rica: the Code of Ethics and Professional Ethics in its article 29 that the nursing professional must support the health authorities to detect the harmful effects of the environment on human health, as well as in the planning of activities that favor conservation and environmental sustainability and that therefore contribute to the improvement of the quality of health and, in Article 32, establishes that within its competences is education about healthy environments (16).
- Mexico: The Code of Conduct for Nursing, article: 28 establishes that the nurse has the social duty to seek a balance between human development and the

conservation of natural resources and the environment, taking into account the rights of future generations (17).

- Peru: The Code of Ethics and Deontology, article 16, determines that the nursing professional must share the responsibility to maintain the natural environment and protect it against contamination, impoverishment, degradation and destruction (18).

It is important to identify that through the Nursing Codes, environmental care and the prevention of environmental risk factors are encouraged, since nursing professionals are in a unique position to interact with the community in the identification of members. potentially linked to environmental exposure (14). Nursing as a historical and ideologically based profession based on welfare principles, teaches a way to rethink the care culture (15). There is a direct connection between nursing actions and environmental health in health care agencies. However, in the daily practice of nursing the environmental impact of procedures such as the administration of a medication, the change of a bandage, or the initiation of an intravenous route are generally not considered; for example, the final destination of the wrappers that represent the by-products of their work is an almost subliminal activity in their professional role, since their approach as a nurse is more frequent in other priorities (16).

What have we researched in Latin America on Nursing and the environment?

In Latin America there are few publications made by nurses in relation to the topic of environmental health. When reviewing the literature, studies with a qualitative approach were found, mostly conducted in Brazil. See tables below for findings.

## EDUCATION ABOUT HEALTH AND ENVIRONMENT

The training of nursing professionals aware of the importance of the environment has been established within the guidelines for accreditation of programs under the ARCUSUR model, that programs should guide content on Ecology and health (24).

| <b>Title</b>                                                                                                    | <b>Objective</b>                                                                                                                                                              | <b>Materials &amp; Methods</b>                                                                                                                                                                                                                                              | <b>Results</b>                                                                                                                                                                                                                                                                                                                                           | <b>Conclusions</b>                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nursing and environmental health: possibilities for action to promote health (17)                               | Understand the meaning of the participation of the members of the Subcommittee of the Rio Salgado Basin Committee                                                             | Qualitative research involving 18 members of the Subcommittee of the River Salgado Basin Committee Salgado River Basin - Brazil                                                                                                                                             | The categories were generated: the participation of social conscience, information, communication in the search for solutions that represent the community.                                                                                                                                                                                              | Nursing should include in its practice comprehensive strategies that contribute to improving the quality of life of human beings and the sustainability of natural and social biota                                                     |
| Environmental awareness in Nursing: the reconstruction of a better world with the contribution of students (18) | Identify how words and drawings issued by students in learning scenarios contribute to the formation of a strengthening of environmental awareness to the nursing profession. | Qualitative research, in which 41 graduate students in nursing from a Brazilian Institution of Higher Education participated. A semi-structured survey and the production of free drawings were used. Data analysis was carried out under the modality of thematic analysis | Three thematic units emerged: the humanization of theory and practice allows the formation of an environmental awareness; the experience-skill articulated with the pedagogical practices promote the sustainability of the environment; and socially apprehended and worked as a learning environment-environment of care strengthens nursing students. | A sustainable mentality and culture can be created in the students, in a formative environment that educates in values, so that they become social agents that promote the commitment of the conservation and protection of the planet. |
| Interface between health and the environment in health professional training                                    | Know the conception of academics from the health area on the health and environment interface, and how it is expressed in their academic experience.                          | Qualitative, descriptive-exploratory study, carried out with 24 professors from the health area of a public University. The information was collected through a semi-structured interview and the data was analyzed through content analysis.                               | The categories that emerged were health, environment and poverty, vague notions about health and the environment.                                                                                                                                                                                                                                        | 91/5000<br>It is necessary to include the subject in the training of professionals in the area of health.                                                                                                                               |
| Perception of nursing teachers on environmental issues: subsidies for nursing training (19)                     | Know the perception of nursing teachers about current environmental problems in order to obtain subsidies for reflection on nursing professional training                     | Qualitative study in which 6 nurse teachers from a University of Brazil participated. A semi-structured survey was used to collect the information, which was closed by saturation of the sample. The data analysis was performed using the content analysis technique.     | The categories of analysis that emerged were: the environment as a space of interaction and place for human existence, the current environmental problems: impacts on human life, and environmental responsibility: intertwining between the individual and professional spheres.                                                                        | In the perception fostered by the teaching nurses there is appropriation of extended and systemic discourses.                                                                                                                           |

|                                                                                                     |                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The environmental problem in view of community health workers (20)                                  | Know what community health agents think about the problematic environment.                                                                                                      | Qualitative study, in which 13 community health agents participated through a semi-structured survey. The data was analyzed through content analysis                                                                                                                                                                                                                               | Four categories were created: Conception of the environment: convergence between the natural and social environment; The environmental problem: between the impact and the need for education; Environmental responsibility: commitment to health promotion and Training: the need to overcome gaps. | There is a need to address environmental education to strengthen the competencies of community health agents in terms of health promotion, in order to help individuals and the community to deal with socio-environmental situations and to work on the prevention of diseases through exposure to environmental problems.             |
| Mitigate consequences of global warming and greenhouse effect: reflections for health training (21) | Reflect on community knowledge regarding the measures adopted by the effects of global warming, by assuming the role of social responsibility as a health training institution. | Ethnographic qualitative study. The key informants were 20 families, which corresponded to the 20 most vulnerable neighborhoods in the city of Valledupar - Colombia. The "snowball" sampling technique was used. The information analysis was carried out through data triangulation and descriptive validity, and adopted intercultural health education as an epistemic stance. | Three categories were established in a pre-established way: knowledge that people have about climate change and warming, self-care adopted by families in situations of increased temperature and characteristics of collective work in the community.                                               | There is ignorance and lack of commitment of people with the care of life and health of self and of the collective, for which it is the responsibility of the University to train nursing professionals highly sensitive to the effects of global warming and with critical capacity and social conscience to assume a competitive role |
| Health and environment (in) visibilities and (dis) continuity in nursing professional training (22) | Know the perception of teaching nurses about the relationship between health and the environment and how the subject is approached in nursing professional training.            | Qualitative study with an exploratory descriptive approach, in which 17 nurse nurses from the Federal University of Rio Grande do Sul participated. The information was collected through a semi-structured interview and the data were analyzed through content analysis.                                                                                                         | Two categories of analysis emerged: health and the environment interface: different areas, and thematic approaches in the professional training of nurses: contexts and challenges.                                                                                                                  | The participants realize that there is an intrinsic relationship between health and the environment, which is polarized, on the one hand, in a perception that it is linked to a cause and, on the other hand, in the complex perspective of ethics collective                                                                          |
| Relationship between attitudes and environmental behaviors in Nursing                               | Identify the relationship between attitudes and behaviors environmental studies in Nursing students of a                                                                        | Descriptive study of a cross section in which 190 Nursing students participated. Attitudes and environmental behaviors and their                                                                                                                                                                                                                                                   | 100% of the attitudes and 46.7% of the behaviors were rated as adequate and a relationship was found between environmental attitudes and age ( $p = 0.021$ ), as well as                                                                                                                             | Although most students have positive environmental attitudes, these are not always reflected in their behavior, making it necessary to improve the training of                                                                                                                                                                          |

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| students (23) | colombian university | relationship with sociodemographic variables.<br>The statistical correlation was analyzed using the correlation coefficient of Spearman | between environmental behavior and age ( $p = 0.001$ ) and, environmental behaviors sex ( $p = 0.012$ ). | professionals to promote the reduction of morbidity and mortality from diseases caused as a result of modifiable environmental factors |
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**ENFERMERÍA AMBIENTAL EN AMÉRICA LATINA**

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Desde los orígenes del cuidado, éste estuvo directamente relacionado con el medio ambiente porque el hombre tuvo que aprender a protegerse de los cambios extremos del clima, a utilizar las plantas para tratar las enfermedades, a elaborar herramientas de piedra y posteriormente de otros materiales, a cazar y pescar, y a utilizar los subproductos de los animales (1) en fin, aprendió a utilizar los recursos de la naturaleza para su supervivencia; no obstante, como consecuencia de las acciones humanas, se han generado problemáticas como calentamiento global, efecto invernadero, desertificación, lluvias ácidas, agotamiento de recursos naturales, desaparición de especies y la acumulación de residuos tóxicos y radioactivos en los suelos, agua y aire, generando factores de riesgo ambientales que afectan la salud de los seres humanos (2).

Un factor agravante es que en los últimos 100 años la población de la tierra se ha cuadruplicado a 7 billones de personas, de las cuales la mayoría se han concentrado en zonas urbanas, siendo la Región de América Latina y el Caribe la más urbanizada del mundo, con el 77% de la población viviendo en las ciudades, una cifra que se espera que alcance el 85% en 2030. Las ciudades pueden ofrecer mejores oportunidades y condiciones de trabajo, pero generan crecimiento no planificado y sin control, inseguridad vial y en las calles, déficit de vivienda, envejecimiento, infraestructura de servicios públicos ineficiente, el aumento de las desigualdades en el acceso a bienes y servicios de salud (3), mayor consumo de energía y mayores necesidades de transporte y por ende mayor emisión de gases a la atmósfera.

Por otra parte, en América, existen diversos ecosistemas y grandes reservas, las cuales son vulnerables debido a la deforestación, la conversión del hábitat natural para uso agrícola o ganadero o la expansión urbana; la alteración de las aguas superficiales a través de la construcción de presas, el riego, y la desviación de la corriente; así como la pérdida de la biodiversidad que se puede producir por la sobreexplotación para pesca o la introducción de especies invasoras (3).

Latinoamérica es una de las regiones con mayor riesgo de enfermedades de origen ambiental, considerando la susceptibilidad relacionada con los determinantes sociales y ambientales. Según la Organización mundial de la salud en la Región (excepto Chile) las muertes per cápita atribuibles al medio ambiente están relacionadas en su orden con enfermedades no transmisibles, por heridas y

en menor proporción por infecciones, parásitos y enfermedades neonatales y nutricionales(4). Esta región, al igual que el resto del mundo, ha sido objeto de numerosos eventos naturales extremos y desastres, relacionados con los efectos del cambio climático, los cuales agravan la situación de salud de las poblaciones más vulnerables.

