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Environmental Impacts on Reproductive Health

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Learning Objectives:

After completing this activity, health care providers should be able to:

- When counseling patients, use the CH_2OPS mnemonic to take a comprehensive environmental health history to assess exposures.
- Name two adverse effects on reproductive health that may be caused by toxicants that patients typically use or to which they are commonly exposed.
- List three strategies for reducing exposures to chemicals with potential adverse effects on reproductive health that can be used when providing guidance to a patient.
- When seeing a female patient who is planning to conceive in the next six months, discuss the risks and benefits of fish consumption and identify consumption guidelines from a reputable source, such as the Food and Drug Administration or the Natural Resources Defense Council.

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The content of this publication is solely the responsibility of ARHP.

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Introduction

In the morning, a patient asks you during an annual well-woman visit how long before conceiving she should stop eating tuna fish. That afternoon, a woman in her third month of pregnancy asks you whether her headaches could be caused by exposure to chemicals in her workplace. On the drive home, you hear a report on the radio saying that the majority of infants are born with detectable blood levels of a chemical that leaches from plastics. When you arrive home, your teenage daughter asks whether she needs to rinse the bell peppers for your family's salad. By the end of the day, are you wondering if you need a better understanding of environmental health issues?

The purpose of this monograph is to provide front-line clinicians with practical guidance on environmental reproductive health issues, based on the best available evidence. Because of ethical concerns about human studies with toxicants, the best available evidence in many cases is derived from animal data. In addition, because of the multifactorial nature of many adverse health effects, it is often impossible to establish direct cause-and-effect relationships with certainty. In many instances, this means that one cannot definitively determine that a particular substance will result in a particular reproductive health effect. However, often there is sufficient evidence from animal and population-based studies to warrant the recommendation that patients reduce their exposure to specific toxicants.

This document provides clinicians at the front lines of care with the information they need in everyday practice to counsel patients on environmental issues that affect reproductive health. This monograph defines key terms, discusses environmental exposures and how they may affect reproductive health, and highlights a few key examples of chemical exposures. Through the use of case studies and vignettes, the document illustrates how clinicians can help patients assess potential environmental exposures and take steps to reduce the impact on their reproductive health. These case studies and vignettes focus on environmental exposures that primary health care providers are likely to encounter in their everyday practice and through questions generated by an increase in media attention. The monograph concludes with a collection of tools and resources that clinicians can use to address environmental health concerns in their daily practices.

Key Definitions

Environmental reproductive health is an emerging field that includes terminology and basic concepts that may be unfamiliar to many clinicians. An important concept to understand is the distinction among the terms hazard, risk, and exposure. Although the terms hazard, risk, and exposure are sometimes mistakenly used interchangeably, in environmental reproductive health, the words have distinct meanings.

- *Hazard* is the *potential* for radiation, a chemical, or another pollutant to cause human illness or injury.[1,2]
- *Exposure* is the *process* by which a substance becomes available for absorption by the target population, organism, organ, tissue, or cell, by any route.[3]
- *Risk* is a measure of the *probability* that damage to life, health, property, and/or the environment can occur as a result of exposure to a given hazard.[1]

The next chapter covers guidance on environmental reproductive health issues for providers.

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Guidance for Providers

This chapter outlines action steps that clinicians can take and specific guidance they can recommend to help patients reduce their exposure to environmental toxicants.

Action Steps for Providers

Given the potential effects of environmental exposures on reproductive health and the importance of preventing potentially harmful exposures, it is critically important that front-line providers of women's health care are able to identify potentially harmful environmental exposures and help mitigate or prevent them. In providing guidance, clinicians must take the realities of a patient's daily life and the certainty of scientific evidence into consideration. If there is a simple way to avoid or mitigate a potentially harmful exposure that has a moderate or greater certainty of evidence, clinicians should maintain a low threshold for recommending it.

Providers can take several specific steps to support their patients in reducing environmental exposures, including:

- Learning about the environmental issues in their local area, to better focus their inquiry with individual patients;
- Incorporating questions about environmental exposures into every health history;
- Suggesting steps to reduce or avoid any exposures that are identified;
- Being prepared to give specific guidance to patients who are or may become pregnant;
- Helping patients assess their risk of environmental exposure at work;
- Providing information or referring patients to reputable educational Web sites; and
- Using their voice as clinicians to shape policies aimed at improving environmental conditions.

