Unit III:
Environmental Health Sciences

INTRODUCTION

Three science areas from biology and public health are essential to understanding environmental health. These are ecology, toxicology and epidemiology. In this unit ecology refers to the study of any living thing in relationship to its environment and toxicology is defined as the study of poisons, or toxins, and the treatment of toxic exposures. Epidemiology is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems (Last, 2001). Unit 3 includes an introduction and resources related to disciplines of science relevant to environmental health. In addition, the scientific process of risk assessment, often considered a part of toxicology, is included in this chapter. The first discussion looks at ecology and ecosystems to highlight the relationship between humans and environment. Second is a look at toxicology with sections relevant to nursing practice such as carcinogens, criteria air pollutants, flame-retardants, and heavy metals. Although there is no section that includes a comprehensive discussion of epidemiology, in this edition, there is an example of environmental surveillance relevant to epidemiology. According to the World Health Organization (WHO), " Public health surveillance is the continuous, systematic collection, analysis and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice. Such surveillance can….monitor and clarify the epidemiology of health problems" (WHO, 2016). In this unit the discussion of the CDC surveillance program, the National Environmental Public Health Tracking Network (CDC, 2016) is an application of environmental surveillance.

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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 relationship 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, n.d.), watersheds are areas of land where the water that is found under it, ends up draining 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."

There is a simplified version of the several different levels of ecologic systems. 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 ecologic 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 the understanding of environmental health impacts on human health; this synergistic relationship among human beings and the environment has impacts along the human development continuum.

According to the EPA (n.d.), 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. Temperate and tropical rainforests have a dramatic relationship with climate change because they help regulate earth's temperature and its weather patterns (The Nature Conservancy, 2015).

Increases in human demands, like home heating and cooling, cause an increase in the use of fossil fuels (such as coal) which in turn, because of their burning, releases those toxic chemicals that cause increases in air pollution. This air pollution contributes to global warming (Allender, 2014). Global warming then has impacts on ecosystems throughout the world and the delicate balance within ecosystems with the resultant weather and environmental impacts that are related to the increase in global warming.

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NTRODUCTION TO TOXICOLOGY

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Toxicology is an important science in understanding environmental health. But, for most nurses the name toxicology itself sounds a bit overwhelming. Toxicology is the study of poisons, or toxins, and the treatment of toxic exposures. As nurses we do not typically study about toxic exposures and their treatment; but we do study other chemical exposures meant to improve human health when we study pharmacology. We can use our understanding of pharmacology to develop and understand toxicology. In both areas the method of exposure (injection, topical, inhaled, or ingested) influences the amount of chemical (or drug) absorbed and then in toxicology, just as pharmacology, we further examine the human biochemical response to the substance in question. Both toxic chemicals and drugs are metabolized or biotransformed and create a biochemical interaction in the human body that can be therapeutic in the case of medicines or could be toxic in the case to too much medication or a toxicant.

It is important, however, to understand that there are unique differences between toxicology and pharmacology that makes the study of toxicology and the determination of toxic exposures a bit more challenging than the study of pharmacology. In pharmacology, drugs have been tested in human populations and are given in prescribed dosages – we know how much medication and the route it is being administered. When giving medications, for the most part, conditions are controlled; vital signs and therapeutic levels are monitored. Whereas, in the case of a toxicant often we have not controlled the route of exposure and we may not have knowledge of the exact amount of exposure (how much was ingested or breathed in). Also frequently, for ethical reasons, the toxic chemical has not been tested on human beings. Therefore, when we examine toxicological data we frequently rely on animal studies and accidental human exposures where we are approximating the amount of exposure to make an informed decision regarding human health. Consequently, many times we make the best decision we can with the available scientific evidence while recognizing that there may be limitations in the data (not the same species for testing, or an unknown amount of exposure). Pharmacology and toxicology share some similar concepts; but, toxicology is much more complex and frequently we must make inferences from the data that we have to determine toxicity of a particular chemical. Therefore, we rely on the best evidence that we have within the context of the Precautionary Principle when making decisions regarding toxic environmental exposures and human health.

As with medications, individuals may be exposed to multiple toxins at the same time. Little research has been conducted regarding human exposure to multiple toxins which can occur at the same time or sequentially. Sometimes we do not even know what toxicant(s) the individual was exposed to. For more comparing toxicology to pharmacology please see EnviRN Evidence - Toxicology.

CARCINOGENS

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A carcinogen is any substance that causes cancer or helps cancer grow. Carcinogens can either be physical, biological or chemical. Physical carcinogens include ultraviolet light and ionizing radiation. A biological example would be the Human papilliomavirus (HPV) which is known to cause cervical cancer in women. Lastly, chemicals used to make many of the products we use daily in our personal and professional lives are carcinogens. Chemicals we encounter in our daily lives can include but are not limited to the following:

- Pesticides are used in agriculture to help feed over 300 million Americans. Individually people use them to maintain a beautiful landscape, keeping insects and animals from ruining their flowers and produce. There are long term ramifications to our ecosystem that results from using these chemicals. Pesticides have been shown to be carcinogenic as well as causing problems with our nervous system, endocrine system and lungs when inhaled. Pesticides infiltrate our groundwater supply polluting our water. To learn more about pesticides and safe handling please refer to the following EPA page epa.gov/pesticides/health/cancerfs.htm. An innovative approach to farming without chemicals is vertical farming. Vertical farming is done indoors free of external factors related to weather, bugs and drought. It is our duty as nurses to advocate and support healthy innovation http://www.verticalfarm.com
- Bisphenol A (BPA) is one of the most common chemicals to which we are exposed in everyday life. It is found in our food and plastic beverage containers. BPA is a synthetic estrogen that can disrupt the hormone system causing reproductive and developmental disorders, particularly when exposures occur while babies are still in the womb or in early life. Elevated estrogen levels generally increase a woman's risk of breast cancer. In 2008, there was a public outpouring for a change amongst reports of "toxic baby bottles" which was revolutionary. Companies had to produce BPA free bottles due to consumer demand. http://www.cansa.org.za/federal-report-looks-at-risks-from-plastics-chemical/; http://ntp.niehs.nih.gov/ntp/ohat/bisphenol/bisphenol.pdf
- Trichloroethylene, is an organic solvent used in industry as a degreaser. According to the Department of Veterans Affairs, between 1957 and 1987, an estimated 750,000 people living and working at Camp Lejeune may have been exposed to drinking water contaminated with trichloroethylene. Some 71 Camp Lejeune veterans have been diagnosed with male breast cancer, and many others suffer rare forms of cancer, leukemia and other debilitating diseases. Children conceived, born and raised on the base are reported to have experienced high incidences of birth defects and developmental and childhood illnesses. In 2011, the EPA ruled that trichloroethylene was a carcinogenic and harmful to humans. The Camp Lejeune case shows us how chemicals can pose health risk for future generations. http://www.epa.gov/ttn/atw/hlthef/tri-ethy.html

A carcinogen has the ability to damage the DNA directly or indirectly cause a disruption of a cellular metabolic process. For example, they may cause cells to divide at a faster rate, which could increase the chances that DNA changes will occur. Cancer is caused by a change in a person's DNA. However, carcinogens do not cause cancer in every case, all the time. A variety of factors such as a person's genetic makeup, the length and intensity of the exposure can determine the level of the cancer causing potential. The damaging effects of carcinogens can be insidious because the effects are often not immediate and lay dormant for many years. Nurses are exposed to numerous toxic chemicals on a shift such as disinfectants, sterilants, cleaners, and maybe some hazardous drugs such as chemotherapy. It is important for nurses to be vigilant at work to decrease the risk of exposure especially when pregnant.