### ¿QUÉ PODEMOS HACER EN DESDE ENFERMERÍA PARA CONTRIBUIR A MINIMIZAR ESTA PROBLEMÁTICA?

El ejercicio profesional de Enfermería implica la inclusión de la ética y la bioética ambiental en las acciones que realiza en cada una de las áreas de desempeño. Son varios los autores que en Latinoamérica han hecho relación a la importancia de recurrir a la ética del cuidado, de tal forma que se utilicen los recursos de forma organizada, para que el medio ambiente pueda recuperarse y continúe siendo autosuficiente. (5) Algunas de las reflexiones en relación al tema son:

- La enfermería, al adoptar acciones ecosistémicas en su quehacer cotidiano, aboga por la atención integral al ser humano y, por lo tanto, tiene la oportunidad de poner en práctica acciones de naturaleza ambiental, ecológica, física, psicológica, espiritual y social, creando así posibilidades de una atención completa e interactiva (6).
- La calidad de vida y la salud tienen una relación estrecha con los aspectos del ecosistema (7).
- La cuestión ambiental debe formar parte de los debates sobre la educación, porque este debate favorece la reflexión de las personas sobre lo que es ecológicamente sano, por lo cual enfermería debe integrar en su quehacer la educación ambiental (8)
- Enfermería debe fortalecerse como disciplina para responder a las necesidades de educación investigación y cuidado en Enfermería, acorde con las tendencias de la globalización en el mundo contemporáneo, así como los drásticos impactos en la salud humana y ambiental (9).
- El enfermero puede ser un educador ambiental y actuar en este espacio, favoreciendo la reflexión sobre las acciones que afectan al medio ambiente y el riesgo para la comunidad (10).
- Es necesario retomar el legado de Florence Nightingale como forma de valorizar la dimensión ambiental como indispensable para el proceso de asistencia a la salud, tanto en lo que se refiere a la promoción de la salud y de la calidad de vida, como la minimización del impacto ambiental proveniente del proceso de trabajo de la salud. La reflexión ética y el abordaje educativo son fundamentales en ese proceso. (11)

- El compromiso de Enfermería frente a la globalización es y su impacto sobre la salud individual y colectiva es reflexionar acerca de sus efectos en el cuidado, con la intención de contribuir en la salud para todos; analiza la importancia de reconocer la pluralidad como camino de producción del conocimiento en Enfermería y salud, así como la necesaria unión entre razón y emoción. Finalmente, discute los desafíos de la educación para la construcción de un sujeto ético, capaz de imprimir las transformaciones que el cuidado de enfermería requiere y desea para América Latina (12).
- El profesional de Enfermería es un actor importante en la promoción de la salud, sobre todo en la salud ambiental infantil y para ello requiere realizar intervenciones dirigidas a promover comportamientos que favorezcan el medio ambiente y que minimicen el riesgo de exposición a factores de riesgo ambiental.

Tal y como lo hicieron el Consejo internacional de enfermeras (CIE) y la Asociación Americana de Enfermeras, en Latinoamérica, algunas de las asociaciones o colegios de profesionales de Enfermería incluyeron en sus códigos de ética el tema de salud ambiental, así:

**Argentina, Brasil, Uruguay y Paraguay:** la Declaración de Principios Éticos, artículo 7 establece que el profesional de Enfermería tiene la responsabilidad de mantener el medio ambiente natural y protegerlo de la contaminación, la degradación, destrucción y abandono(13).

**Colombia:** el Código deontológico de Enfermería, artículo 27 señala que el profesional de Enfermería se debe abstener de promover la utilización de productos que sepa que hacen daño a los seres humanos o al medio ambiente (14).

**Chile:** el Código de ética Colegio de Enfermeras de Chile, en el numeral 7.1 establece que el profesional de enfermería debe informarse acerca de los estudios y planes de acción conducentes a detectar las consecuencias nocivas que el medio ambiente ejerce sobre el hombre, así como los planes de conservación de los recursos naturales (15).

**Costa Rica:** el Código de ética y moral profesional en su artículo 29 que el profesional de enfermería debe apoyar a las autoridades sanitarias a detectar los efectos nocivos del medio ambiente sobre la salud humana, así como en la planificación de actividades que favorezcan la conservación y sostenibilidad del ambiente y que por ende contribuyan al mejoramiento de la calidad de la salud y, en el artículo 32, establece que dentro de sus competencias está la educación sobre ambientes saludables (16).

**México:** el Código de conducta para la enfermería, artículo: 28 establece que la Enfermera tiene el deber social de buscar un equilibrio entre el desarrollo humano y la conservación de los recursos naturales y el medio ambiente, teniendo en cuenta los derechos de las generaciones futuras (17).

**Perú:** el Código de ética y deontología, artículo 16 determina que el profesional de Enfermería debe compartir la responsabilidad de mantener el medioambiente natural y protegerlo contra la contaminación, el empobrecimiento, la degradación y la destrucción (18).

Es importante identificar que a través de los Códigos de Enfermería se fomenta el cuidado del medio ambiente y la prevención de los factores de riesgo ambiental, ya que los profesionales de Enfermería están en una posición única para interactuar con la comunidad en la identificación de los miembros potencialmente vinculados a exposición ambiental (14). Enfermería como profesión histórica e ideológicamente fundamentado en los principios de bienestar, enseña una manera de replantear la cultura de cuidado (15). Hay una conexión directa entre las acciones de enfermería y la salud del medio ambiente en las agencias de cuidado de la salud. Sin embargo, en la práctica diaria de enfermería generalmente no se considera el impacto ambiental de procedimientos como la administración de un medicamento, el cambio de un vendaje, o iniciar una vía intravenosa; por ejemplo, el destino final de los envoltorios que representan los subproductos de su trabajo es una actividad casi subliminal en su rol profesional, ya que su enfoque como enfermera es más frecuente en otras prioridades (16).

### ¿QUÉ HEMOS INVESTIGADO EN LATINOAMÉRICA SOBRE ENFERMERÍA Y MEDIO AMBIENTE?

En Latinoamérica son escasas las publicaciones realizadas por enfermeras en relación al tema de salud ambiental. Al revisar la literatura se encontraron estudios con enfoque cualitativo, en su mayoría realizados en Brasil:

| Título                                                                                                                  | Objetivo                                                                                                                                                                                                    | Materiales y métodos                                                                                                                                                                                                                                                                                         | Resultados                                                                                                                                                                                                                                                                                                                                                                 | Conclusiones                                                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Enfermería y salud ambiental: posibilidades de actuación para la promoción de la salud (17)                             | Comprender el significado de la participación de los miembros de la Subcomisión del Comité de Cuenca de Rio Salgado                                                                                         | Investigación cualitativa en la que participaron 18 miembros de la Subcomisión del Comité de Cuenca de Rio Salgado Cuenca del Rio Salgado – Brasil                                                                                                                                                           | Se generaron las categorías: la participación de la conciencia social, información, comunicación en la búsqueda de soluciones que representan a la comunidad.                                                                                                                                                                                                              | Enfermería debe incluir en su práctica estrategias integrales que contribuyan a mejorar la calidad de vida de los seres humanos y la sostenibilidad de la biota natural y social                                                                                                                                                                           |
| Sensibilización ambiental en Enfermería: la reconstrucción de un mundo mejor con la contribución de los estudiantes(18) | Identificar cómo las palabras y dibujos emitidos por los estudiantes en escenarios de aprendizaje contribuyen a la formación de un fortalecimiento de la conciencia ambiental a la profesión de enfermería. | Investigación de tipo cualitativo, en el que participaron 41 estudiantes de posgrado en enfermería de una Institución Brasileña de Educación Superior. Se utilizó una encuesta semi-estructurada y la elaboración de dibujos libres. Se realizó análisis de datos bajo la modalidad de análisis temático     | Surgieron tres unidades temáticas: la humanización de la teoría y la práctica permite formar una conciencia ambiental; la experiencia-habilidad articuladas con las prácticas pedagógicas promueven la sostenibilidad del medio ambiente; y lo social aprehendido y trabajado como escenario de aprendizaje-ambiente de cuidado fortalece a los estudiantes de enfermería. | Se puede crear una mentalidad y cultura sostenible en los estudiantes, en un entorno formativo que eduque en valores, para que ellos se conviertan en agentes sociales que promuevan el compromiso de la conservación y protección del planeta.                                                                                                            |
| Interfaz entre salud y medio ambiente en la formación profesional en salud                                              | Conocer la concepción de académicos del área de la salud sobre la interfaz salud y medio ambiente, y cómo se expresa en su vivencia académica.                                                              | Estudio cualitativo, descriptivo-exploratorio, realizado con 24 profesores del área de la salud de una Universidad pública. La información se recolectó por medio de una entrevista semi-estructurada y los datos se analizaron por medio de análisis de contenido.                                          | Las categorías que emergieron fueron salud, medio ambiente y pobreza, nociones vagas sobre salud y medio ambiente.                                                                                                                                                                                                                                                         | Es necesario incluir la temática en la formación de los profesionales del área de la salud.                                                                                                                                                                                                                                                                |
| Percepción de los docentes de enfermería sobre la problemática ambiental: subsidios para la formación en Enfermería(19) | Conocer la percepción de los docentes de enfermería sobre los problemas ambientales actuales con el fin de obtener subsidios para la reflexión sobre la formación profesional en enfermería                 | Estudio cualitativo en el que participaron 6 Enfermeros docentes de una Universidad de Brasil. Se utilizó una encuesta semi-estructurada para la recolección de la información, la cual se cerró por saturación de la muestra. El análisis de datos se realizó mediante la técnica de análisis de contenido. | Las categorías de análisis que surgieron fueron: el medioambiente como espacio de interacción y lugar para la existencia humana, los actuales problemas ambientales: impactos sobre la vida humana, y la responsabilidad ambiental: entrelazamiento entre las esferas individuales y profesionales.                                                                        | En la percepción fomentada por los Enfermeros docentes existe apropiación de discursos ampliados y sistémicos.                                                                                                                                                                                                                                             |
| El problema ambiental a la vista de los agentes de salud comunitaria (20)                                               | con el objetivo de conocer lo que los agentes de salud comunitaria piensan del entorno problemático.                                                                                                        | Estudio cualitativo, en el cual participaron 13 agentes de salud comunitaria a través de una encuesta semi-estructurada. Los datos se analizaron a través de análisis de contenido                                                                                                                           | Se crearon 4 categorías: Concepción del ambiente: convergencia entre el medio natural y el social; El problema ambiental: entre el impacto y la necesidad de educación; Responsabilidad medioambiental: compromiso con la promoción de la salud y Formación: la necesidad de superar brechas.                                                                              | Existe la necesidad de abordar la educación ambiental para fortalecer las competencias de los agentes comunitarios de salud en cuanto a promoción de la salud, para poder ayudar a los individuos y a la comunidad a enfrentar las situaciones socio-ambientales y a trabajar en la prevención de enfermedades por exposición a los problemas ambientales. |