Taking an Environmental Health History

"CH_2OPS," which stands for **C**ommunity, **H**ome/**H**obbies, **O**ccupation/School, **P**ersonal, and **S**ocioeconomic, is a helpful memory aid for reviewing the various domains of a patient's life in which environmental exposures occur. Providers can use CH_2OPS domains when taking the environmental history to assess a patient's environmental exposures and to educate and raise awareness about potential harmful exposures. Clinicians also can help guide patients by learning about and making patients aware of resources and alternatives in their communities, homes, workplaces, and personal lives that can help them to minimize exposure to toxicants. Clinicians can consult the final chapter of this monograph, **Resources for Providers and Patients**, for resources for their own education and to have ready access to information for patients. Many of the following chapters also contain resources and counseling points, included in shaded boxes, specific to the topic addressed in that chapter.

Table 1: Examples of Guidance for Patients, Based on CH_2OPS Mnemonic

Domain	Area of Concern	Example of Guidance
Community	Hazardous waste sites	Have well water tested
	Solvents	Patronize dry cleaners that avoid toxic solvents
	Toxic chemicals	Ask beauty salons to use products without toluene, phthalates, and other toxic chemicals
	Pesticides	Buy organic produce when possible; join community groups to advocate for restrictions on spray drifts from agricultural operations
Home/**H**obbies	Drinking water	Be aware of the safety of private well water and community sources of drinking water
	Furniture products Detergents Automotive care products	Read labels carefully, contact manufacturers if necessary to assess contents, and avoid exposure if necessary
	Adhesives and solvents (e.g., for art projects)	Use in well-ventilated spaces
	Household cleaners	Use non-toxic products (e.g., vinegar and baking soda); avoid mixing ammonia and chlorine; use ammonia and chlorine bleach sparingly, with ventilation
	Heavy metals	Be aware of fish advisories for locally caught fish (i.e., for hobby fishing); check for lead paint and pipes; follow recommendations about seafood consumption (for both species and amount)
	Plastics	Avoid foods and beverages in plastics number 3, 6, and 7; avoid vinyl products; avoid heating food in plastic containers
	Pesticides	Avoid using pesticides in homes, lawns, gardens, or on pets; wash fruits and vegetables; buy organic produce when possible
Occupation/ School	Chemicals	Become familiar with all chemicals used or encountered at work and learn about any toxic properties; wash exposed skin; change from work clothes at the workplace; wash exposed work clothes separately; use protective gear; take extra steps to avoid exposure if pregnant or planning pregnancy
	Radiation (e.g., dental or health care workers) or biological agents (e.g., laboratory or health care workers)	Use protective gear; take extra steps to avoid exposure if pregnant or planning pregnancy
	Pesticides	Avoid use of pesticides on school grounds and in the workplace
	Heavy metals (e.g., arsenic)	Avoid use of pressure-treated wood in playground equipment
Personal	Diet, alcohol use, tobacco use, substance abuse	Review and modify personal habits to maximize overall good health
	Medications	Review any prescription and non-prescription medications with health care provider
	Insect repellents	Investigate ingredients of products; contact manufacturer if necessary
	Personal care products and cosmetics	Investigate ingredients of products; contact manufacturer if necessary; check product databases (e.g., www.cosmeticsdatabase.com)
Socioeconomic	Air pollution Heavy metals Asbestos	Know tenant and citizen rights; work with community organizations and governmental agencies to raise awareness of hazards and advocate for prevention

The next chapter will address the links between environmental exposures and reproductive health, the concept of toxicity, and some of the mechanisms by which exposures result in negative health outcomes.

The Links Between Environmental Exposures and Reproductive Health

This chapter explains how exposures to certain toxicants might result in adverse effects on reproductive health.

Environmental health has been defined as "the branch of public health that protects against the effects of environmental hazards that can adversely affect health or the ecological balances essential to human health and environmental quality."[1] As such, the field encompasses research, assessment, and guidance about the health effects of a variety of exposures in our environment, including radiation, chemicals, and some biological agents. This monograph focuses specifically on chemicals and heavy metals such as mercury that can have adverse effects on reproductive health.

Chemicals in the Environment

Of the 87,000 chemicals registered for commerce in the United States, only one-tenth have been tested for potential health effects.[2,3] Of those that have been tested, only a portion have been assessed for reproductive health effects. Although many of these chemicals are integral components in the production of important materials and goods, some may adversely affect human health or the environment.