HOW DO WE FIND OUT IF SOMETHING IS A CARCINOGEN?

Scientist get much of their data about whether something might cause cancer from lab studies in cell cultures and animals. Another important way to identify carcinogens is through epidemiologic studies, which look at human populations to determine which factors might be linked to cancer. However, humans do not live in a controlled environment so the studies have their limits. People are exposed to many substances at any given time, including those they encounter at work, school, or home; in the food they eat; and in the air they breathe. By combining data from both types of studies, scientists do their best to make an educated assessment of a substance's cancer-causing ability. When the evidence is conclusive, the substance is labeled as a carcinogen. When the available evidence is compelling but not felt to be conclusive, the substance may be considered to be a probable carcinogen. But in some cases there simply isn't enough information to be certain one way or the other.

WHO DETERMINES HOW A CARCINOGEN IS CLASSIFIED?

Several agencies (national and international) are responsible for determining the cancer-causing potential of different substances. Each agency has its own classification standards. These agencies tend to focus on substances and exposures most likely to cause cancer, but there are many others that have not been studied fully yet.

- International Agency for Research on Cancer - The International Agency for Research on Cancer (IARC) is part of the World Health Organization (WHO). Its major goal is to identify causes of cancer.
    - Group 1: Carcinogenic to humans
    - Group 2A: Probably carcinogenic to humans
    - Group 2B: Possibly carcinogenic to humans
    - Group 3: Unclassifiable as to carcinogenicity in humans
    - Group 4: Probably not carcinogenic to humans
- National Toxicology Program - This program was started in 1978 in response to the concerns from people within the United States regarding the relationship between the environment and cancer. The National Toxicology Program (NTP) is formed from parts of several different US government agencies, including the National Institutes of Health (NIH), the Centers for Disease Control and Prevention (CDC), and the Food and Drug Administration (FDA). The NTP updates its Report on Carcinogens (RoC) every few years.

  The Report on Carcinogens identifies 2 groups of agents:
  1. "Known to be human carcinogens"
  2. "Reasonably anticipated to be human carcinogens"
- Environmental Protection Agency- The US Environmental Protection Agency (EPA) maintains the Integrated Risk Information System (IRIS), an electronic database that contains information on human health effects from exposure to certain substances in the environment. EPA has published the revised Guidelines for Carcinogen Risk Assessment 2005. The Guidelines provide a framework to EPA scientists for assessing possible cancer risks from exposures to pollutants or other agents in the environment.
    - Group A: Carcinogenic to humans
    - Group B: Likely to be carcinogenic to humans
    - Group C: Suggestive evidence of carcinogenic potential
    - Group D: Inadequate information to assess carcinogenic potential
    - Group E: Not likely to be carcinogenic to humans
- Other agencies and groups - Other federal agencies, such as the CDC's National Institute for Occupational Safety and Health (NIOSH), the Food and Drug Administration (FDA), and the National Cancer Institute may comment on whether a substance or exposure may cause cancer and/or what levels of exposure to a particular substance might be considered acceptable.

MY PERSONAL ACCOUNT OF CANCER AS A PRACTICING BEDSIDE NURSE:

I graduated from nursing school in 1997 and worked at a local ER. Initially, I had limited exposure and experience with the oncology patient because there were always rooms available on the oncology floor for them to be directly admitted. The ER was just considered "too dirty" of a place for these immunocompromised patients. Fast forward to current practice, oncology patients are sitting in waiting rooms for hours waiting to get a gurney in the emergency department. Now, some shift's have a whole section with active oncology patients or patients with a history of cancer. My journey to environmental nursing started when I started to get "burnt out" and realized I suffered from moral distress. To witness the physical decline and pain and emotional upheaval cancer has on a patient and family made me question my role as a nurse. I realized that I needed to get more involved in advocacy, working up stream, and having the moral courage to speak out on behalf of my patients. I needed to become more active in reducing the likelihood of cancer.

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CRITERIA AIR POLLUTANTS

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Air pollution is the largest environmental risk to human health (World Health Organization, 2014). Globally, outdoor air pollution contributes to 3.7 million annual deaths and is among the top 9 risk factors for disability adjusted life years lost (Lim et al., 2013; World Health Organization, n.d.). Major health conditions impacted by outdoor air pollution include acute lower respiratory diseases (e.g. pneumonia), obstructive lung diseases, ischemic heart disease, stroke, and lung cancer – all conditions commonly seen by nurses in a variety of settings (Lim et al., 2013; World Health Organization, 2014). The sources of most outdoor pollutants are emissions from industry, transportation, processes to create energy, and waste management (World Health Organization, 2014).

Nearly 130 million Americans live in communities where air quality does not meet healthy standards, posing an ongoing source of health risk (U.S. Department of Health and Human Services, n.d.). People with pre-existing lung or cardiovascular disease, children, and the elderly are more susceptible to the health effects of air pollution exposure (Lim et al., 2013; World Health Organization, 2014).

NURSES' ROLE IN REDUCING EXPOSURE TO AIR POLLUTANTS

Nurses equipped with knowledge about common air pollutants are in key positions to educate patients and families on strategies to reduce exposures and risks. Nurses also can contribute to community advocacy and building coalitions that reduce community levels of exposure. Additionally, nurses can inform ongoing policy by sharing their clinical experiences in caring for affected patients and communities (American Nurses Association, 2007).

OUTDOOR AIR POLLUTANTS

The most common and pervasive harmful outdoor air pollutants in the United States are called "criteria" air pollutants (EPA, 2014, 2016a, 2016b). The six criteria pollutants are sulfur dioxide, nitrogen oxides, particulate matter (identified by a mean diameter of less than 10 or 2.5 μm), ozone, lead, and carbon monoxide (EPA, 2014, 2016a, 2016b). Improved regulation and innovations in pollution sources (such as industrial processes and automobiles) have continually improved levels of criteria air pollutants in the United States, as can be seen on http://www.epa.gov/air-trends/. However, climate change predictions indicate the potential for future increased levels of these pollutants, especially ozone and particulate matter (EPA, 2012). More information on the individual criteria air pollutants can be found at the Environmental Protection Agency's website. Table 1 summarizes each pollutant and their health effects.