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| Mitigar consecuencias del calentamiento global y efecto invernadero: reflexiones para la formación en salud (21) | Reflexionar sobre el conocimiento comunitario frente a las medidas que adoptan los efectos del calentamiento global, al asumir el rol de la responsabilidad social como institución formadora de salud. | Estudio cualitativo etnográfico. Los informantes clave fueron 20 familias, las cuales correspondían a los 20 barrios más vulnerables de la ciudad de Valledupar - Colombia. Se utilizó la técnica de muestreo "bola de nieve". El análisis de la información se realizó mediante triangulación de datos y validez descriptiva, y adoptaron la educación sanitaria intercultural como postura epistémica. | Se constituyeron de forma pre-establecida tres categorías: conocimiento que tienen las personas sobre el cambio climático y el calentamiento, autocuidado que adoptan las familias en situaciones de aumento de la temperatura y características de trabajo colectivo en la comunidad.             | Existe desconocimiento y falta de compromiso de las personas con el cuidado de la vida y la salud de sí mismo y del colectivo, por lo cual es responsabilidad de la Universidad formar profesionales de enfermería altamente sensibles a los efectos del calentamiento global y con capacidad crítica y conciencia social para asumir un rol competitivo |
| Salud y ambiente (im) visibilidades y (des) continuidad en la formación profesional en enfermería (22)           | Conocer la percepción de enfermeros docentes sobre la relación salud y ambiente y como se da el abordaje del tema en la formación profesional en enfermería.                                            | Estudio cualitativo con enfoque descriptivo exploratorio, en el que participaron 17 enfermeros docentes de cursos de Enfermería de la Universidad Federal de Rio Grande do Sul. La información fue recolectada mediante una entrevista semi-estructurada y los datos fueron analizados mediante análisis de contenido.                                                                                   | Surgieron dos categorías de análisis: la salud y la interfaz medio ambiente: áreas distintas, y enfoques temáticos en la formación profesional de las enfermeras: contextos y desafíos.                                                                                                            | Los participantes se dan cuenta de que hay una relación intrínseca entre la salud y el medio ambiente, que se polariza, por un lado, en una percepción de que está vinculado a una causa y, por otra parte, en la perspectiva compleja de la ética colectiva                                                                                             |
| Relación entre actitudes y comportamientos ambientales en Estudiantes de enfermería(23)                          | Identificar la relación entre actitudes y comportamientos ambientales en estudiantes de Enfermería de una universidad colombiana                                                                        | Estudio descriptivo de corte transversal en el que participaron 190 estudiantes de Enfermería. Se analizaron las actitudes y comportamientos ambientales y su relación con las variables sociodemográficas. Se analizó la correlación estadística utilizando el coeficiente de correlación de Spearman R                                                                                                 | El 100% de las actitudes y el 46,7% de los comportamientos fueron calificados como adecuados y se encontró relación entre las actitudes ambientales y edad ( $p = 0,021$ ), así como entre comportamientos ambientales y edad ( $p = 0,001$ ) y, comportamientos ambientales sexo ( $p = 0,012$ ). | Aunque la mayoría de estudiantes tiene actitudes ambientales positivas, éstas no siempre se ven reflejadas en su comportamiento, haciéndose necesario mejorar la formación de los profesionales para favorecer la disminución de la morbilidad y mortalidad por enfermedades causadas como consecuencia de factores ambientales modificables             |

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## NEONATAL RISK EXPOSURE AND NICU ENVIRONMENT

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### INTRODUCTION

In the United States, over 300,000 neonates are hospitalized in the neonatal intensive care unit (NICU) each year. Studies of newborn cord blood have confirmed that developing fetuses are exposed to nearly 300 different toxic chemicals through the placenta (Environmental Working Group, 2001). However after delivery, term and preterm neonates remain vulnerable to ongoing chemical exposures due to a multitude of physiologic and environmental risk factors; found both at home and in the hospital.

### NICU POPULATION RISK

The neonatal period is defined as the first 30 days of life and is marked by rapid growth and development; physically, neurologically, and physiologically. Depending on the gestational age at birth, neonates in the NICU may have immature organ function which makes them particularly vulnerable to the adverse effects of exposure to harmful chemicals or toxicants. Harmful exposures can have long term effects on learning, behavior, and future health (Hagan, Shaw, and Duncan, 2017). Physiologic factors placing the term or even more so the preterm neonate at increased risk for environmental exposures include:

- **Increased growth velocity:** Growth velocity is highest from 0 to 9 months of life. This high growth velocity is characterized by rapid cell division, particularly in the tissues of the blood, epithelium, and lungs. This rapid cell division makes the neonate highly vulnerable to carcinogens (ATSDR, 2016).
- **Increased skin surface area to body weight ratio:** The neonate's ratio of skin surface area to body weight is roughly three times higher than in the adult. Therefore, dermal exposure and transdermal absorption of any toxicant through the skin results in

a larger dose per unit of body weight (Guzelian et al., 1992).

- **Increased skin permeability:** Increased skin permeability results in higher rates of absorption of topical chemicals. Even in the term neonate, the stratum corneum, which provides the important barrier function of the skin, is 30% thinner than that of the adult. The degree of thickness of this protective keratinized layer of skin depends upon the level of prematurity, with the most premature neonates having the most permeable skin (Telofski, Morello, Correa, & Stamatas, 2012).
- **Increased perfusion of epidermis:** Neonates have greater perfusion and hydration of their epidermis than older children and adults. This creates greater absorption of hydrophilic toxins such as phenolic compounds found in some disinfectants (Clemens & Neumann, 1989).
- **Increased respiratory rate:** Neonates have respiratory rates 2-3 times higher than the average adult. Premature neonates suffering from respiratory distress syndrome (RDS) may have respiratory rates in excess of 100 breaths per minute. Inhalation exposure can be amplified for premature neonates being cared for in incubators where air-borne toxicants cannot disperse as readily as in an open room. In addition, early exposure to air-borne contaminants has been linked to increased incidence and severity of asthma (ATSDR, 2016).
- **Immature hepatic glucuronidation and renal clearance:** Through glucuronidation, the body increases the water solubility of chemicals allowing for elimination through the urine or feces. Renal clearance is the process of plasma filtration by the kidneys that allows toxins to be eliminated in the urine. Both vital metabolic processes are immature in the neonate resulting in a decreased ability to clear toxins (Ku & Smith, 2015).

### COMMON TOXICANTS IN THE NICU

#### Heavy Metals

Lead, mercury, arsenic and cadmium are all potent neurotoxins and are known to cause developmental delays and other chronic conditions in neonates and growing children. These heavy metals can be transferred from the mother to the fetus through the placenta or to the newborn or infant through human milk. Methylmercury is a well known neurological teratogen, and neonates are highly vulnerable to its adverse effects and even short-term exposure can cause developmental delays and

neonatal seizures. In some populations methylmercury has been detected in human milk which can extend a neonate's exposure even after delivery (Falck, Mooney, Kapoor, White, Bearer, El Metwally, 2015).

### Volatile Organic Compounds (VOC)

Volatile Organic Compounds are chemical compounds released into the air from solid objects, such as plastic PVC products or building materials, such as plywood and household paint. According to the American Lung Association, breathing VOCs can irritate the eyes, nose or throat, and can cause respiratory distress, damage to the central nervous system, and has been linked to some cancers. Exposure to inhaled VOCs has also been linked to increased urinary biomarkers for oxidative stress and systemic inflammation (Icahn School of Medicine at Mount Sinai, 2019). VOCs may be present in the NICU and can exert a negative effect on staff, visitors, and our tiny patients. Remodeling projects in the NICU, even simple ones like a new coat of paint, should strive to use building materials, paint, and furniture with low or no-VOC's whenever possible.

### Phthalates

Phthalates are a group of chemicals known as plasticizers that are commonly used in the manufacture of polyvinyl chloride (PVC) products and in fragrance-laden lotions, soaps, and shampoos. The chemical structure of phthalates is similar to endogenous steroid hormones (e.g. estrogen) so when phthalates are present in the bloodstream they can interact with steroid receptor sites on the cell, causing an endocrine disrupting effect. Increased levels of phthalates and phenols have been linked to a multitude of adverse health effects including asthma, attention-deficit hyperactivity disorder, breast cancer, obesity, type II diabetes, low IQ, neurodevelopmental issues, behavioral issues, autism spectrum disorders, altered reproductive development and male fertility issues (LaRocca, Binder, McElrath, & Michels, 2015).

There are various types of phthalates utilized as plasticizers in the manufacture of medical products commonly used in the NICU. Phthalates are a danger to neonates as they easily leach from a solid plastic material into the air, fluids, or food they contact and cause an exposure. This leaching process may be increased in high heat or humidity conditions such as inside neonatal incubators, when intravenous catheters are exposed to body heat, and when using heated humidified respiratory support circuits.

Phthalates are also commonly used in the manufacturing of "fragrances", including the fragrances added to

traditional baby skin care products and shampoos to create that familiar "new baby smell". Starting in-utero, neonates can be exposed to phthalates from the products used by their mother, such as cosmetics, personal care products, and perfumes. These early fetal and neonatal exposures have been linked to poor executive functioning, psychological/psychosocial issues such as depression, inattention, and impaired emotional regulation later in life (Falck et al., 2015).

### Phenols

Phenols are manufactured chemical compounds used in disinfectants and plastic products. Like phthalates, phenols are endocrine disruptors, and studies are ongoing to determine their association with a number of adverse effects including breast cancer and the early onset of puberty. While bis-phenol A (BPA) has been removed from a wide variety of plastic products, including most plastic baby bottles, other sources of phenolic compounds remain in use in the hospital, in the NICU, and in the home including Triclosan [5-chloro-2-(2,4-dichlorophenoxy)-phenol] (TRCS) which can be found in cleaners, hand sanitizers, toothpaste, and other personal care products.

### Polyethylene glycol, 1,4-dioxane and other ethylated surfactants

Products with ingredients that contain the letter "eth"—such as polyethylene, polyethylene glycol (PEG), and SLS (sodium Laureth sulfate) — should heighten ones suspicions to the possible presence of the toxic contaminant 1,4-Dioxane. During the manufacturing process, PEG and its derivatives can become contaminated with 1,4-Dioxane and ethylene oxide, which are known carcinogens and nervous system toxicants.

Sodium laureth sulfate is often added to products to produce the "bubbly and sudsy" properties of soaps, shampoos, and even toothpaste and exposure may be toxic or harmful to adults and children (SkinDeep, 2019). Polyethylene glycol (PEG) is a petroleum-derived ingredient added to body care products to thicken, soften and to act as moisture-carriers in cosmetic creams; and it is used as a laxative in pharmaceuticals (David Suzuki Foundation, 2019).

Although 1,4-Dioxane can be vacuum stripped from PEG and SLS after manufacturing the FDA does not require that product labels include this disclosure which leaves consumers unsure if the product is contaminated with 1,4-Dioxane. It has been estimated by the Environmental Working Group (EWG) that 57% of all baby soaps are contaminated with 1,4-Dioxane. A study of lactation

transfer of chemicals in human milk concluded that 1,4-Dioxane was among the top 3 of 19 different chemicals that posed the highest exposure risks to infants (Lawrence & Lawrence, 2015). 1,4-Dioxane can be transferred through breast milk and has been known to cause miscarriages and stillbirths when combined with other chemical exposure. The Environmental Protection Agency has classified 1, 4-Dioxane as a carcinogen, it can also cause kidney and liver damage and short term irritation to the eyes, nose and throat in adults. No adverse effects have been studied in the neonatal population (Wilbur, 2007).

### Parabens

Parabens are often used as preservatives in personal care products; from baby lotions to deodorants. Parabens may appear on a product's label in various combinations (i.e. butylparaben, propylparaben, etc) and may even be disguised as other names, such as benzoic acid or propyl ester. As with phthalates, parabens are potent endocrine disruptors with strong estrogenic effects, as well as neurotoxicant potential. High doses of parabens can cause hyperbilirubinemia and bone abnormalities. (Cuzzolin, 2017). Parabens typically enter the body through the skin and have been detected in blood samples confirming a systemic absorption from topical exposures and have been linked to breast cancer, as well as reproductive toxicity (Sattler, Randall, & Choiniere, 2012). The Center for Disease Control (CDC) found that the blood of over 60% of children surveyed by the National Center for Environmental Health was contaminated with significant levels of parabens. Most governments around the world have not examined the safety of parabens, an exception is Denmark, which has banned parabens in products for children under 3 years of age (Preethi, 2018).

### POTENTIAL EXPOSURE SOURCES IN THE NICU

#### Bathing and Skin Care

Bathing and skin care products for infants, including soaps, shampoos, lotions and creams are used universally whether the infant is in the home and in hospital and are therefore, a significant source for chemical exposures beginning on the first day of life.