Testing of the chemicals used in the United States is limited by the fact that current legislation—the Toxic Substances Control Act (TSCA), which was passed in 1976—assumes that most chemicals are safe unless proven otherwise. These chemicals make up a large majority of the chemicals used in the United States today. Furthermore, many chemicals in common use—such as those in pesticides and many personal care products—are not regulated under TSCA.[3] In addition, as a result of advances in toxicology, including better understanding of low-dose effects, many experts believe that the current regulatory methods for testing toxicity are no longer adequate.

Concerns About Reproductive Health Effects

Over the past several decades, awareness has been growing regarding the reproductive health effects of exposures to certain chemicals. Scientists, clinicians, and patients have concerns about a number of recently identified trends in fertility and reproduction (see Figure 1). Some of these trends are localized to specific geographic locations; others are more widespread.

Given the history of the slow response to emerging data on toxicants, many scientists, clinicians, and advocates are concerned that delays in addressing exposures will occur again.[14] Experience has demonstrated that waiting until firm "proof" is available can cause significant time lags between the point where there is knowledge of a link between health outcomes and exposure to an environmental toxicant and the time when regulatory action is taken or clear guidance provided. In the past, serious steps to prevent and mitigate some environmental threats to public health were taken only after decades of data were collected—and thousands of lives affected. For example, physicians did not counsel patients to avoid tobacco exposure until several decades after there were clear scientific data on the health effects of smoking. Lead, mercury, and asbestos are other examples of this unfortunate lesson. For this reason, many experts are fostering more widespread adoption of a precautionary, or preventive, approach.

As early as the 1970s scientists developed the concept of the precautionary principle, which 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."[15] This principle provides a general approach to guide policy-making, patient counseling, and personal decision-making about environmental exposures. On the basis of currently available evidence, providers can take a precautionary approach and recommend actions to avoid exposures.

Reproductive Trends in Some Geographic Areas Raise Concerns

- Increase in testicular cancer incidence
- Decreasing sperm counts
- Decline in serum testosterone
- Earlier pubertal development in girls
- Fewer males being born
- Documented increases in certain types of birth defects

Figure 1: Reproductive Trends in Some Geographic Areas Raise Concerns[4-13]

Impact on Reproductive Health

Reproductive toxicants may contribute to a spectrum of adverse effects on reproductive health. These effects include menstrual irregularities, early or delayed puberty, infertility, subfertility, early pregnancy loss, fetal death, impaired fetal growth, low birthweight, premature birth, and structural (e.g., cardiac defect) or functional (e.g., learning disability) birth defects.[16,17] The impact of exposure to a reproductive toxicant may not be immediately evident. Instead, the effects may emerge at key life transitions: for example, when attempting conception, during pregnancy, during development of the embryo or fetus, in the newborn, and during the offspring's childhood, puberty, and eventual fertility as an adult.[18] For this reason, it is important to be aware of the potential effects of a substance over a long period of time, rather than only during the period immediately after exposure.

Exposure to Reproductive Toxicants

Substances with potentially harmful effects on reproductive health are present in water, air, soil, dust, food, and consumer products. Individuals may encounter these toxicants in the home, community, school, or workplace. To result in an adverse effect, a toxicant must come into contact with an individual and enter the body, a step referred to as biologic uptake. *Biologic uptake* is the point at which exposure occurs (see Figure 2).

Toxicants enter the body in one or more of three ways: inhalation, ingestion, or absorption through the skin. After entering the body, toxicants are distributed to various tissues and subject to metabolism and excretion. Toxicants, or their metabolites, travel to target organs, such as the thyroid, ovaries, or testes, where they exert biological effects.[19] Some toxicants can be stored for long periods of time in muscle, bones, adipose tissue, or other soft tissues. For example, lead can reside in bone for decades. These substances are described as having long "half-lives" within the body. They can continue to leach from these tissues and travel to target organs for long periods of time.