Table 1: Health effects of criteria air pollutants

Pollutant	Common health effects linked to Increased ambient levels
Sulfur Dioxide	General irritation of the eyes, nose, throat, and lungs. Worsening asthma and chronic obstructive pulmonary disease (COPD), respiratory infections, heart attack, cardiac dysrhythmia, hypertension, abdominal pain, depression, headache, lung cancer
Nitrogen Oxides	General irritation of the eyes, nose, throat, and lungs. Worsening asthma and chronic obstructive pulmonary disease (COPD), respiratory infections, heart attack, cardiac dysrhythmia, hypertension, abdominal pain, depression, headache, lung cancer
Particulate Matter[a]	Heart attack and stroke, cardiac arrest, clots, chest pain, cardiac dysrhythmia, shortness of breath, respiratory infection, fatigue, headache
Ozone	General irritation of the eyes, nose, and throat. Worsened lung function and asthma. Cardiac arrest, dysrhythmia, depression, and skin irritations
Carbon Monoxide	Heart attack, cardiac dysrhythmia, asthma, pneumonia, depression, headache, and ear infection
Lead[b]	Anemia, hypertension, decrease in kidney function, cardiovascular events, altered childhood neurological development (behavioral and intelligence)

[a] Assembled impacts of various sizes of particulate matter

[b] Ingestion of paint, dust, and soil is the most frequent route of exposure. Ambient levels add to the accumulation in the environment.

TEACHING TOOLS

Several teaching tools for healthcare providers' continuing education and communication with patients about common air pollutants are available at http://www.airnow.gov/index.cfm?action=health_providers.index. Examples from this Environmental Protection Agency site include patient education posters on how common air pollutants impact respiratory and cardiac health. Posters are in English and Spanish versions.

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CHEMICALS OF CONCERN: FLAME RETARDANTS

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Flame retardants are chemicals marketed to the public as a mechanism of protection from fires; yet products containing flame retardants provide no more protection against fires than other safety barriers (Babrauskas, Blum, Daley, & Birnbaum, 2011). Moreover, research shows that these chemicals are disruptive to a person's health. Vulnerable populations are especially susceptible to the health impacts from exposure to flame retardants. The continued use of flame retardants is misleading to the public as one assumes that domestic products, especially children's products, are safe to use.

WHAT ARE CHEMICAL FLAME RETARDANTS?

Flame retardants are chemicals that are added to materials for the purpose of making those materials more resistant to fire or reducing the speed that a flame spreads. Consumer products, such as upholstered furniture and electronics, contain flame retardants.

The use of flame retardants in the manufacturing of upholstered furniture began about 1975 when California adopted the Furniture Flammability Standard, Technical Bulletin 117 (Babrauskas et al., 2011). This standard requires polyurethane foam to resist an open flame for 12 seconds. In a short video, The Chicago Tribune tells how the tobacco industry was successful in shifting the focus from cigarette companies producing cigarettes that easily started fires to furniture manufacturers making upholstered furniture that would easily ignite and once ignited the fire would spread quickly. This led to the widespread use of chemical flame retardants in upholstered furniture.

Some of the leading chemical flame retardants on the market today are polybrominated diphenyl ethers (PBDEs), Firemaster 550, Tris (1-chloro-2-propyl) phosphate (TCPP), Tris (1,3-dichloro-2-propyl) phosphate or chlorinated tris (TDCPP), and Tris (2-chloroethyl phosphate) (TCEP). PBDEs are a group of flame retardants that contain bromine. Over the past decade, several PBDEs have been phased out of production because they were found to be linked to health problems, such as hyperactivity and learning disabilities in children and thyroid dysfunction (American Academy of Pediatrics [AAP], 2013). PBDEs are not bound to the products that contain them, thus they can be dispersed into the environment. Since PBDEs are lipophilic, meaning they adhere to fat cells in the body, and have a long half-life, they continue to present a health risk (National Resources Defense Council, 2005). The majority of the public have PBDEs in their system because of past exposure or current exposure to products purchased before the phase out. The Environmental Working Group has created an information sheet on PBDEs that nurses can use with clients and health professionals to describe the health impact of PBDEs and ways to limit exposures.

Today, Firemaster 550 is being used instead of PBDEs and is frequently found in upholstered furniture and other foam products. Firenmaster 550 consists of four major chemicals: triphenyl phosphate, Triaryl phosphate isopropylated, Bis (2-ethylhexyl) tetrabromophthalate, and 2-ethylhexyl-2,3,4,5-tetrabromobenzoate (2). There is evidence that this chemical flame retardant is associated with endocrine system disruption, including thyroid function (Center for Environmental Health [CEH], 2013b; Patisaul et al., 2013). Similar to other flame retardants, Firemaster 550 has lipophilic and non-adherent properties. It can be found in dust, sewage sludge, and marine animals (Babrauskas et al., 2011), and presents risk of inhalation and ingestion for humans and pets. .

Flame retardants TCPP, TDCPP, and TCEP are from the "Tris" family, and all have similar properties and health risks. These chemical flame retardants can be found in products made of polyurethane foam, such as couches and automotive seats; baby products such as strollers and nursing pillows; electronics; adhesives; the back-coating of carpets; plastics; vinyl products made out of PVC; and paints (CEH, 2013b; Ecology Center, 2013; National Resource Defense Council [NRDC], 2010). Researchers found that TCPP is linked to genetic alterations and menstrual changes (Center for Environmental Health [CEH], 2013a), and that TDCPP is associated with cancer of multiple systems. TDCPP was banned from children's clothing in 1977 due to causing significant health problems, but it is still being used in other children's products. Current research on TCEP shows that it is associated with fertility problems in males and females, thyroid and kidney cancers, and hyperactivity (NRDC, 2010). This flame retardant has been found in infant changing pads and car seats (CEH, 2013b).

WHERE ARE CHEMICAL FLAME RETARDANTS FOUND?

Table 1: Sources of chemical flame retardants

Everyday Consumer Products:	Baby and Children's Products	Hospital Setting
- Upholstered furniture (items made out of polyurethane foam) - Automotive seating - Backing of carpets - Insulation - Car dashboards **Electronic Devices:** - Televisions - Remotes - Cell Phones - Computers - Cables **Food** - 20% of exposure to flame retardants is from diet - Butter - Seafood - Meat - Dairy	- Crib mattresses - Changing pads - Bassinet pads - Car seats - Strollers - Furniture/ plush chairs - Electronic tablets (Fuhu Nabi Jr., Kurio Touch 4's, VTech InnoTab 3, LeapFrog, LeapPad 2 explorer) - Nursing pillows - Baby carriers - Rocking chairs/gliders - Foam cubes and mats for gymnasts	- IV pumps - TV's - Mattresses - Infant bassinet pads - Furniture cushions - Privacy curtains - Pulse oximeters - Ventilators - Electronics

Babrauskas et al., 2011; Bradman et al., 2012; Carignan et al., 2013; CEH, 2013a; Clean and Healthy New York, 2011; Ecology Center, 2013; Health Care Without Harm, n.d; Stapleton et al., 2011; Stromberg, 2012

ENVIRONMENTAL HEALTH CONCERNS OF FLAME RETARDANTS

Chemical flame retardants are released into the environment during production. When they are in products, there is also continuous release of these chemicals into consumer homes and businesses. As consumers interact with these products, a greater percentage of the chemical is released. For example, when a person sits on a couch the friction created from movement increases the amount of chemical that is released into the environment. When chemical flame retardants are released into the environment, they adhere to dust, which has been found to be a major source of exposure of flame retardants (Stapleton et al., 2009). Children's behaviors put them at a greater risk of exposure. For example, children often have their hands on furniture and other items that may be covered with this chemical-bound dust. They then put their hands in their mouth and ingest the chemical. Since their bodies are small, children are more susceptible to health risks because of exposure.