Although recent trends have shown cosmetic and skin care companies rebranding and removing parabens and phthalates from their adult products, these chemicals still remain behind in many popular products marketed for newborns and infants. Phthalates are used to help lotions penetrate and soften the skin, and to help fragrances last longer. Baby powder, lotion, and shampoo with added synthetic fragrance have the highest phthalate

concentrations and should be a top priority to be removed from the NICU or at a minimum replaced with safer products which are widely available through hospital purchasing contracts worldwide.

Powders are not recommended for daily use in NICU patients and infants for several reasons. The main substance causing a concern is baby powder. First is the fact that talc is used to create talcum powder, which in turn is used in the formulation of baby powder, which naturally contains asbestos. As recently as 2019, brand name baby powders were removed from the shelves for concerns of asbestos contamination (Dyer, 2019). Second, is the potential aspiration of the talc powder "cloud" into the lungs during use causing a pneumonic reaction, which could lead to aspiration and respiratory distress in some infants (Moon et al, 2011). Most powders also contain synthetic fragrances, which has previously been discussed as a concern. Last and certainly not least, there have been a few recent lawsuit settlements to women who alleged their daily use of Johnson's & Johnson's talcum powder was linked to their diagnosis of ovarian cancer (Dyer, 2019).

#### Diapers and Diaper Care

Every day in the NICU, hundreds if not thousands of diapers are changed, diaper wipes are used and discarded, and dozens of tubes of diaper cream are used. Unfortunately, these common practices also pose many hidden dangers when it comes to exposures to toxic chemicals. Most disposable diapers are made of polypropylene and polyethylene, which are considered to be "safer" plastics. However, when these materials are exposed to heat (like inside a baby's diaper) they can seep a toxic metalloid, known as antimony, into the skin. Another concern with disposable diapers is the presence of dioxins, which have been named "supertoxins" and is a known carcinogen. Dioxins are by-products of the chlorine manufacturing process and are likely present whenever chlorine bleach, bleached paper or products are used. Dioxins can cause skin lesions and affect the liver, reproductive, nervous, immune and endocrine system (WHO, 2016). In the past, commercial diapers used mostly bleached paper pulp, however consumer pressure over the last decade has moved many brands to switch to a non-chlorine bleaching process to whiten materials used in baby diapers. Along with chlorine and plasticizers disposable diapers may also contain dyes and fragrances, which are all well-known skin irritants.

Disposable baby wipes and diaper rash creams are another staple of baby care, and unfortunately can be heavily laden with chemicals. As mentioned before,

phthalates and parabens can likely be found in any product that contains added synthetic fragrances or preservatives. These ingredients can be absorbed during topical application and may potentially cause endocrine disruption, and developmental and reproductive toxicity (SkinDeep, 2019).

Some baby wipes contain ethylated surfactants to enhance cleaning of stool from the skin, which creates the opportunity for additional exposure to the contaminant 1,4-dioxane which may be irritating to sensitive skin. In the NICU, many infants already have broken or irritated skin and the use of these added surfactants could make their skin condition worse and may result in additional absorption of these harsh and harmful chemical additives into their bloodstream.

### Artificial Nipples and Bottles

In the last decade, BPA has mostly been removed from all plastic bottles and nipples due to enormous consumer pressure and legislative actions by a few US States. Silicone nipples are now recommended instead of rubber, glass bottles are preferred to plastic, and there is a recommendation to also avoid plastic liners for bottles whenever possible. Even though BPA has been removed from the actual bottle itself it may still be found in the lining material of powdered formula cans or the plastic lids on liquid formula bottles. In the NICU, it is standard practice to warm milk or formula, however heating and reusing plastic bottles can cause an increase of chemicals leaching into the milk (EWG, 2019).

### Medical Devices and Accessories

Products such as endotracheal tubes, oxygen masks, nasal prongs or cannulas, venous or arterial catheters, enteral feeding tubes, and parenteral nutrition bags are typically manufactured from phthalate treated PVC (Demirel, Coban, Yildirim, Dogan, Sanci, & Ince, 2016). One of these phthalates, Diethylhexyl phthalate (DEHP) is the most common plasticizer for PVC in medical products. Multiple studies have linked the use of DEHP products to increased phthalate and phenol levels in the urine of NICU patients. A European study measured chemicals from products commonly utilized in the pediatric intensive care unit (PICU), and found that the products were leaching a number of harmful or potentially harmful chemicals including DEHP into the body (Malarvannana, Onghenaa, Verstraete, Puffelenc, Jacobs, Vanhorebeek, Verbruggen, Joosten, Van den Berghe, Jorens, & Covaci, 2019).

In the United States, DEHP alternative products are becoming more widely available, however, many NICUs

still utilize phthalate containing medical devices. One recent study found that NICU patients requiring respiratory support through plastic circuits had 95-132% higher levels of phthalate biomarkers in their urine compared with neonates not requiring respiratory support (Mount Sinai, 2018). On the positive side, over the last few years, phenols such as BPA plasticizers have been replaced in most polycarbonate plastic products used daily in the hospital such as intravenous administration sets, syringes, and catheters (Duty, Mendonca, Hauser, Calafat, Ye, Meeker, Ackerman, Cullinane, Faller & Ringer, 2013) but they have not been eliminated completely from all products used in the NICU.

### Parenteral Nutrition

Total Parenteral Nutrition (TPN) is a life saving measure to provide adequate nutrients, fluid intake, and the metabolic demands of premature and/or ill infants. Not with-standing the benefits of TPN, there are several risks associated with its long-term use as well, such as liver injury, infection, cholestasis and direct hyperbilirubinemia. Most IV catheters, tubing and other TPN associated products are made of products that expose neonates to phthalates, parabens and other toxins (Oznur, Dilara, Turkan, 2019).

Aluminum is a common contaminant in TPN additives, primarily calcium and phosphate. Overall, TPN accounts for almost 90% of aluminum exposure in neonates. Neonates with aluminum exposure are at an increased risk of a learning delay later in life as well as issues associated with cholestasis from accumulation of aluminum in the liver (Fortenberry, Hernandez & Morton, 2017; Popinska, Ksiazek, Friedman-Gruszczynska, Nowicka, Migdal, & Pietraszek, 2009). Physicians and researchers agree that a decrease in aluminum contamination from TPN additives is desirable but unlikely due to a lack of alternative products (Griffin, 2019).

### Formula and Human Milk

Formula fed infants are at risk for chemical exposures through several separate mechanisms. First, powdered formula and liquid formula concentrate must be reconstituted using water which places the neonate at risk for exposure to water-borne toxicants. Therefore, filtered tap water is recommended when reconstituting powdered or liquid formula. If using bottled water, it should always be fluoride free. Canned formula may contain dangerous chemicals, such as BPA or other phenols found in the inner lining metal cans which can leach into the liquid or powders with prolonged contact. It is recommended by the EWG to use liquid, ready-to-feed, formulas in plastic

or glass bottles in lieu of canned powdered formulas whenever possible (EWG, 2019). Additionally, studies have found toxic contaminants and heavy metals in formula which may be byproducts of raw materials or from the manufacturing process. The American Academy of Pediatrics and other leading organizations recommend breastfeeding and/or providing human milk whenever possible. However, even an exclusive human milk diet for the neonate may also pose a risk to the neonate for toxicant exposure depending on the maternal chemical body burden and ongoing environmental exposures such as contaminated drinking water. Maternal exposures directly affect which chemicals and/or toxins are transferred via human milk to the neonate (Lawrence & Lawrence 2015).

### Disinfectants and Antiseptics

Hospital policies are highly focused on maintaining an aseptic environment, especially in the NICU environment. Topical antiseptics are used in every health care setting, but they are not without risk such as chemical burns, systemic absorption, and toxicity. Skin antisepsis prior to skin breaking procedures is widely practiced, and protocols vary regarding gestational age guidelines for the type of antiseptic agent utilized. Products of concern in the NICU are betadine (povidone-iodine) and chlorhexidine (CHG).

Premature neonates and those with non-intact skin are particularly at risk to toxic exposure as studies have found CHG detected in the blood of preterm infants two to three days following topical application (Chapman, Aucott, Gilmore, Advani, Clarke, & Milstone, 2013). While it is known that some systemic absorption of CHG occurs, it is not known what level of serum concentration may cause harm in neonates. Several in vivo, in vitro, and animal studies have raised concerns regarding cytotoxic and neurotoxic effects, as well as disruptions in thyroid function (Chapman, Aucott, & Milstone, 2012). Betadine (povidone-iodine) is also known to cause thyroid dysfunction and reproductive toxicity. Topical application in neonates less than 32 weeks should be avoided and excess iodine should be removed promptly from the skin of any neonate post-procedure to minimize cutaneous injury and systemic absorption (Williams, Watson, Day, Soe, Somisetty, Jackson, Velten, & Boelen, 2017).

A concern related to topical and surface disinfectants is the noxious scent. The olfactory system of the neonate has been shown to aid in promoting oral feeding, pain reduction and maternal-infant bonding (Van et al, 2017). The sense of smell is developed in utero around 8 week's gestation and is recognized by neonates around 24 week's

gestation. This leads us to determine that infants, especially premature infants, have a higher risk of repeated and chronic exposure to noxious scents which have harmful, unintended consequences (Lipchock et al, 2011). All noxious stimuli, including scents, can lead to neurodevelopmental issues later in life (Santos et al, 2015).

### Air Quality

Air quality is yet another potential source for chemical exposures, especially for air pollutants, such as VOCs and airborne particles. Neonates may be exposed to several VOCs in the NICU environment and specifically within the microenvironment of the incubator. Studies have found elevated levels of the VOC cyclohexane in unused incubators raising the concern for exposure through inhalation. Airborne particulate matter (PM) including airborne particles are concerning in the NICU as inhalation of these particles has been associated with adverse health effects including increased mortality and respiratory morbidity (Bhangar et al, 2016). While studies have shown that exposure is increased with higher temperatures and humidity in incubators, more research is needed to determine if this is consistent in all types of incubators and what other factors contribute to issues with air quality such as combined medication exposure, maturation of toxins, and do infants on supplemental oxygen have less of an exposure risk than those not (Brion, 2008).

## STRATEGIES FOR PROMOTING A SAFER NICU ENVIRONMENT

### Demand for "Greener" Practices and Supporting Parents

Just as consumer pressure over the last decade has pushed the cosmetic and household industry to remove potentially harmful ingredients from the products they make, patients have also begun to express their preferences and expectations for "greener" products in the hospital and in the NICU environment.

One in five consumers report preferring alternatives to traditional medicine, and twelve percent report that they would prefer natural remedies over prescription medications (Samueli Institute, 2010). Over the last decade we have all seen an increasing demand for complementary and alternative health products and practices by all patient populations, and in the NICU we have seen some practices such as probiotics, acupuncture and aromatherapy increase in use too. Despite this trend, families with preferences for "organic" products, foods and clothing are often labeled by NICU staff as "difficult", "uneducated", or "hippies". These attitudes and names create a barrier to open communication, family-centered

care, and collaboration. It is recognized that the purchasing practices in hospitals may be slow to change, but it is the hope of the authors that NICU policies of the future will allow for families to provide alternative, and potentially safer, products for their infant; especially when the hospital does not have access to them or they are not yet part of the standard of care.

### Essential Oils

Essential oils are highly concentrated volatile compounds distilled from the bark, flowers, leaves and roots of plants and provide aromatic scent with many known therapeutic benefits. Studies have proven that neonatal massage is beneficial to neonates, especially those in the NICU. Massages can be done with sunflower or grapeseed oil and may at times include diluted essential oils for term infants.