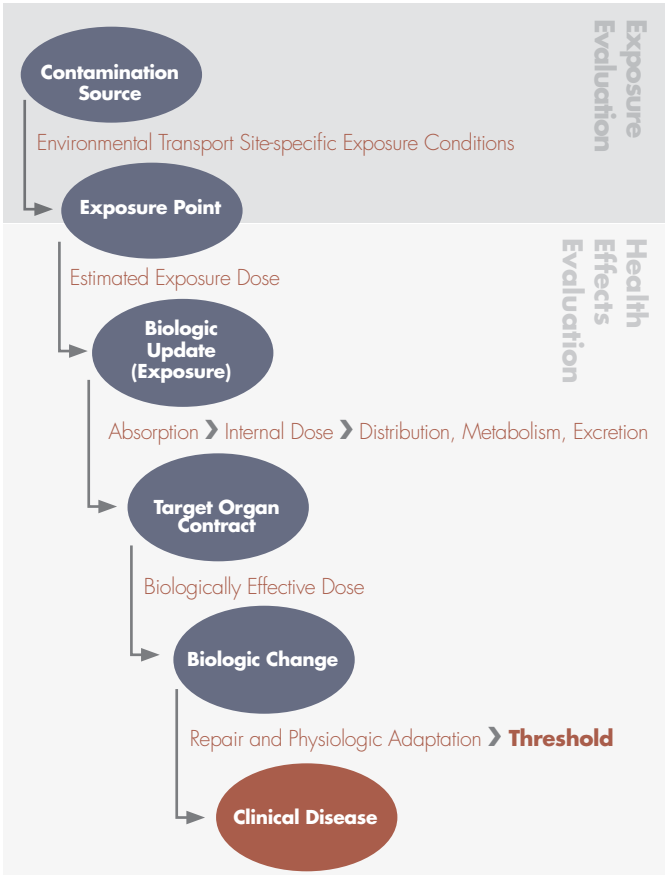

Figure 2: The Exposure Pathway[19]

In the same way that all smokers do not develop lung cancer, every person exposed to toxicants does not necessarily experience adverse health effects. Many factors—in addition to the exposure dose and the concentration of toxicant in the environment—affect whether an exposure ultimately results in a harmful health effect.[19] These factors, which are listed in Figure 3, can directly influence cells, tissues, and organs, and they can alter gene function or expression.

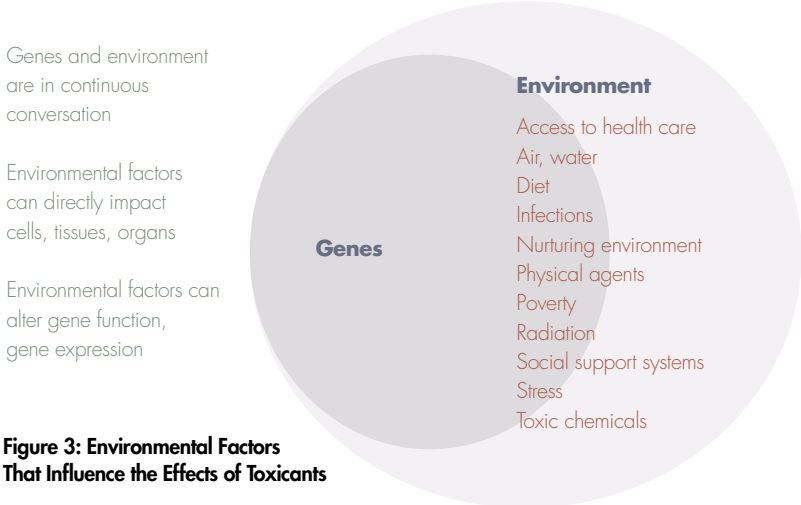

Figure 3: Environmental Factors That Influence the Effects of Toxicants

Whether or not an environmental exposure results in adverse effects on reproductive health in an individual ultimately depends on the *interaction* among these various factors. For this reason, it is often impossible to document a clear tie between a specific toxicant and a specific reproductive health effect.

"Safe" Levels

Environmental experts now are challenging the traditional assumptions about "safe" levels of toxicant exposures at a population level. Recently, the National Academy of Sciences stated that based on the extent of multiple chemical exposures individuals experience, disease frequency, age status of the population, and genetic variability, it is reasonable to assume that exposures to certain chemicals will carry some risk, though that risk may be small or large.[20] At present, it can be challenging to quantify the risk because traditional testing of chemicals—using high doses in adult animals, often with little genetic or other variability—makes it difficult to predict precisely the effects of everyday exposures.[14] For this reason, it is difficult to create clear clinical guidance that addresses the potential health effects of lower levels of exposures, which are more common in the general population. It is important for clinicians to recognize that some occupational exposures to hazardous chemicals are substantially higher than those for the general population.