According to a study from the University of California Berkeley's Center for Environmental Research and Children's Health (CEH, 2013a), children were found to have flame retardant levels in their bodies that are three times higher than the levels found in their mothers. Children of color and low socioeconomic status were found to have higher levels of flame retardants in their bodies (CEH, 2013a). Contributing factors include more time spent indoors due to poor play conditions outside, and generally homes might have lower cost products and older furniture that might contain flame retardants previously phased out, such as PentPBDE (CEH, 2013a).

Exposure can also occur prenatally as flame retardants readily pass through the placenta. Newborns and infants can be exposed to these chemicals through breastmilk (Laboratory Equipment, 2012). However, even though breastmilk is a mode of transfer of flame retardants to children, the benefits of breastfeeding still outweigh the risks of exposure. Children have an increased vulnerability to these chemicals because their bodies go through rapid growth and development during early childhood (CEH, 2013a).

Flame retardants can also invade the human body or other living organisms through the air and skin. When a person is sitting in a room that has a product containing chemical flame retardants, they are breathing in the chemical that is free floating in the air. Researchers found that 97% of Americans tested have flame retardant chemicals present in their bodies (CEH, 2013a). Wildlife animals, including fish, birds, and marine mammals, also have increasing levels of these chemicals in their systems (Babrauskas et al., 2011).

Firefighters are another vulnerable group because of how these chemicals react during fires. When the chemicals burn, they produce high levels of toxic gases, such as carbon monoxide, dioxins, furans, hydrogen cyanide, soot

and smoke (Babrauskas et al., 2011; CEH, 2013a; Laboratory Equipment, 2012). Inhalation of these gases cause more fire injuries and fire deaths then the fire itself (Laboratory Equipment, 2012). Studies found that firefighters have higher rates of multiple myeloma, non-Hodgkins lymphoma, prostate, and testicular cancer than the average person (CEH, 2013b).

Chemical flame retardants can cause a variety of health problems. Table 2 lists health problems that are associated with chemical flame retardants. The systems that can be affected by toxic chemical flame retardants include neurologic, reproductive, endocrine, development, thyroid, and immune systems.

Table 2: Health Problems flame retardants cause

Cancer - Multiple systems **Altered thyroid hormone levels** **Neurologic impairments** - Memory - Learning **Developmental** - Adverse effects on motor, cognition, and behavioral outcomes - Lower IQ - Hyperactivity	**Reproductive** - Infertility - Cryptorchidism - Adverse birth outcomes including decreased weight, length, and chest circumference **Endocrine** - Type-2 diabetes - Insulin resistance - Obesity

AAP, 2013; Babrauskas et al., 2011; CEH, 2013a; Gascon et al., 2012; Stapleton et al., 2011

Watch this short Youtube video on why dust bunnies can make you ill.

Chemical flame retardants are not only a concern because they are harmful to our health and environmental systems, but recent research found that they are not effective at reducing fires. These chemicals are applied to polyurethane foam that is then covered by fabric or another covering. During fires, the fabric is ignited first. By the time flames reach the foam, the fire is no longer a small open flame, but a larger fire; thus the flame retardants are no longer effective (Babrauskas et al., 2011; CEH, 2013a) The United States Consumer Product Safety Commission (CPSC) conducted burn tests of upholstered chairs and concluded that the standards in California's TB 117 do not provide a significant fire safety benefit (Babrauskas et al., 2011).

Lastly, one of the dangers of chemical flame retardants is that they do not leave the human body, homes, and the environment once they are banned or phased out. People don't throw out their upholstered furniture when a chemical flame retardant stops being produced. In addition, if a product containing flame retardants ends-up in a landfill, the chemicals leak into the environment. These chemicals linger for years in the environment and build up in the human body because of their long half-lives (CEH, 2013a).

Watch this CNN 9 minute clip on why the safety and effectiveness of flame retardants is being questioned.

WHAT HAS BEEN DONE TO PROTECT OUR HEALTH?

In 1977, the chemical flame retardant chlorinated Tris (TDCPP) was removed from children's pajamas because it was found to cause cancer in test animals. At the time of removal, cancer in humans and flame retardants were not linked, but the perceived risk to a child's health was high (United States Consumer Product Safety Commission, 1977). Even though this chemical was banned in children's pajamas in 1977, it has remained in production and is in other children's products. Two other chemical flame retardants, PentaBDE and OctaBDE, have been phased out of production in the past decade due to scientific evidence that they are accumulating in our environment and in humans and may present a health risk (United States Environmental Protection Agency, 2013).

Through legal action in 2013 by the Center for Environmental Health, flame retardant chemicals were successfully removed from children's nap mats. Nap mats are often used in daycare settings, exposing young children and teachers to these unhealthy chemicals (CEH, 2013a).

In 2013, California passed a new fire safety law, TB 117-2013, that went into effect January 1, 2014. This new fire safety standard allows companies to make fire retardant-free products, but does not ban the use of flame retardant chemicals. The new standard states that a product must not smolder for more than 45 minutes after a lit cigarette is placed on it. Fire barriers or use of less flammable fabrics are ways manufacturers can avoid chemical flame retardants (CEH, 2013a).

TB 117-2013

Effective January 14, 2014

- Companies don't need to use chemical flame retardants to adhere to the new standard
- Products must pass a 45 minute smolder test
- Does not make chemical flame retardants illegal
- Details of ruling: http://www.bearhfti.ca.gov/about_us/tb117_faqs.pdf

WHAT CAN WE DO TO PROTECT OUR HEALTH NOW?

To reduce our exposure to flame retardants, consumers can send a strong message to manufactures by not purchasing products treated with chemical flame retardants. For example, when purchasing furniture, look for products that are polyester, wool, cotton, or down filled; made out of wood or canvas; or that attest to meeting the flammability standards without using chemicals. In addition, do not purchase products that contain polyurethane foam (CEH, 2013a). In the online resource section of this chapter, a list of known manufacturers who do not use toxic flame retardant chemicals is included. When remodeling or building a new home limit the use of carpeting and draperies as these products are known to contain flame retardants (CEH, 2013b).

Frequent hand washing is one of the most important prevention strategies to ingesting toxic flame retardants, especially for young children who are crawling or playing on the floor where more dust is found. Dryer lint and vacuum cleaner bags have high levels of flame retardants in them, so make sure to wash your hands after handling these. Vacuuming, especially with a HEPA vacuum cleaner, or wet mopping weekly to remove dust, can help decrease home levels of toxic flame retardants (CEH, 2013a; CEH, 2013b).

Due to the prevalent use of flame retardants in furniture and baby products, consumers need to execute certain precautions with these products to reduce their exposure:

- Inspect foam products for rips or product breakdown, and replace the product if possible.
- Don't reupholster foam furniture
- Execute caution when removing old carpet by isolating the work area, wet-mop to pick up small particles left behind, and carefully handle the padding.

Eliminating your exposure to toxic chemical flame retardants from electronics can be a little more difficult. Consumers can utilize the Center for Environmental Health's electronics shopping guide to help them purchase products that are free of brominated and chlorinated flame retardants (CEH, 2013b). In addition, don't let children play with or mouth electronic devices that are known to have flame retardants in them such as remotes and cell phones. If they do touch these objects, wash their hands as soon as possible and before eating.