There is limited research on the use of essential oils in the premature neonatal population. However, evidence is beginning to accumulate for term infants. A clinical trial is underway in Kentucky to investigate the use of aromatherapy patches of lavender and chamomile to calm infants with Neonatal Abstinence Syndrome (NAS) and their pilot data showed a reduction in the length of stay as well as the amount of pharmaceutical intervention required. In this study, the aromatherapy patches were placed in the infant's environment, not on the skin (Daniel, 2017). A randomized control trial from a NICU in Iran showed positive results for pain control during venipuncture blood sampling when term infants were exposed to 8 hours of the scent of lavender at night and then again at the time of blood draw (Razaghi, Hoseini, Aemmi, Mohebbi, & Boskabadi, 2015). Of importance to note is that both studies, although both small samples, also showed no negative reactions to the use of scent for these populations.

### Creating Safer NICUs for Babies

In this chapter the authors have discussed the primary sources of exposure in the NICU, the potential health effects of these harmful chemicals, as well as the unique developmental characteristics that make neonates additionally vulnerable to these exposures. We have shared that skin care products made for babies, diapers, feeding systems, medical devices, and accessories, TPN, infant formula, human milk, disinfectants, antiseptics and poor air quality all carry a significant risk of chemical and/or toxin exposure to neonates in the NICU and even after discharge to home. While not all products used in the NICU have safer alternatives, many do.

Hospitals, and NICU nurses in particular, should be diligent in adopting the "Precautionary Principle" (i.e. better safe, than sorry) in their purchasing practices and when choosing equipment and products for the NICU. NICU nurses need to become strong advocates for purchasing policies that limit, if not eliminate the ongoing use of any product that could potentially be harmful or contribute to long-term detrimental health effects in NICU patients. For example, disposable diapers and skin wipes that are fragrance, chlorine, and dye free should be made available for purchase by special order for the NICU or through existing group purchasing organization contracts. Skin care and bathing products currently in use in the NICU can be easily evaluated at the EWG's SkinDeep® Cosmetic Database ([www.ewg.org/skindeep](http://www.ewg.org/skindeep)) and many non-toxic alternatives are widely available to hospitals worldwide.

Some medical grade equipment (ventilators, monitors, beds, etc.) do not yet have "healthier" alternatives due to product necessity, availability, cost, and safety, however, it is vital that nurses become a significant voice on purchasing committees, not only to evaluate products for patient safety and efficacy of "greener" products, but also to advocate for the development of safer alternative products directly with manufacturers and vendors when not yet available. A recurrent theme in all literature related to creating more sustainable hospital environments, including NICUs, is cost. Although this may be an initial deterrent, the main barrier to implementation is the overall lack of knowledge about alternative products and the potential health benefits of sustainable, eco-friendly, non-toxic products in the NICU. Awareness and continuing education are key to advancing these initiatives and create more green, sustainable NICUs in the future and safer environments for our tiniest patients, their families, and staff.

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# Unit V:

## *Sustainable Communities*

### WHAT ARE SUSTAINABLE COMMUNITIES?

The term “sustainable communities” refers to a goal to ensure survivable communities globally. Sustainable communities use resources to meet current needs while considering the needs of future generations. Elements of sustainability include safe and healthy housing, transportation that reduces harmful exposures to the environment and provides opportunities for all citizens to engage in community life, access to healthy and affordable foods, smart growth, and social and economic opportunities all supported by involved community members.

For more than 25 years, civic groups, local communities and non-governmental organizations have worked to advance sustainable living. The [Institute for Sustainable Communities](#) has partners in the United States, China, Vietnam, Thailand, Bangladesh and India. There are [videos](#) online that show the work of sustainable cities, towns and neighborhoods.

Since 2009, the US Federal Government has a program entitled the [Partnership for Sustainable Communities](#) that is composed of three federal agencies: the U.S. Department of Housing and Urban Development (HUD), U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA). The goal of the partnership is to protect the environment while improving access to affordable housing, increasing transportation options and lowering transportation costs. According to their website, the “Partnership for Sustainable Communities (PSC) works to coordinate federal housing, transportation, water, and other infrastructure investments to make neighborhoods more prosperous, allow people to live closer to jobs, save households time and money, and reduce pollution. The partnership agencies incorporate six principles of livability into federal funding programs, policies, and future legislative proposals” (PSC, 2016).

Successful projects sponsored by the partnership include [Bridgeport, CT](#), [Greenville, SC](#) and [Milwaukee, WI](#). In addition, other examples of communities that have developed programs for sustainable communities include those supported by the [Making a Visible Difference in Communities](#) program of the EPA, as well as [Smart Growth](#) initiatives.

### INTRODUCTION

Unit 5 includes a discussion about Green Buildings, which is a topic that many nurses are likely to know about as a result of the current efforts to build environmentally responsible workplaces. The Green Cleaning in Homes chapter provides information and resources to inform nurses about healthier choices for cleaning products. Unit 5 also addresses transportation concerns, Brownfields in communities, and antibiotic use in agriculture. These topics impact the health and well being of community residents. The chapter, Environmental Justice, builds upon the issue of health disparities related to the social determinants of health. While communities work to foster social and economic health and well-being, hazardous exposures impact community citizens differently. This chapter addresses both the development of the environmental justice movement, the federal and state mandates developed in response to this movement and efforts by community members to address injustice and work toward healthy sustainable communities.

## ECOLOGY, ECOSYSTEMS, AND WATERSHEDS

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The word **Ecology** originated in the late 19th century and was first called oecology from the Greek oikos that meant ‘house’ + –logy. The Oxford English Dictionary defines ecology as the branch of biology that deals with the relations of organisms to one another and to their physical surroundings. An additional definition is the political movement that seeks to protect the environment, especially from pollution (OED, 2015).

**Ecology** refers to the study of any living thing in relation to its environment. Darwin, around the year 1859, classified the “[web of life](#)” and acknowledged the immense complex set of interrelationships that existed between organisms and their environment (Sattler, 2009). Similarly, **ecosystem** describes the active communities of microorganisms, plants, and animals, along with the lifeless environment in which they live (Allender, 2014). Rainforests are Earth’s oldest living ecosystems that cover only 6% of the earth’s surface but end up housing more than ½ of the earth’s plant and animal life (SRL, 2014). According to the [Environmental Protection Agency](#) (EPA), **watersheds** are lands where the water that is found under it and drains to the same spot. The well-known scientist geographer, John Wesley Powell described a watershed as “that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community.” A watershed describes an area of land that contains a common set of streams and rivers that all drain into a single larger body of water, such as a larger river, a lake or an ocean. For example, [the Mississippi River watershed](#) is an enormous watershed (mbgnet, 2002).

There is a simplified version of the several different levels of ecologic systems that exist and are mentioned above. This simplified version is broken down into two levels, the [microsystem](#) and the [macrosystem](#). The microsystem can be thought of as the environment that is directly surrounding the individual, for instance their family and household. On the other hand, the macrosystem is the broader framework, in which the microsystem is embedded. The macrosystem consists of one’s culture, their traditions, customs, societal norms, governmental agencies, schools, organizations, economic policies and the physical environment (Sattler, 2009). The relationship between [Commoner’s Law](#) and these ecological systems can be compared as “everything is connected to everything else and everything must go somewhere.” Ecosystems help regulate water, gases, waste recycling,

nutrient cycling, and biology as well as provide recreational and cultural opportunities for human use. The scientific analysis of **ecosystems** is critical to understanding of environmental health impacts on human health; this synergistic relationship among human beings and the environment has impacts along the human development continuum.

Further, a **watershed** can provide several ecosystem services like “nutrient cycling, carbon storage, erosion/ sedimentation control, increased biodiversity, soil formation, wildlife movement corridors, water storage, water filtration, flood control, food, timber, recreation, and reduced vulnerability to invasive species, the effects of climate change, and other natural disasters”. Rainforests provide food, water, and oxygen to the rest of the world, and its temperate and tropical rainforests have a dramatic relationship with climate change since it helps regulate earth’s temperature and its weather patterns (The Nature Conservancy, 20015).

An increase in human demands, like home heating and cooling, causes an increase in the use of fossil fuels, like natural gas, oil, and coal. Burning fossil fuels releases toxic chemicals that create air pollution and contribute to global warming (Allender, 2014). Global warming then has impacts on ecosystems and watersheds throughout the world; thus the delicate balance within ecosystems and watersheds with the resultant weather and environmental impacts continues to impact climate change and its consequences of poor water quality, air pollution and drought.

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## GREEN CLEANING, DISINFECTING, AND SANITIZING IN HOMES

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### WHY GREEN CLEANING IS RECOMMENDED IN HOMES

Exposure to potentially toxic substances is often a result of common household activities. The Environmental Protection Agency (EPA) found levels of common pollutants to be 2 to 5 times higher inside homes than outside, regardless of the home's location (EPA, n.d.a.). Health effects from chemical exposures include eye, nose and throat irritation, headaches, nausea, contact dermatitis, and central nervous system dysfunction. Inhalation of respiratory irritants is a common trigger of asthma symptoms. Many toxic chemical cleaning products are not only more expensive than more natural methods, they also end up in the water systems after rinsing, and in landfills after disposal of unused products. Some cleaning chemicals are known or suspected to cause cancer in humans (EPA, 2012).

One way to avoid the exposures to potentially toxic chemicals is to read labels carefully. Non-toxic commercial products are available to the consumer who is willing to do some research. The market is full of products that claim to be "all natural", "safe for the environment" or "biodegradable", but these terms are not subject to guidelines for their use. When looking for environmentally safe products, the Environmental Protection Agency has an on-line resource for their Safer Choice Program. This program was developed from the earlier, "Design for the Environment" (DfE) program. Products with the Safer Choice designation have been evaluated for human health and environmental risks, including risk to fish. This is a voluntary program for companies that make cleaning products to participate and demonstrate that their products meet the EPA Safer Choice Standard (EPA, n.d.b.). Consumers can check if specific products that have been approved have the EPA's "Safer Choice" label by checking the EPA Search Safer Choice Products website at: <https://www.epa.gov/saferchoice/products>. Look for the Safer Choice label when purchasing cleaning products.



Reprint of EPA Safer  
Choice Label (2021),  
reproduced as part of  
public domain.

Manufacturers are not required to list the content of cleaning products; however, household products should carry the following warnings if applicable:

- Caution – slightly toxic
- Warning – moderately toxic
- Danger – highly toxic
- Poison—use precautions to avoid exposure (Findley & Formicelli, 2009).

Reading the product labels and using the product as directed is the first step in reducing health risks to the user and those in the home. Sprays, especially aerosols, can linger in the air for hours or days. If used on a

regular basis, the result is chronic inhalation of chemical substances. This is important to consider in light of the increasing popularity and frequent (often continuous) use of air "freshening" and scenting candles, sprays, plug-ins, etc. A clean home will be odorless; however, many American consumers have become fond of scenting their home. There are effective ways to ensure that your home has a pleasant scent without using expensive commercial scenting products, for example using flowers or essential oils.

### SAFER CLEANING PRACTICES IN HOMES

The COVID-19 pandemic highlighted the importance of handwashing and keeping our homes and workplaces clean to reduce the environmental risk of a pathogen such as the SARS-CoV-2 virus. However, when selecting products and cleaning methods we must consider what is the purpose of our cleaning and understand commonly used terms. To reduce exposure of family members to chemicals in the home, greener cleaning products can easily be made from common household ingredients. Many of these cleaning substances have been used effectively for years, but have fallen out of favor due to the successful marketing of "new and improved" methods.