Timing of Exposure

The timing of exposure is another factor that strongly influences the ultimate biological effect of exposure to environmental toxicants. Although exposure to these substances can affect individuals at all stages of life, exposure during critical windows of susceptibility may have more significance. These windows vary somewhat depending on the particular toxicant and include periods during gestation, childhood, adolescence, and adulthood. Because these windows of susceptibility include very early pregnancy, clinicians should counsel women about exposures throughout their reproductive lives.

Mechanisms of Effects

Some chemicals have direct toxic effects on the reproductive system. Endocrine-disrupting chemicals (EDCs) can exert effects on hormone-producing glands, such as the thyroid or pituitary, which in turn affect reproductive health. EDCs also may have direct effects on the reproductive system.

Toxicants can exert negative reproductive effects through several mechanisms, as shown in Figure 4.[21] Some chemicals kill or damage cells. If these cells are oocytes or sperm cells, exposure to the chemicals can result in infertility. If they are other types of cells, developmental problems can occur. For example, the anti-seizure drug phenytoin causes birth defects by disrupting normal embryonic and fetal development without causing mutations in DNA.[16,22] Other chemicals alter the structure of DNA, causing gene mutations.[21] Depending on the genes affected, mutations can result in an inability to conceive or in birth defects in the offspring. Some chemotherapeutic agents cause DNA mutations. Some industrial chemicals, such as benzene, also are mutagenic. Finally, some chemicals, such as diethylstilbestrol (DES), cause an epigenetic effect: they change the way in which genes are expressed, which can affect reproductive outcomes.

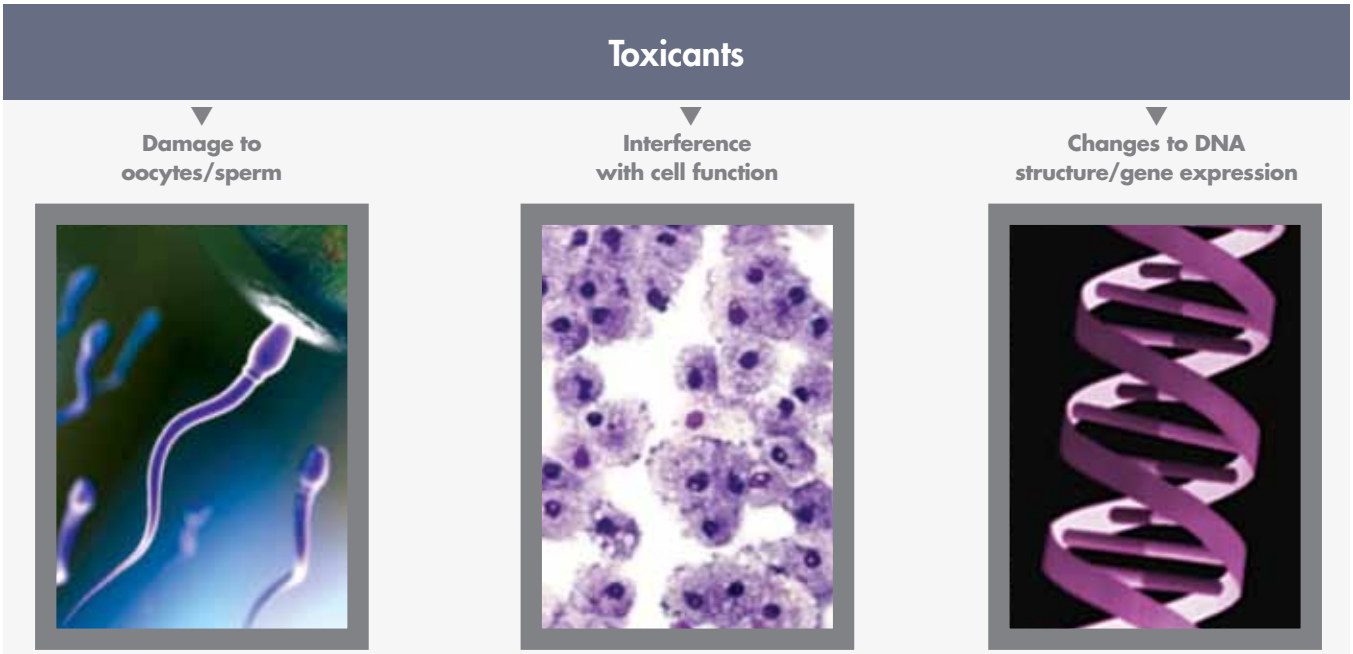

Figure 4: Environmental Effects Have Multiple Mechanisms[21]