When purchasing new products, look for the new TB 117-2013 label to see if chemical flame retardants have been added. Consumers should be cautious of discounted furniture as manufactures are able to sell their inventory that meets the old TB 117 standard until it is sold out. Consumers can ask manufactures if they use flame retardants in their products to determine product safety (CEH, 2013a).

In addition, consumers need to continue to support legislation that will change chemical policy regulations to create a toxic free environment. Encouraging and supporting companies to use better fire prevention strategies that do not use toxic chemicals can help reduce the environmental exposure to these toxins. Product design, use of physical barriers, and type of material used are ways companies can change their fire retardant strategies.

ONLINE RESOURCES/TOOL KITS

For Healthcare providers

The Center for Environmental Health has a variety of resources available to the public, which include:

- A great educational pocket size card to give patients providing them with tips on how to reduce their exposures to chemical flame retardants. http://www.ceh.org/wp-content/uploads/2013/08/Tips-to-Reduce-Exposure-to-Flame-Retardants-WEB.pdf
- A report on flame retardants found in children's furniture http://www.ceh.org/wp-content/uploads/2013/11/Kids-Furniture-Report-Press.pdf
- A list of products that contain harmful chemical flame retardants http://www.ceh.org/campaigns/flame-retardants/health-impacts/list-of-products-in-violation-of-california-law/

The National Resources Defense Council has a 2 page pamphlet that highlights TDCP and TCEP flame retardants focusing on the vulnerability of children.

The Environmental Working Group has a 1 page guide on PBDEs on what they are, where they are found, why their harmful, and how to avoid them.

For Parents and Child Caregivers

- The Center for Environmental Health offers testing of foam for flame retardants. Results take 2-3 weeks to get back and is free.
- Companies that advertise that they produce flame retardant-free furniture

If you live in California:

- Cisco Home (www.ciscohome.net)
- Eco-Terric (www.ecoterric.com)
- EcoBalanza (www.greenerlifestyles.com)
- Ekla Home (www.eklahome.com)
- Furnature, (www.furnature.com)
- Green Sofas (www.greensofas.com)
- Viesso (www.viesso.com)
- The Futon Shop (www.thefutonshop.com)
- LEE Industries (www.leeindustries.com)

If you live outside of California

- Corinthian (www.corinthianfurn.com)
- Drexel Heritage (www.drexelheritage.com)
- EcoSelect (www.ecoselectfurniture.com)
- Endicott Home (www.condosofa.com)
- LEE Industries (www.leeindustries.com) (CEH, 2013a)

Baby products

- Baby Luxe Organic: Polyester-filled and cotton-covered pads and mattresses
- Baby Bjorn: Polyester-filled and cotton-covered baby carriers
- Orbit Baby: Strollers and car seats with Expanded Polypropylene foam that meets TB 117 without halogenated chemicals
- Boppy: Nursing pillows filled with polyester and no added flame retardant chemicals (CEH, 2013b)

Children's Pajamas

- Sleepwear for children less than 9 months usually don't contain flame retardant chemicals because they don't have to meet flammability standards.
- Sleepwear for children older than 9 months may contain flame retardants
- look for snug-fitting sleepwear, tag will say "not flame resistant"
- avoid 100% cotton sleepwear
- avoid products that are treated with Proban or Securest
- News and reports on flame retardants in children's products including kids furniture and mattresses
- Handout on flame retardants in baby products and healthy tips
- Alliance for Toxic Free Fire Safety website has up to date information on chemical flame retardants. Sections include products, home, people, fire, and policy. They have a variety of resources and how to take action again chemical policy.

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HEALTH EFFECTS OF HEAVY METALS

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Metals are natural elements found in the earth and they have been mingling in the waters of the earth for ages and eons. They are also another emerging and growing category of global pollutants. As human industry extracts them from the earth, they are harnessed to industrial production, weapons, and the production of power, and then released again into the environment. We breathe, eat, and drink them more and more.

Metals are widely dispersed in our daily activities, in our occupations, our neighborhoods, our bridges, paints, and soils. People willingly have tattoo dyes containing metals injected into their skin (U.S. Food & Drug Admin., 2009). Metals are known to accumulate in select body tissues, especially the brain and kidneys, and many are toxic.

Surprisingly, the definition of what a heavy metal is varies, and it is loosely defined. Some definitions are based on the atomic weight of the metal, while others are based on its toxicity (Duffus, 2002). To further confuse the issue, some heavy metals are essential to body functions in certain quantities (like vanadium, manganese, iron, cobalt, nickel, copper, zinc and molybdenum), but those same metals may be toxic at sufficiently excessive amounts (Burger & Waishwell, 2001).

Toxicity varies, too, according to the metal involved and the specific form of that metal, the dose, the chronicity of the exposure, the age and size of the individual exposed to it, and the route of exposure. People may be exposed to heavy metals in many ways, such as through their diet, medications they take, their environment, and their occupational and recreational activities (Adal, A., 2013).

For instance, according to the Environmental Protection Agency's statistics, fish consumption advisories have been issued for over 16% of U.S. freshwater lakes and 7% of rivers due to chemical pollution, much of which is due to heavy metals (Burger & Waishwell, 2001).

Welders may exhibit Parkinson-like symptoms from occupational manganese exposure (Perl, Olanow, & Warren, 2007), and some medications, such as some imported Chinese and Ayurvedic medicines, have been found to contain dangerous levels of arsenic, mercury, and lead (Medicines and Healthcare Products Regulatory Agency, 2013; 2014).

In another example, acute renal failure secondary to ingestion of Ayurvedic medicine containing mercury in a 2 year old is discussed in this article (Sathe, Ali, & Ohri, 2013).

However, aluminum, bismuth, gold, gallium, lithium, and silver are also being used therapeutically in medicine (Adal, 2013), and mercury, silver, gold, and other metals have long been used in dental amalgams. According to Dr. Mark Houston, in his presentation to the 13th International Symposium of The Institute for Functional Medicine, "The Environmental Protection Agency has determined the safe daily intake of mercury to be less than 0.1 µg/kg/day (about 7 µg/day for a 154 lb person). It is estimated that 1 dental amalgam filling releases about 3-17 µgs of mercury vapor per day. The typical amalgam is composed of 50% mercury, 25% silver, 25% tin, copper, and nickel" (2007).

The chief heavy metals of interest in the environmental science literature in discussions about occupational exposures are lead, mercury, cadmium, chromium, copper, manganese, nickel, zinc, and silver (Hogan, 2010), but regulations of waste incinerator emissions may also include arsenic, cobalt, tin, and thallium.

The high temperatures of waste incineration tends to convert heavy metals into their oxide and chloride forms, which are then released as fine particulate matter into the surrounding atmosphere (Donnelly, 1991). Industrial effluent continues to pollute water worldwide, too.

In Life Support: The Environment and Human Health, McCalley (2002, p. 77) writes "Prescriptions to Reduce Human Exposure to Heavy Metals". He advises:

- Prescription 1: Accelerate and complete the global phaseout of leaded gasoline.
- Prescription 2: Begin an effort to monitor levels and trends in metals pollution worldwide.
- Prescription 3: Establish population-based biomonitoring for selected metals.
- Prescription 4: Educate government, scientists, and the general public about the toxicity of metals.
- Prescription 5: Declare a moratorium on the production, distribution, and use of products likely to significantly increase global exposure to toxic metals.
- Prescription 6: Continue basic research into the impact of metals on human health.