Cleaning, disinfecting, and sanitizing are frequently used interchangeably, but they have very different meanings. *Cleaning* involves removing the dirt and debris on surfaces or objects (CDC, n.d.a.). Soap or a detergent can be used to clean. If everyone in the household is healthy and does not have an infectious disease, general cleaning is

appropriate using soap or a detergent. According to the CDC, cleaning frequently used surfaces removes most pathogens, such as viruses (CDC, 2021). If someone within the home has an infectious disease such as strep throat or the seasonal flu, disinfecting may be needed. Before disinfecting, cleaning of the area or object must occur; then *disinfecting* is done to kill pathogens, such as bacteria. Safer disinfectants have hydrogen peroxide or alcohol as the active ingredient (EPA, n.d.b.). Avoid products with ammonia or bleach and NEVER combine bleach and ammonia; as together, these chemicals create a toxic gas. When using a disinfectant, be sure to follow the instructions and leave on the surface or object for the time directed on the label (CDC, n.d.). *Sanitizing* is done to reduce the overall number of pathogens. Sanitizing is typically reserved for areas where many people come together and there is a risk of infections such as a restaurant or clinic. Examples of sanitizing are using a dishwashing machine or antibacterial wipes (CDC, n.d.).

Some people prefer to use fewer chemicals within their homes to reduce exposure of family members to chemicals. These home recipes that have been used effectively for years, but have fallen out of favor due to the successful marketing of more convenient manufactured products. It is important to note that many of these home recipes have not been tested and often people do not follow the recipe and make their own adaptations. Thus, this is a challenging area to study for safety and efficacy. Nevertheless, we are sharing some common techniques of green cleaning in the home. These products are only recommended for cleaning and not for disinfecting or sanitizing. This is an area for further nursing research.

## CLEANING BASICS

One strategy for keeping the home clean is to reduce clutter, which in turn reduces dust. In addition, some houseplants are effective at removing toxins from the air. Through photosynthesis, houseplants use carbon dioxide and emit oxygen and can remove a significant amount of toxic chemicals from the air. Recommended plants include English Ivy, ferns, and rubber plants (Leader, 2013).

Avoid using “antibacterial” soaps and cleaners as they are unnecessary for cleanliness and can be harmful. Many antibacterial products contain triclosan, which has been associated with endocrine system disruption, environmental pollution, and the increasing emergence of drug-resistant strains of bacteria. In addition, antibacterial soaps offer no additional health benefits over washing with soap and water (U.S. Food and Drug Administration, 2013).

Basic cleaning ingredients include the following:

- Distilled water (for mixing ingredients – works better than tap water)
- Baking soda (abrasive)
- Liquid dish soap (non-toxic formula)
- White vinegar (deodorizer, disinfectant)
- Hydrogen peroxide (disinfectant, whitener)
- Lemons (disinfectant, deodorizer, degreaser)
- Spray bottle
- Essential oils (optional, for scenting).  
Suggestions: lavender, lemongrass, lemon, lime, orange, cinnamon, clove, pine, rose, tea tree.
- Cotton rags (recommended over commercial products that are often made from plastics) (Dadd, 2011; Findley & Formicelli, 2009)

Other helpful items for specific purposes include the following: activated charcoal (deodorant), raw potatoes, (to remove rust from cookware), isopropyl “rubbing” alcohol (disinfectant), and newspapers (use for window washing instead of paper towels).

## RECIPES FOR HOME-MADE CLEANING PRODUCTS (adapted from Dadd, 2011 and Findley & Formicelli, 2009)

### All-purpose Cleaner:

- 1 part white vinegar
- 2 parts liquid soap
- 4 parts water
- 2-3 drops of essential oil (optional) for scenting

Mix ingredients in a spray bottle. This mixture can be used as a basic cleaner for kitchen and bath surfaces, as well as a window cleaner.

### Disinfectant:

- White vinegar **or**
- Hydrogen peroxide
- (do not mix)

Wipe with straight white vinegar, followed by hydrogen peroxide for particularly messy clean-ups, for example after handling raw meat. For best results, use hydrogen peroxide from a bottle that has been open for less than six months.

### Abrasive Scrub:

- Baking soda
- Liquid soap

Place baking soda in a dish. Add soap until it makes a paste; dilute with a small amount of water if desired for a looser mixture. Apply to a sponge or brush and scrub.

### CLEANING A HOME, SPECIAL TOPICS

(adapted from Dadd, 2011 and Findley & Formicelli, 2009)

#### KITCHEN

##### Oven:

- 2 cups hot water
- 1 tablespoon liquid soap
- 1 teaspoon baking soda

First, remove as much soil as possible by scrubbing with crumpled aluminum foil or newspaper. Mix ingredients, apply to soiled areas, let stand for 20 minutes and wipe off. Repeat as needed.

##### Drain (with garbage disposal) Opener:

- 1 quart hot water
- 1 tablespoon of liquid soap

Boil water, then add soap. Pour directly into the drain.

##### Grill Cleaner:

Crumple aluminum foil into a ball and use as a scrub.

##### Rusty Cookware:

Cut a raw potato in half. Dip the cut end in salt or baking soda and use as a scrub.

#### BATHROOM

##### Toilet Bowl Cleaner:

- 1 cup vinegar
- ¼ cup baking soda

Mix ingredients and let sit for 15 minutes to a few hours in the toilet bowl (Overnight is another suggested method). Scrub and flush.

##### Drain Opener:

- 1 cup vinegar
- ½ cup baking soda

Combine the ingredients and pour into the drain. Let sit for 15-20 minutes. Rinse with hot water. Repeat if necessary or leave the mixture to sit overnight.

##### Mold/Mildew Remover:

- 2 parts water
- 1 part hydrogen peroxide

Mix ingredients and spray affected area. Let stand for 10-15 minutes and wipe clean. (Note: hydrogen peroxide may bleach surfaces such as wallpaper, linens or clothing.)

##### Mirror cleaner:

Use all-purpose cleaner, above. Or half vinegar and half water.

##### Tub and tile cleaner:

Use abrasive scrub, above.

#### LIVING AREAS

##### Dusting/Furniture Polish:

- Lemon or pine essential oil
- Liquid beeswax

Mix the ingredients and apply a small amount to a lint-free cotton cloth and wipe surfaces.

##### Windows:

Use the all-purpose cleaner, above. Wipe with newspapers.

##### Air Freshening:

Baking soda is a traditional and effective odor eliminator. Place an open box in areas where odors accumulate. Some ideas for home scenting include:

- Add essential oils to an aromatherapy infuser. Alternately, mix an essential oil with water in a spray bottle and spritz the air or surfaces. (Try a small amount first to make sure the oils do not stain fabrics.)
- Decorate with fresh or dried flowers, herbs, or citrus
- Simmer aromatics (e.g., citrus fruits or cinnamon) to combat cooking odors.
- Soy candles with essential oils are available commercially.
- Remember to bring in some fresh air from time to time. Even in winter, on milder days briefly open a window a few inches.

#### CLEANING CLOTHING

##### Washing:

In general, washing machines clean clothing in cold water as effectively as in hot or warm water. Hot water is needed only for heavily soiled items (such as diapers) or greasy items.

- 1 bar natural soap, shaved
- 1 cup borax\* or baking soda
- 1 cup washing soda

Combine the ingredients and store. If a liquid detergent is desired, use liquid (e.g., castile) soap and heat the ingredients in enough water to cover and mix.

\*Note: While borax is commonly recommended as a laundry booster, and is safe for the environment, the Environmental Working Group (EWG) rates borax as “high concern” for developmental and reproductive toxicity and is best avoided, particularly by women and children (EWG, 2011; EWG, 2014).

### Fabric softener:

Add distilled white vinegar or baking soda to the rinse cycle.

### Drying:

Clothes dryers are the second-largest users of home appliance energy, after refrigerators (Steingraber, 2011). They are also a leading cause of home fires. Keep in mind that the purpose of a clothes dryer is to evaporate water; wet clothing would dry anyway if exposed to air. The sun has been the traditional “solar dryer” since humans began wearing clothing. A brief time spent outdoors can save energy and money and leave your clothing smelling fresh. (Be careful of pollen if allergies are a problem for your family members.) Indoor drying systems can be used in inclement or cold weather. Heavy clothing, such as jeans and towels, can be dried in the drier for 10-15 minutes to remove wrinkles, and then air dried.

### DRY CLEANING

The standard cleaning solvent used in commercial dry cleaning facilities is tetrachlorethylene (perchloroethylene), or “perc”. The Environmental Protection Agency (EPA) classifies perc as “likely to be carcinogenic” (EPA, 2012). While the EPA does not recommend that consumers avoid wearing clothing that has been dry cleaned with perc, the solvent is a highly toxic environmental contaminant. Consumers can look for dry cleaner facilities that use less toxic methods, such as liquid silicone (“D5”), liquid CO<sub>2</sub>, or Professional Wet Cleaning (PWC). If clothing is dry cleaned with perc, remove the plastic and air out the clothing prior to bringing it into the home. When purchasing clothing, consider buying garments that can be machine or hand washed.

### INTEGRATED PEST MANAGEMENT

Integrated Pest Management (IPM) is an environmentally sensitive approach to pest control. IPM uses knowledge of the behavior and life cycles of pests to achieve the least possible hazard to people, property, and the environment (EPA, 2014). Pests need a place to live, food, and water. The first step in the home setting is to avoid keeping food in open containers and to keep surfaces free of food and soil. In addition, cracks and holes where pests enter the home should be repaired. Fix areas where there are water leaks, such as pipes and faucets.

Avoid using insect sprays and foggers; in general, enclosed traps expose family members to fewer chemicals. Be sure to handle any traps according to the directions and keep out of the reach of children. For crawling insects, food-grade diatomaceous earth, a non-toxic fine powder, can be applied to surfaces where these pests are found, such as in cracks and crevices, in garbage cans, or in drains. But keep this powder away from pets, children, and food. When seeking a pest management company, select a company that uses integrated pest management.

### RESOURCES

- Guides to product safety: [Environmental Working Group](#)
- Toxic substances information: [Agency for Toxic Substances and Disease Registry](#)
- Pediatric environmental hazards: [Children's Environmental Health Network](#)
- [Green Seal of Approval](#)
- Health indoor living information: [Healthy House Institute](#)
- Alternatives to pesticides: [Pesticide Action Network](#)
- Information/advocacy on cold-washing and air-drying laundry: [Project Laundry List](#)
- Information/advocacy on protecting families from toxic chemicals: [Safer Chemicals, Healthy Families](#)
- Information/advocacy for safer products for women: [Women's Voices for the Earth](#)

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## TRANSPORTATION AND HEALTH IMPLICATIONS

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In addressing health issues, transportation is almost always part of the problem or part of the solution. That is so whether improving air quality, getting children immunized, providing early prenatal care, utilizing appropriate preventive and primary care services, or responding to an emergency. Transportation can be defined broadly as the means of moving people and goods to desired destinations. Transportation includes public transit options of rail and bus; individual automobile use and shared rides; bicycling and walking.

The health benefits of active transportation that includes biking and walking as part of a pattern of regular exercise are well known in preventing obesity and numerous chronic diseases, and in promoting health and quality of life. In fact, Maizlish and colleagues (2013) found that physical activity was increased from four to 22 minutes a day, the risk of cardiovascular disease and diabetes was decreased by 14%.