Polychlorinated Biphenyls (PCBs) and Diethylstilbestrol (DES):

Well-Known Examples of Endocrine-Disrupting Chemicals

PCBs were used as coolants and lubricants in electrical equipment before their use was banned in 1977.[14,18] Today, the main source of exposure to PCBs is food contamination. PCBs first entered the air, water, and soil through manufacture, use, and disposal. They may still be released into the environment today from hazardous waste sites or the burning of certain wastes in incinerators. Because PCBs do not break down readily, they remain in the environment for many years. They are taken up by small organisms in water and then accumulate in the fish that eat these organisms, in some cases reaching levels thousands of times higher than that found in the water.[23] Exposure and human levels of PCBs have decreased since 1977 and have recently leveled off. PCB exposure is a matter of concern because it has been linked to both reproductive effects, including menstrual disturbances in women and reduced fertility in men, as well as developmental effects, such as reduced birthweight.[24] Table 2 lists the many potential reproductive effects of PCBs.

Table 2: Lessons Learned from PCBs[18]

Examples of potential effects:
• Altered neurodevelopment as a result of in utero exposure
• Endometriosis
• Reduced fertility
• Decreased semen quality
• Miscarriage
• Altered pubertal development
• Reproductive tract malformations

DES is an example of an endocrine-disrupting chemical that causes delayed, rather than relatively immediate, effects on reproduction.[25-29] From the 1930s to the 1970s, the synthetic estrogen DES was prescribed to pregnant women in the mistaken belief that the drug would prevent miscarriage. Later, researchers learned that the drug actually increases the risk of miscarriage and other pregnancy complications (see Figure 5). In addition, the drug causes reproductive health abnormalities and reproductive tract malignancies in the children of women exposed during pregnancy. Animal studies suggest that grandchildren also may be affected.[17]