There is much to be done!

A table named Typical Presentation of the Most Commonly Encountered Metals and Their Treatment from an article entitled Heavy Metal Toxicity may be accessed by clicking here (Adal, 2013). It lists acute and

chronic symptoms of exposure, pertinent lab values and concentrations, as well as recommended treatment regimes.

The following is a listing of some of the more common heavy metals of concern, with a brief introduction to each, and useful web links for further investigation.

ARSENIC

Arsenic is a known toxin and carcinogen, and it is also known that human exposures to arsenic are common. Safe levels of exposure are still being debated by scientists and government regulators. It is found naturally in rock, many water supplies, and crops that are grown in arsenic-tainted waters, like rice, or apples from orchards with a history of being doused with lead arsenate or copper arsenate. It is also found in pressure-treated wood products that have been treated with chromium arsenate.

Arsenic Web links:

- Agency for Toxic Substances & Disease Registry (ATSDR, 2012): Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs
- ATSDR: Patient education and instruction sheet
- Centers for Disease Control and Prevention (CDC) Health Hazard Evaluation Table

CADMIUM

Cadmium exposure is not especially common, though it tends to be associated with occupations dealing with pigments, metal plating, batteries, and some plastics. However, exposure to cadmium may also be through emissions from a cadmium smelter into the air or into sewage sludge later used as fertilizer for food crops. People have a hard time excreting cadmium, and it has been found to damage the lungs, testicles, and kidneys (McCally, 2002).

Cadmium web sites:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs

CHROMIUM (HEXAVALENT)

Chromium may be found in various forms. The hexavalent form is thought to be the most toxic and carcinogenic, and is used extensively in some industries like leather tanning. Factory runoff from those industries has become a major problem. It is highly corrosive and allergenic and lung cancer is associated with its inhalation.

Chromium web sites:

- OSHA Fact Sheet: Health Effects of Hexavalent Chromium
- U.S. EPA fact sheet on Chromium Compounds

COBALT

For most people, cobalt exposure may occur through consuming foods and beverages (like cobalt-fortified beer). For others, exposure to cobalt occurs occupationally as cobalt powders are used industrially in enamels, and in the creation of metal alloys. It is mainly absorbed through the pulmonary and the gastrointestinal tracts, and the main target organs are the skin and the respiratory tract.

Cobalt web links:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs

COPPER

Interestingly enough, levels of copper and iron which may be normal during the reproductive years, may be later found to contribute to diseases of aging such as atherosclerosis, Parkinson's Disease, and inflammatory diseases, or to contribute to aging itself via free radicals of oxidation (Brewer, 2007).

Copper websites:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs

LEAD

Lead has been mined and used by people for centuries, and exposure is common. It is the most widely used of the metals, and the worrisome health effects of lead have likely been the most studied of all the heavy metals. In the 20th century, when lead was used in plumbing, gasoline, solder in food cans, paint, and ceramic ware, lead levels in the human population rose to dangerous levels. Now, in the 21st century, we have made great strides in reversing the trend, but there is still a lot of lead around.

There is lead in city water supplies like Washington, DC (EPA, 2014). There is lead in the paint in bridges, buildings, and infrastructure across the world. There is lead in cheap plastics like lunch bags (Daluga & Miller, 2007), diaper bags,

purses, Christmas lights, and vinyl window blinds. People willingly have tattoo dyes containing metals injected into their skin (U.S. Food & Drug Admin., 2009), and there is even lead in many brands of lipstick, though the EPA reports state that studies have not shown that enough lead is ingested for there to be a proven health risk.

Lead is associated with a wide variety of health problems, ranging from convulsions, coma, renal failure, anemia, hypertension, metabolic and neurological disorders. The EPA states that, " Studies continue to show that elevated Blood Lead Levels (BLL) are associated with neurological effects, including reduced intelligence, changes in brain function, fatigue, impotence, and reductions in nerve conductivity. There are also systemic effects from lead exposures, such as changes in the level of circulating thyroid hormones and changes in immune system parameters."

Furthermore, maternal bone stores of lead are mobilized during pregnancy and passed on to the next generation during pregnancy and lactation.

Public health education regarding minimization of exposures through housekeeping and dust control, the use of personal protection during renovation projects, and reduction in the use of lead in everyday products is important. For a lecture regarding lead exposure and regulations please see: http://lecture.envirnevidence.org/lead/

Lead websites:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs
- Environmental Protection Agency: Lead in DC Drinking Water

LITHIUM

According to Hsing Po Kang and his fellow researchers (2013, April), "Rechargeable lithium-ion (Li-ion) and lithium-polymer (Li-poly) batteries have recently become dominant in consumer electronic products because of advantages associated with energy density and product longevity. However, the small size of these batteries, the high rate of disposal of consumer products in which they are used, and the lack of uniform regulatory policy on their disposal mean that lithium batteries may contribute substantially to environmental pollution and adverse human health impacts due to potentially toxic materials."

Lithium web links:

- Centers of Disease Control & Prevention: NIOSH guide to chemical exposures
- Centers of Disease Control & Prevention: Lithium Hydride Immediately Dangerous to Life or Health Concentrations (IDLH)

MANGANESE

Manganese is considered a "trace element", and small amounts are necessary to be healthy. People consume manganese in food and water. However the higher level of exposure in occupational settings, like those observed in the welding and steel production industries, have been associated with the development of symptoms similar to Parkinson's Disease (Perl & Olanow, 2007). At high levels, manganese can cause brain damage.

Manganese exposure is increasing and has become of global concern since the addition of a manganese-based additive to gasoline called methycyclopentaldienyl manganese tricarbonyl, or MMT.

Manganese links:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs
- CT Dept. of Public Health: Drinking Water Fact Sheet on Manganese
- U.S. EPA Fact Sheet About Manganese

MERCURY

Mercury may be found in various forms (and as inorganic and organic compounds). It is released into the air when coal is burned or when trash, especially medical waste is incinerated. It is used in various chemical, metal-processing, automotive, and electrical-equipment manufacturing, and in dental amalgams, batteries, and thermometers. The form and variety of mercury highly influences its level of toxicity.

The organic form of methylmercury bioconcentrates up the food chain, so that many species of larger fish carry worrisome levels, levels that are potentially dangerous to the unborn and to little children. National advisories are in place to limit the consumption of the fish species with the highest levels.

Health effects include developmental problems (effects during periods when organs are developing), gastrointestinal (digestive) problems, neurological

disorders, ocular difficulties (eyes), and renal/urinary problems (Agency for Toxic Substance & Disease Registry, 2011).

Mercury websites:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs

NICKEL

Nickel is a very abundant metal and is found in many metal alloys, batteries, industrial compounds, metal-plating, and chemical reactions. It may be released into the environment from the chimney stacks of power plants and waste incinerators. The ATSDR states that,

> "Food is the major source of exposure to nickel. You may also be exposed to nickel by breathing air, drinking water, or smoking tobacco containing nickel. Skin contact with soil, bath or shower water, or metals containing nickel, as well as, metals plated with nickel can also result in exposure. Stainless steel and coins contain nickel. Some jewelry is plated with nickel or made from nickel alloys. Patients may be exposed to nickel in artificial body parts made from nickel-containing alloys. Exposure of an unborn child to nickel is through the transfer of nickel from the mother's blood to fetal blood. Likewise, nursing infants are exposed to nickel through the transfer of nickel from the mother to breast milk."