Public transit carries with it exercise benefits because transit riders walk or bike to transit stops. In addition, public transit lessens the health effects of air and water pollution, the risk of injury and deaths from automobile accidents, the stresses of driving in congested traffic and driver road rage. An often overlooked benefit of transit is its role in developing a sense of community among regular riders, reducing social isolation as a risk to health.

Adequate, available, affordable public transit provides access to health care, to jobs, to education, to grocery stores, to religious and social gatherings, all of which are essential components of healthy living. Without alternatives to driving individual cars, some of the most vulnerable segments of the population—the poor, persons with disabilities, the elderly—are even more likely to be unable to meet basic requirements for daily living, much less to have productive roles in society. Not having to own a car or reduced use of an automobile lessens stress on family budgets.

Public transportation helps alleviate environmental, energy, and economic problems. As documented in the American Public Transportation Association's 2014 Fact Book: "Public transportation plays an important role in reducing the nation's energy use and greenhouse gas emissions. Due to the combined reduction in private passenger vehicle miles, reduced automobile congestion and reduced travel distances due to the proximity created by public

transportation, more than 4 billion gallons of gasoline are saved and 37 million metric tons of carbon dioxide emissions are avoided" (APTA, 2014, p.21).

"According to the US Environmental Protection Agency's Greenhouse Gas Calculator, it would require 7.2 million acres of new pine or fir forests per year to match the annual carbon dioxide reductions provided by public transportation. Priced at \$3.60 per gallon, the 4 billion gallons of gasoline saved annually saves the US consumer \$14.4 billion per year" (APTA, 2014, p.21).

"Transit's impact on reducing congestion has also resulted in significant savings for drivers and their communities. Without transit, drivers would have used 450 million more gallons of gasoline because of added roadway congestion during 2011. Drivers would have been stuck in traffic an additional 865 million hours if there were no transit. Overall, the costs of congestion to drivers would have been an additional \$20.8 billion if there had been no transit service" (APTA 2014 Fact Book, p. 21-22).

Opportunities for improving health through transportation include:

3. Policies that support adequate funding for public transit as well as safe roads.
4. Built community design/modification that includes:
  - cross streets,
  - eliminating single entrance/exit neighborhoods,
  - safe spaces for walking and biking for children and adults, i.e. bike lanes/paths, sidewalks, to shops, restaurants, work, and entertainment.
  - mixed used neighborhoods to increase ease of access to shopping and services
5. Applying proven strategies for rural transit, e.g., van pools, park and rides, flexible routes.
6. Use of existing and additional rail lines for passenger as well as freight service.
7. Programs that assist first time riders, especially the elderly.
8. Collaborative efforts with schools and employers to encourage, facilitate and provide incentives for transit use.

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## BROWNFIELDS AND NURSING IMPLICATIONS

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In this chapter we will learn what brownfields are and what the nursing implications should be related to them. This will include nursing education, practice, policy/advocacy, and research.

### DEFINITION OF A BROWNFIELD

Brownfields can be defined in a variety of ways, but the term typically refers to urban industrial or commercial facilities that are abandoned or underutilized due, in part, to environmental contamination or fear of contamination. There have been special efforts in recent years to target brownfields for cleanup and reuse for several reasons, including the potential to revitalize distressed communities, increase tax dollars, and provide new jobs.

### AUTHORIZING LEGISLATION AND ENVIRONMENTAL PROTECTION AGENCY (EPA) MISSION

In January, 2002, Public Law 107-118 (H.R. 2869): "Small Business Liability Relief and Brownfields Revitalization Act" was enacted:

"To provide certain relief for small businesses from liability under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, and to amend such Act to promote the cleanup and reuse of brownfields, to provide financial assistance for brownfields revitalization, to enhance State response programs, and for other purposes" (GPO, 2002). EPA's Brownfields Initiative empowers States, communities, and other stakeholders in economic development to work together in a timely manner to prevent, assess, safely clean up, and sustainably reuse brownfields.

### WHY IS THE BROWNFIELDS ISSUE IMPORTANT?

In recent years, many manufacturing plants and military bases have closed or relocated. Often, new development on these "brownfield" sites is made difficult by real or perceived environmental contamination. Through the Brownfields Cleanup and Redevelopment Program, EPA helps states, tribes, communities, and other organizations to:

- environmentally assess existing properties,
- prevent further contamination,
- safely clean up polluted properties, and
- design plans to re-use them.

EPA's investment in the Brownfields Program has resulted in many accomplishments, including leveraging more than \$14 billion in brownfields cleanup and redevelopment funding from the private and public sectors and leveraging approximately 60,917 jobs. The momentum generated by the Program is leaving an enduring legacy. The Brownfields Program and its partners have provided guidance and incentives to support economic revitalization, and empower communities to address the brownfields in their midst. EPA's Brownfield Program continues to look to the future by expanding the types of properties it addresses, forming new partnerships, and undertaking new initiatives to help revitalize communities across the nation (EPA, 2015).

To view the brownfields and other related sites in your area, go to Clean-ups in my Community. You have a choice of mapping cleanups across the USA, mapping or listing cleanups for a ZIP code or city, or creating a table of cleanups or grants.

### STATE EXAMPLE: MARYLAND

As indicated above, EPA does not regulate the Brownfields program alone, but delegate's authority to the States. States take a wide range of approaches and use an assortment of tools. Some States specifically address brownfields through their voluntary cleanup programs, others supplement their voluntary program activities, and still others have separate brownfields cleanup and redevelopment programs.

In Maryland, this program is called the Brownfields Redevelopment Initiative (MD Department of the Environment, 2015). Brownfields are included in Voluntary Cleanup Program and the goals are:

1. Encourage the investigation of eligible properties with known or perceived contamination;
2. Protect public health and the environment where cleanup projects are being performed or need to be performed;
3. Accelerate cleanup of eligible properties; and
4. Provide predictability and finality to the cleanup of eligible properties (MD Code, 1997).

### WHY NURSES?

So what can nurses bring to the very technical world of hazardous waste cleanup, like brownfields? There are actually a lot of important roles that we are uniquely trained to do. We can:

- Enhance community connections / facilitate dialog
- Identify populations at risk

- Improve community education and risk communication
- Expand the multidisciplinary nature of your environmental health (EH) work
- Assist with translating science into policy
- Enlist undergraduate and graduate students for data collection.

### CHALLENGES OF COMMUNITY INVOLVEMENT AT BROWNFIELD CLEANUPS

One of my former roles was providing community outreach and technical assistance to residents with hazardous waste sites in their midst. Through the six plus years I worked for the US EPA funded Hazardous Substances Research Center (the only regional center that had a school of nursing conducting the outreach), I learned some important lessons.

Including all stakeholders: It was often difficult to know who the stakeholders were, when first interacting with a community. I was often approached by a small group of concerned citizens or someone from the local government. This is not a comprehensive list, but you need to make sure to include:

- Community members
- Local businesses
- Representatives from local, state and federal government
- Local and state health department
- Department of Environment
- Health care providers
- Religious leaders
- Schools
- Financial institutions
- Developers
- Contractors
- Youth
- Responsible party(s)

Multiple agendas: I learned very early, there were often multiple agendas and they were not always obvious. Mostly citizens were concerned about health and then property values or effect on business. Then there would be other hidden agendas, like avoiding liability.

Who's in charge: One of my major tasks was trying to help the community understand the roadmap of who was in charge of the decision-making authority. Depending on the type of site and what city and state it is in, who is in charge can change. It is possible for EPA or State Department of Environment to have the lead. Also involved will be potentially responsible parties and their contractors, EPA's contractors, other consultants, Agency for Toxic Substances and Disease Registry (ATSDR), State Health Department, Local Health Department, and other local officials.

Agency responsibilities and limitations: Closely tied to who is in charge, is what each organization is allowed to do by the regulations that govern them. EPA and state departments are directed and limited by their legislative mandates. There are some things they have to do and some processes are set by the regulations. Some things they have no control over. For example, they cannot address property values or zoning; this is a local level issue. That is why it is important to have a large group of stakeholders at the table, so if an issue does not fall under one agency, it probably does fall under another.

### POLICY GAPS

After introducing the brownfields definition, legislation, program and implementation, some policy gaps have been identified for future advocacy:

- Environmental justice in permitting process: Need to consider the cumulative impacts already in the community before siting new facilities.
- No program exists to address community-wide elevations of background contaminants
- No program exists to address multimedia problems
- No program exists to address school siting. Some sites do not have coverage under current regulations; schools are one of these. They often fall through the cracks and a school can build without any testing or cleanup.

### ADDITIONAL RESOURCES

National Library of Medicine

- [MEDLINEplus](#)
- [TOXNET](#)

Agency for Toxic Substances and Disease Registry

- [ToxFAQs](#)
- [Toxicological Profiles](#)

- [Envirofacts](#)
- [IRIS](#)
- [Tools and Technical Information](#)
- [Brownfield Training Conference Newsletter emails](#)

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## HEALTH IMPLICATIONS OF FOOD AND AGRICULTURE

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### INTRODUCTION

In Michael Pollan's best-selling book *The Omnivore's Dilemma*, he characterizes the American people as collectively suffering from a "food disorder" (Pollan, 2006). In the context of Pollan's critique of the American diet, we are suffering from an abundance of food choices but a lack of understanding about how our food is grown and raised, processed and transported, marketed and ultimately shows up on our plate, or too often eaten from a to-go container.

We further lack an understanding about the abiding relationship between our health and what we eat. As a result, we have both an epidemic of obesity and a crisis of chronic diseases. This chapter is not about human nutrition but rather about some of the public health implications of how we grow and raise our food. Having said that, there is a growing understanding of "food as medicine" which explicitly recognizes the benefits of healthy foods generally and of specific foods in terms of their ability to ward off chronic diseases and address specific health effects, including diabetes and cardiovascular diseases.

As nurses, we encourage people to eat a "healthy diet" but what do we really know about how healthy our food is - for the immediate consumer of the food, for those that farmed and harvested it, for those involved in its slaughter and processing, and equally importantly for the ecosystem that supports it all along the way. On average food products in the US travel 1,500 miles from farm to table. (CUESA, n.d.) This reliance on distant food sources alone is a significant contributor to climate change. This chapter will review some of the human and ecological health impacts of our current agricultural practices.

### MODERN FARM PRACTICES

For many people who do not live in agricultural areas our image of a "farm" is often some variation on the theme of a beautiful green setting with cows and chickens and corn fields, images that evoke the many "farm toys" and "farm books" that are created for children – the ones with the big red barns. The truth is that most of the food in the US is produced by single-animal or single-crop production and on very large scales.



50,000,000,000 animals are raised and slaughtered in factory farms globally each year. (Duda, 2016)

### Meat Animals

#### Confined Animal Feed Operations

In terms of meat animal production, the idealized farm has been replaced by Confined Animal Feeding Operations (CAFOs) which are the type of animal production facilities that are sometimes referred to as factory farms. These facilities house over a thousand large animals like beef cows or hogs, and tens of thousands of chickens. Over 50% of our meat in the US is derived from animals in CAFOs, even though they comprise only 5% of US farms. This gives a sense of the scale of their production (UCS, [https://www.organicconsumers.org/sites/default/files/cafos\\_uncovered.pdf](https://www.organicconsumers.org/sites/default/files/cafos_uncovered.pdf)).