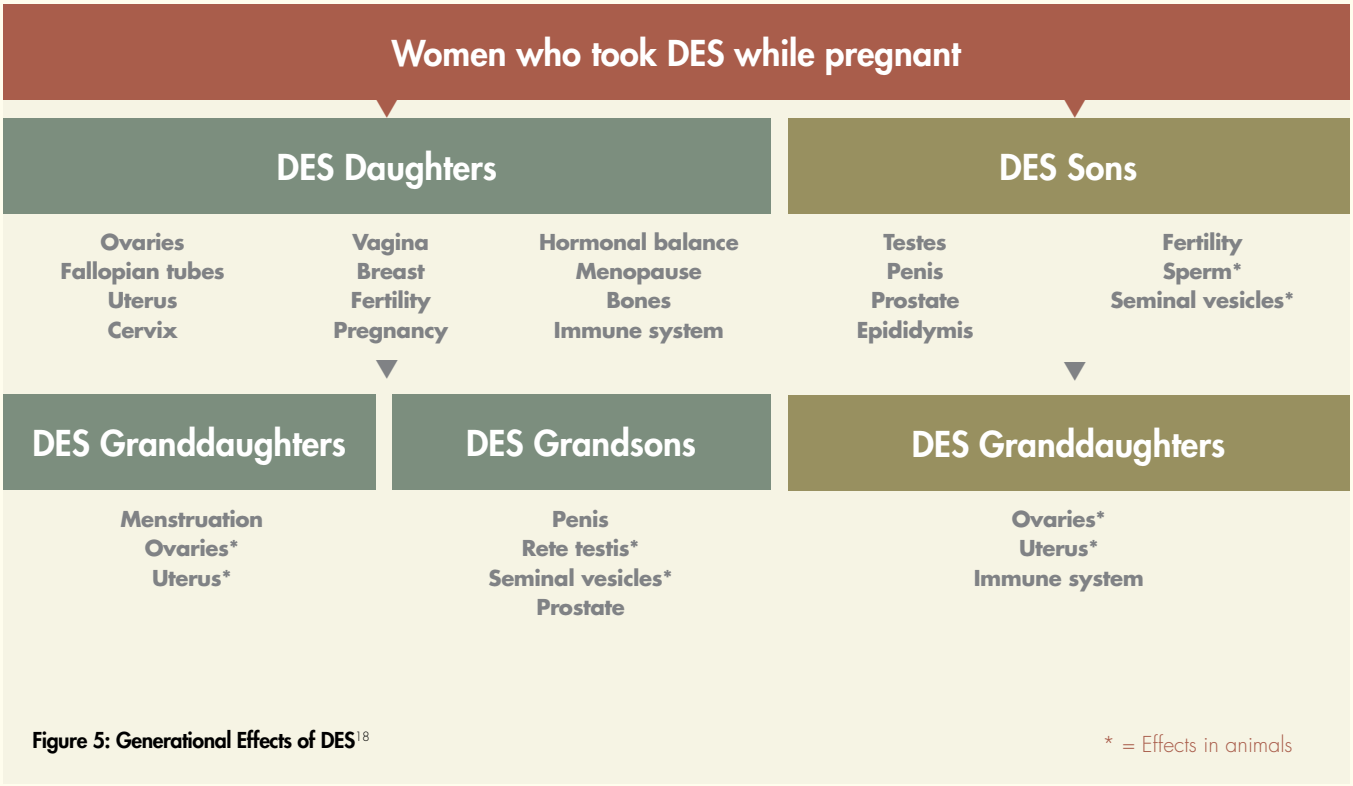

Figure 5: Generational Effects of DES[18]

A later chapter addresses bisphenol A, another EDC, in detail.

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Putting Risk in Perspective

This chapter focuses on how providers can help patients to keep environmental risks in perspective.

Although patients can take many steps to mitigate toxic exposures and potentially increase the odds of a successful pregnancy outcome and overall reproductive health, the elimination of all hazardous environment exposures is an unrealistic goal. It is most important to make changes that reduce or eliminate significant, known reproductive hazards (e.g., smoking cessation to avoid known adverse pregnancy outcomes, elimination of known reproductive toxicants in the workplace) rather than try for complete elimination of exposure to all potential hazards. Patients need a balanced perspective on the reproductive health risks of environmental exposures. Their perspective should be informed as much as possible by empirical data, while recognizing that many potential toxicants have not undergone sufficient safety testing to generate reliable data. Health care providers can help patients achieve this balanced perspective.

Population Versus Individual Risk

Clinicians work with individual patients, not whole populations. One of the challenges of clinical care is translating data on effects seen in a population into information on real-life risks for an individual patient. Providers should remember—and convey to patients—that the elevated risks identified in population-wide studies may represent a small risk to an individual and depend on multiple factors that influence that person's vulnerability to the effect. It is important to remember that a rare event will remain rare for an individual, even if the risk doubles or triples. For example, if a chemical increases the risk of a particular health outcome from 1 in 100,000 to 3 in 100,000, it remains a small risk overall.

However, even a modest increase in risk can translate into a sizable public health concern if the exposed population is large enough. In addition, a large increase in the population-wide risk has important implications for individuals, even if the number of exposed individuals is not high. Figure 6 illustrates how a small shift in the distribution of an attribute in a population (in this case IQ) can affect a large number of individuals. The effect of low levels of lead exposure on IQ is relatively small for an individual with an IQ score near the average, which is 100. However, this small shift has a dramatic effect at the low and high ends of the distribution curve, which are referred to as the "tails."

In the graph, the area under the left tail represents the proportion of the population with an IQ of less than 70, which is the level used to define significant intellectual impairment or mental retardation. When the average IQ in the population is 100, there are about 6 million people who meet the criteria