The most common health effect of nickel is an allergic reaction to the nickel-coating on jewelry (ATSDR, 2011).

Nickel websites:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs
- NJ Dept. of Health: Right to Know Fact Sheet on Nickel
- U.S. EPA: Nickel Compounds

SILVER

Silver is a natural element most often found as a compound with sulfur, chlorine, and nitrogen. It is used in jewelry, dental amalgams, electronic equipment, pool sanitation, and is being used recently in nanoparticle-form as an antibacterial agent.

High levels of silver exposure in the air have been associated with breathing problems, lung and throat irritation, and stomach pains. Skin contact with silver can cause mild allergic reactions such as rash, swelling, and inflammation in some people. Chronic high level exposure can cause a blue-grey skin discoloration called arygria.

Silver web links:

- Agency for Toxic Substances & Disease Registry: ToxFAQS
- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal

THALLIUM

In a review of public health and environmental concerns, Peter and Viraraghavan (2005) state that, "Thallium (Tl) is a rare but widely dispersed element. All forms of thallium are soluble enough to be toxic to living organisms. Thallium is more toxic to humans than mercury, cadmium, lead, copper or zinc and has been responsible for many accidental, occupational, deliberate, and therapeutic poisonings since its discovery in 1861".

Thallium is used in the manufacture of electronic devices and switches, special glasses, and in medical procedures to evaluate heart disease (ATSDR, 1992).

People can be exposed to thallium through food (the largest exposure), air, and water, cigarette smoke.

Thallium can cause neurological, respiratory, cardiac, liver, and kidney problems if large amounts are consumed for short periods of time. Vomiting and diarrhea, temporary hair loss can also occur, and death may result after exposure to large amounts of thallium for short periods of time.

Thallium web sites:

- Agency for Toxic Substances & Disease Registry: Public Health Statement
- Thallium: a review of public health and environmental concerns

VANADIUM

Vanadium is a metal that everyone is exposed to, mostly from food, but also from air and water. High levels of exposure tend to occur within occupational settings. It has been found that vanadium compounds may damage the male reproductive tract in animal studies.

Vanadium has been found to irritate the lungs, causing asthma-like symptoms and bronchitis, anemia, and also kidney damage (ATSDR, 2012).

Vanadium web sites:

- New Jersey Department of Health and Senior Services: Hazardous Substance Fact Sheet
- Agency for Toxic Substances & Disease Registry: ToxFAQs

ZINC

Zinc is one of the most common elements on earth and is found in air, water, and virtually all foods. It is essential to our health, but either too little or too much can be problematic. It has many commercial uses in batteries, metal coatings to prevent rust, and in the production of metal alloys. It is used to make paint, rubber, dyes, wood preservatives, and ointments.

Too high levels can cause stomach cramps, nausea and vomiting, or a short-term condition called metal fume fever, which causes flu-like symptoms such as fever, chills, nausea, fatigue, joint pains and muscle aches, shortness of breath, cough and chest pains (Malaguernera, et al., 2013).

Zinc web sites:

- Agency for Toxic Substances & Disease Registry: Toxic Substances Portal
- Agency for Toxic Substances & Disease Registry: ToxFAQs

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ENVIRONMENTAL PUBLIC HEALTH TRACKING

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In 2000, the Pew Environmental Health Commission was charged with developing a blueprint to rebuild the nation's public health defenses against environmental threats. At the time a survey to registered voters found that the majority (87%) were seriously concerned about risks to their health from pollutants in the environment. Most said that taking a national approach to tracking environmental health should be a priority of government at all levels (America's Environmental Health Gap: Why the Country Needs a Nationwide Health Tracking Network, Pew Environmental Health Commission 2000). In response, the Centers for Disease Control and Prevention (CDC) developed a national tracking program to integrate existing health and environmental information systems and build state-based tracking networks.

The Environmental Public Health Tracking (EPHT) network or "Tracking" is the ongoing collection, integration, analysis and interpretation of data about environmental hazards, exposure to environmental hazards, and human health effects potentially related to exposure to environmental hazards. The overall mission of EPHT is to improve the health of communities. With enhanced surveillance, data is more readily available to determine prevalence and trends of certain diseases associated with environmental exposure.

Unlike research, the EPHT program tracks certain acute and chronic diseases suspected of having an environmental connection with key environmental data (i.e., asthma and air pollution). While associations between environmental exposures and health effects have been documented, much more research is this area is needed.

The tracking network is designed to assist health professionals in exploring trends in their communities and to generate hypotheses for future study. Using the network, nurses can view maps, tables and charts with data about chemicals found in the environment, along with chronic diseases. Nurses can view this by areas of geographic interest. With EPHT, nurses have access to quality, nationally consistent data measures, in order to conduct community assessments, plan environmental health investigations, including health impact assessments (HIAs), and respond to questions from patients and peers.

The National EPHT network allows health care providers to explore health and environmental data in one easy to find location. For example, users can examine possible health risks from contaminants such as air pollution and explore the relationship to myocardial infarction within specific geographic regions of a state. Or nurses can observe the amount of lead in drinking water and the relationship to premature births at the county level.

Currently 25 states and the city of New York participate in the EPHT program. Readily available health data from the tracking network allows national, state and local health officials to respond and develop effective public health actions to prevent or control certain diseases that may have environmental etiologies. In addition, the public is provided with a better understanding of what is occurring in their communities and what actions they may take to protect or improve their health (*EPHT Program: Closing America's Environmental Public Health Gap* 2004, CDC). For further information and to view the current EPHT states, visit the CDC National EPHT website.

INTRODUCTION TO RISK ASSESSMENT IN ENVIRONMENTAL HEALTH

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WHAT IS RISK?

The Environmental Protection Agency defines risk as "the chance of harmful effects to human health or to ecological systems resulting from exposure to an environmental stressor" (EPA, 2012a).

The EPA defines a stressor as "any physical, chemical, or biological entity that can induce an adverse response. Stressors may adversely affect specific natural resources or entire ecosystems, including plants and animals, as well as the environment with which they interact" (EPA, 2012a).

It is important to keep in mind that risk can be actual (based on empirical data) or perceived (based on cultural and/or personal beliefs). For a noteworthy view on the difference between the two read Perceived vs. Actual Risk (Schneier, 2006).

Remember, risk is also a matter of perception. For example, every time you work with paper, you are at risk of getting a paper cut. One could say that the risk of a paper cut has minimal perceived risks to human health and therefore people continue to work with this material without warning labels.

Changing perception is a matter of gathering relevant and accurate data and balancing this against beliefs and values.

If the negative outcomes of a paper cut were perceived as significant, one could demand that all reams of paper include a warning label informing the end user of the impending dangers. Sound a little extreme? That's because we don't perceive paper cuts as a major threat to human health. On the other hand, warning labels are found on cigarette packages, medication bottles, household cleaning agents, plastic bags and thousands of other products that are perceived and proven to negatively impact health.