There are a great many human and ecological health issues that arise when raising animals this way. There is also the obvious ethical one regarding the inhumane way in which the animals are treated.

The most significant ecological issue is waste management. Animal waste is not regulated in the same way that human waste is. For example, an adult hog can produce 7 pounds of waste a day, which in the case of a 5,000-hog CAFO translates to 245,000 pounds of hog manure a week. In hog production, lagoons are created to hold the combined urine and manure. The contents of these “holding” ponds can leach into the ground and overflow into nearby waterways, particularly when there are extreme rain events – perhaps indicating that hold-nothing ponds might be a better term. These lagoons also produce air pollutants, including volatilized ammonia, and extremely noxious odors that are associated with health risks to the nearby community. Airborne ammonia is also a known respiratory irritant. The farmworkers who work inside the pig barns have increased risk of respiratory dysfunction that is associated with gases, microbes, endotoxins, and dust (Charavaryamath and Singh, 2006).

When released into nearby waters, two main components of manure, nitrogen and phosphorus, can cause eutrophication – which acts like aquatic fertilizer and causes the proliferation of certain plants and organisms that rob the waterways of oxygen thus killing the fish and other marine life. Further downstream and into bays and oceans this eutrophication is responsible for dead zones, which have occurred in the Gulf of Mexico and the Chesapeake Bay.

Companies that operate CAFOs have been able to reduce their costs by their “economy of scale” but also through significant public subsidies, including (until very recently) low-cost feed. They have also benefited from taxpayer-supported pollution cleanup programs and technological “fixes” that may be counterproductive to overall human and public health, such as the overuse of antibiotics (Gurian-Sherman, 2008).

When our tax dollars are used to subsidize bad farming processes, then better/good farming practices appear, by comparison, to be less cost effective. But if smaller scale sustainable farms were on a level economic playing field, they would be equally and even more efficient. There is clear evidence that smaller scale, pasture-based production can be profitable and better for the environment. Later in this chapter we will discuss the US Farm Bill that is responsible for setting food production subsidies and many other food-related policies.

### Antibiotic Use in Animal Production

No nurse farmer would allow their animal to suffer with an infection for which an antibiotic exists. But the majority of antibiotics used in animal production are not prescribed for infections. Low (non-therapeutic) levels of antibiotics have been found to increase the weight of animals – as much as 5%. Given that farmers and ranchers sell their meat animals by the pound, using antibiotics in the feed of their otherwise healthy animals has become a regular practice.

According to the FDA, more than 20 million pounds of medically important antibiotic drugs were sold for use on livestock farms in 2014 — about 80 percent of all antibiotics sold in the country (Center for Veterinary Medicine, 2015). These antibiotics wind up in the guts of meat animals and they wind up in the manure. This results in manure-related run-off into waterways and manure that may be spread on fields where food crops are grown. The presence of antibiotics in our environments create the conditions for antibiotic-resistant organisms to develop. Community-acquired antibiotic resistant infections are on the rise and a major public health concern. We also know that workers in chicken houses, where non-therapeutic antibiotics are put in the chickens’ water, develop antibiotic-resistant organisms in their guts (RuleSean et al, 2008).

Since 2017, the US Department of Agriculture has decreed that medically important antibiotics – those used for treated humans – should not be used to promote animal growth. There are still numbers of antibiotics that are being used, however, and as a result, antibiotic resistant organisms are likely to keep developing.

The former Director-General of the World Health Organization (WHO), Margaret Chan, noted that, “[I]n the absence of urgent corrective and protective actions, the world is heading toward a post-antibiotic era, in which many common infections will no longer have a cure and, once again, kill unabated” (Chan, 2011). WHO released the first-ever report on global antibiotic resistance in 2014, outlining the serious threat antibiotic-resistant bacteria present to public health around the world (WHO, 2014). This is an issue that is extremely important for nurses to track and to engage in policy decisions that aid in the prevention of antibiotic resistant organisms.

### HORMONE USE IN ANIMAL PRODUCTION

#### Beef Cattle

Since the 1950s, the US Food and Drug Administration (FDA) has approved a number of steroid hormone drugs for use in beef cattle and sheep, including natural estrogen,

progesterone, testosterone, and their synthetic versions (US FDA, 2020). The steroids are delivered via a subcutaneous implant. [No steroid hormone implants are approved for growth purposes in dairy cows, veal calves, pigs, or poultry.] Europe has had a non-hormone treated cattle (NHTC) program since 1999 and China limits its acceptance of US meat imports because of hormone usage. Few long-term studies have been done to establish the human health risks.

### Dairy Cows

The hormone that is given to dairy cows is bovine somatotropin (bST), also known as bovine growth hormone or recombinant bovine growth hormone (rBGH). It is an animal drug approved by the FDA to increase milk production in dairy cows (US FDA, 2020). Fifteen to 20% of US dairy cows receive rBGH and there is some controversy regarding the potential human health risks associated with this hormone. In their 2015 review article, Malekinejad and Rezebakhch found that “the presence of steroid hormones in dairy products could be counted as an important risk factor for various cancers in humans” (Malekinejad & Rezebakhch, 2015). The FDA does not consider rBGH a health threat to humans. However, the American Cancer Society notes that there have been studies showing strong associations between consuming dairy products from cows that have been given rBGH and certain cancers (prostate, breast, and colorectal) and it must be noted that there have been studies showing little evidence of association (ACS, 2014).

Nevertheless, there is adequate evidence that rBGH can be harmful to the cows that receive it. The health effects that they experience are the following: 50% increase in lameness, 25% increase in mastitis, as well as increased risk for infertility problems, cystic ovaries, fetal loss, and birth defects (Center for Food Safety, n.d.). The increase in mastitis is then associated with increased use of antibiotics.

Regarding rBGH, the following recommendation for Nurse Actions is part of Health Care Without Harm's factsheet on rBGH:

### What Nurses Can Do

1. **Educate yourself & other nurses with the Nurse's Toolkit on rBGH.** You'll find scientific studies & other important information from Health Care Without Harm on rBGH. Visit: <https://noharm-global.org/documents/nurses-are-concerned-artificial-growth-hormones-dairy-products>.

2. **Educate your patients.** Ask them to read the "Know Your Milk" brochure & watch the video from the Oregon Physicians for Social Responsibility's Campaign for Safe Food. Visit: [www.oregonpsr.org](http://www.oregonpsr.org).
3. **Purchase organic or rBGH-free dairy products** and encourage your family and your patients to do the same. For a list of rBGH-free dairy products in your state from Food and Water Watch, visit: [www.foodandwaterwatch.org](http://www.foodandwaterwatch.org).
4. **Ask your hospital or health care facility to purchase rBGH-free dairy products** and join other hospitals around the country in doing so. For more information, visit: [www.healthyfoodinhealthcare.org](http://www.healthyfoodinhealthcare.org).
5. **Start a green team or food committee at your hospital or health care facility** to address these and many other environmental health and healthy food concerns.

The whole factsheet can be found here: [https://noharm-uscanada.org/sites/default/files/documents-files/131/Nurses\\_Concerned\\_rBGH.pdf](https://noharm-uscanada.org/sites/default/files/documents-files/131/Nurses_Concerned_rBGH.pdf)



### PLANT-BASED FOODS

The first things that we need to know about healthy plant food production – healthy for humans and healthy for whole ecosystems – is what is going on with our soil, seeds, and pollinators, along with water and climate. And then we can move on to other critical topics, like farmworker health and safety, pesticides, and climate.

### Soil

*“The nation that destroys its soil destroys itself.” Franklin Roosevelt*

Soil is the organic matter and minerals on the surface of the land on which plants and other life grows. Without soil, we will have no food. And yet, we have been in a steady state of abusing and losing soil, one of nature's most important gifts to us. Each year, an estimated 50 trillion pounds of fertile soil are lost due to erosion. That is 7,500 pounds lost every year for every person on the planet (UNCCD, 2015). This fertile soil either blows away or erodes and runs towards the oceans via creeks, stream, rivers, and lakes.

Soil is so much more than dirt – it's alive. Soil is a living ecosystem—a large community of living organisms linked

together through nutrient cycles and energy flows. Every teaspoon of soil is home to billions of microorganisms—bacteria, fungi, nematodes, insects, and earthworms that each play important roles (UME, 2018).

As we are only recently discovering the importance of the human microbiome, soil scientists have long understood the importance of the microbiome of the soil. And it turns out there is a connection between the two. Clinical interventions to improve our human microbiome with probiotics and prebiotics are showing promise.

Just as we have unwittingly destroyed vital microbes in the human gut through overuse of antibiotics and highly processed foods, we have recklessly devastated soil microbiota essential to plant health through overuse of certain chemical fertilizers, fungicides, herbicides, pesticides, failure to add sufficient organic matter (upon which they feed), and heavy tillage. These soil microorganisms -- particularly bacteria and fungi -- cycle nutrients and water to plants, to our crops, the source of our food, and ultimately our health. Soil bacteria and fungi serve as the "stomachs" of plants. They form symbiotic relationships with plant roots and "digest" nutrients, providing nitrogen, phosphorus, and many other nutrients in a form that plant cells can assimilate. Reintroducing the right bacteria and fungi to facilitate the dark fermentation process in depleted and sterile soils is analogous to eating yogurt (or taking those targeted probiotic)...to restore the right microbiota deep in your digestive tract (Amaranthus and Allen, 2013).

We are now in a place where critical soil microbes that are necessary for healthy soil have been destroyed in many large-scale, single crop (mono-culture) commercial agricultural enterprises. These are the microbes that would otherwise be helping plants to access, conserve, and cycle nutrients and water for plants and, equally importantly, regulate climate. The result is dying soil and crops that are losing their nutrient content.

To shore up the deficits in our soil, the US has become a major importer of synthetic fertilizers. Though only 5% of the world's population, the US uses 12% of the world's synthetic nitrogen fertilizer which is produced by natural gas (fossil fuel) powered ammonia plants in countries like Trinidad and Tobago (Philpott, 2010). Consider the climate change contribution that producing and transporting fertilizers is making to greenhouse gases. In this way, modern industrial farming is extractive – continually taking from the soil and using petrochemical fertilizers and other fossil-fuel related inputs to make up the difference.

In instances where conventional, mono-culture farming continues, the introduction of micro-organisms into the

soil has been shown to increase nutrient up-take and reduce water needs. This trend is in play as the bio-fertility (micro-organisms) industry has become a \$500 million industry. This is yet another industry that is using energy, water and other resources and transporting product.

[To better learn about the plight of soil on earth, watch [Dirt: The Movie](#), a great documentary available for free on YouTube.]

The following are a set of tips that nurses (and others) can follow to support healthy soil.

#### Six tips for healthy soil in your garden

1. Test your soil (Google "soil testing" in your city / county).
2. Add organic matter.
3. Incorporate compost to compacted soil to increase air, water and nutrients for plants.
4. Protect topsoil with mulch or cover crops.
5. Don't use potentially harmful chemicals.
6. Rotate the annual vegetable crops.

For a fuller explanation of each of these tips, go to : <https://extension.umn.edu/how-manage-soil-and-nutrients-home-gardens/living-soil-healthy-garden>

As is often true, once we are clear about the problem, we can work on the solutions. First and foremost, we have discovered that organic farming, no-till (or minimum tilling) farming, cover crops, and rotating crops can help naturally replenish the soil and keep it healthy. We need to be incentivizing these farm practices.

#### SEEDS

There is something wonderful about the similarity between human and plant embryos - in both, an entire life form begins.