WHY IS RISK ASSESSMENT IMPORTANT TO NURSES?

Nurses perform risk assessments on a daily basis. For example, an acute care nurse must assess a patient's risk of developing pressure ulcers in the hospital. Alternatively, a discharge coordinator will assess a client's risk of falls based on their home environment. In doing so, nurses seek to reduce and prevent harmful effects to human health, including disease, disability, and premature death. One way of achieving this is to limit human exposure to environmental stressors and promote healthy, sustainable environments. Nurses need to know how to identify environmental hazards and assess human risk related to these hazards. Thus, risk assessments can be done for individuals, families, communities or larger cohorts.

HOW DOES ONE ASSESS A RISK?

The first step in risk assessment is to define a problem. What is the problem, how big is it, how does it impact humans or the environment and which stakeholders are salient enough to help solve the problem? The methodology used in this section combines two excellent risk assessment frameworks:

1. Health Canada's Decision-Making Framework for Identifying, Assessing and Managing Health Risks (Health Canada, 2000)
2. EPA's Human Health Risk Assessment (EPA, 2012b).

Problem solvers beware! New risk managers make the mistake of skipping over risk assessment and jumping straight to a solution. Do not make this mistake. The assessment process is what tells you whether or not you even have a risk.

Step One: Identify and Characterize a Problem

For all things risk related, identifying a problem is the starting point. A problem could be a hunch, an observation, or the product of existing information. Below is a list of questions to ask in order to fully understand the problem.

Who is impacted by the problem?

Whenever possible provide a quantitative value.

- Individual/ group
- General population
- Life stages such as children, teenagers, pregnant/ nursing women
- Population subgroups - highly susceptible (for example, due to asthma, genetics, etc.) and/or highly exposed (for example, based on geographic area, gender, racial or ethnic group, or economic status) (EPA, 2012b).

Example: "75% of South Asian men and women aged 45 and up, living in Surrey, have diabetes."

What type of problem/hazard is in question?

- Chemicals (single or multiple/cumulative risk)
- Radiation
- Physical (dust, heat)

- Microbiological or biological
- Nutritional (for example, diet, fitness, or metabolic state)
- Socio-Economic (for example, access to health care) (EPA, 2012b).

Example: "Children aged 0-10 are experiencing increased heat exhaustion due to the recent record breaking temperatures."

How is the problem reaching humans?

- Point sources (for example, smoke or water discharge from a factory; contamination from a Superfund site)
- Non-point sources (for example, automobile exhaust; agricultural runoff)
- Natural sources (EPA, 2012b).

Example: "There is an increase in reports of asthma attacks downwind of the power plant."

How does this problem enter the human body?

- Pathways (recognizing that one or more may be involved)
    - Air
    - Surface Water
    - Groundwater
    - Soil
    - Solid Waste
    - Food
    - Non-food consumer products, pharmaceuticals
- Routes (and related human activities that lead to exposure)
    - Ingestion (both food and water)
    - Contact with skin
    - Inhalation
    - Non-dietary ingestion (for example, "hand-to-mouth" behavior)

Example: "Residents of the Kingston neighborhood are complaining of a change in the taste of their water and an increase in unusual skin rashes."

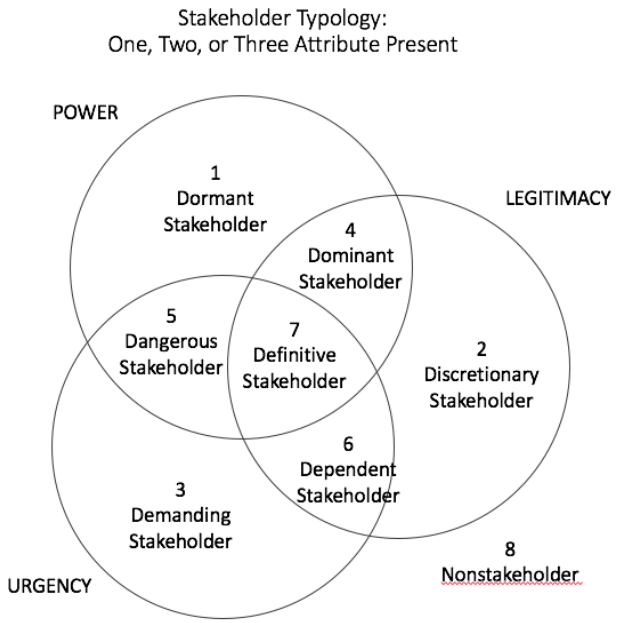
Lastly, it is important to define whether the problem is acute or chronic; what the severity of the adverse effects are; what time frame the problem occurs in; and if the risk is only to humans or to other species as well (EPA, 2012c).

Health Canada (2000) suggests drawing from one or more of the following sources to characterize a risk:

- Toxicology studies (e.g. on laboratory animals, cultured cells, or tissues);
- Epidemiology studies (e.g. of occupationally exposed workers);
- Environmental monitoring (e.g. levels of chemical contaminants in air);
- Biological monitoring (e.g. lead levels in blood);
- Product surveillance (e.g. adverse reactions to specific therapeutic products);
- Disease surveillance (e.g. distribution of cases of a disease over time);
- Investigations of disease outbreaks;
- Targeted risk assessment programs;
- Targeted public health research;
- Information supplied by industry as required by legislation;
- Lack of compliance with legislative requirements;
- Consultation with experts (e.g. advisory committees);
- Literature review;
- Monitoring of the news media;
- Communications from interested and affected parties (e.g. health care professionals, consumers, industry);
- Focus groups
- Examination of public perceptions and concerns.

Step Two: Identify and Characterize the Salient Stakeholders

In this step, identify and characterize the key stakeholders. You will discover that certain stakeholders exhibit power, urgency and/or legitimacy or a combination thereof. Mitchel et al. (1997) categorized stakeholders using these three main attributes as depicted in the Venn diagram below (Figure 1). For more information on how to characterize stakeholders read Mitchel et al. (1997).



Step Three: Formulate a Problem Statement

If the nurse has done a good job collecting the data above, then this step will be easy. Take your "hunch" from step one and make it more specific.

For example, the problem, "Sudden Infant Death Syndrome occurs more often in babies than before" can be transformed to a thorough problem statement.

Problem Statement: (data is fictitious) "Sudden Infant Death Syndrome (SIDS) impacts 1 in 10 infants aged 0-5 months old in North America. This number is equitably distributed across socioeconomic status, ethnicity and geographic regions. Sleeping position is a strong precursor of SIDS; infants sleeping prone (face down) have a 30% increased risk of SIDS as compared to infants that sleep face up."

Resources about Risk Assessment

- EPA Risk Assessment
- Healthy People 2020. Environmental Health
- National Research Defense Council. (2012). Strengthening Toxic Chemical Risk Assessments to Protect Human Health
- World Health Organization. Children's Environmental Health: Environmental Risks

CONCLUSION

This section presented the steps of identifying a problem and gathering pertinent information to assess whether or not a problem poses a health risk. In addition to assessing actual risks it is important to identify the perceived risks through your most salient stakeholders. Selected resources about risk assessment are provided. Finally, this is an iterative process which allows one to truly assess, is this problem really putting the target population at risk?

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