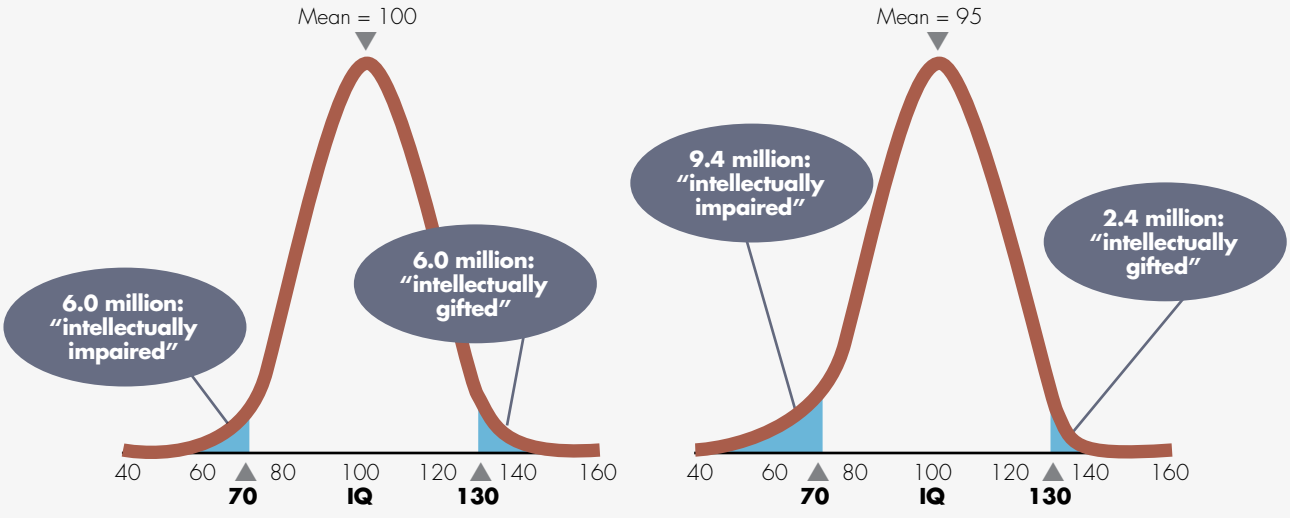

Figure 6: Small Individual Effects Can Have Significant Population Effects[1]

for severe intellectual impairment. If the average IQ were shifted to 95, there would be a significant increase in the number of intellectually impaired individuals. Tragically, this shift to the left could mean the difference between a person's ability to live independently and being unable to manage his or her own care. Thus, population-based shifts in IQ of just a few points—due to low-level lead exposure, for example—have real effects in the middle of the distribution curve but dramatic effects on the number of individuals at the low and high ends of the distribution. If the distribution curves for testosterone level, sperm count, or thyroid hormone level were similarly shifted due to an environmental exposure, the clinical significance also could be similar.

The Relative Impact of Various Factors on Reproductive Outcomes

Providers can help patients put environmental risks in perspective by helping them take a balanced approach to risk prevention. For example, a pregnant woman should understand that changes such as smoking cessation and avoidance of reproductive toxicants at work are both important steps for reducing reproductive risks.

Clinicians can support patients by providing comprehensive guidance to all women of reproductive age. Topics should include nutrition, physical activity, family planning, chronic health problems, intimate partner violence, substance abuse, smoking, mental health, and access to care, as well as avoidance of harmful environmental exposures. Armed with this information, patients can focus on setting priorities for changes to increase the likelihood of positive reproductive health outcomes.

The next chapters cover some exposures that are salient for front-line providers of women's health services: pesticides, methylmercury, chemical exposures in the workplace, and plastics-related chemicals, such as bisphenol A.

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Pesticides

This chapter focuses on pesticides, chemicals to which many individuals are exposed in their homes, workplaces, schools, and communities.

Synthetic pesticides are substances used to inhibit the growth of or kill unwanted organisms, such as insects, fungi, plants, and rodents.[1] This monograph addresses only synthetic chemical pesticides or chemically derived pesticides.

Chemical pesticide formulations contain two types of ingredients: active and inert. Active ingredients are those that exert the desired pesticidal effect: inhibiting the growth of or killing the unwanted organisms. Inert ingredients support the function of the active ingredients. However, "inert" is not synonymous with "benign."[2,3] Some inert ingredients have been shown to be reproductive toxicants.

Exposures to Pesticides

Use of chemical pesticides is widespread in the United States. According to the Environmental Protection Agency, more than 1.2 billion pounds of the chemicals are used each year.[4] Household use represents as much as 10 percent of the total amount used annually. In fact, pesticides are used in 78 million US households.[4] They are often used for insect and rodent infestation, lawn and garden care, and protection against fleas and ticks.

Individuals are exposed to pesticides through a number of different sources: residue on food, contaminated tap water, occupational exposure, and community application of pesticides.[5,6] They also are exposed from the use of insecticides, insect repellents, rodent traps, weed killers, and pet flea products within the home. In addition, individuals are exposed through contaminated dust in the home and pesticides tracked in from outdoors by pets and humans.[5,6]

Data on the Reproductive Health Effects of Pesticides

Data on the health effects of pesticides come primarily from animal studies and population-based epidemiological studies. Randomized clinical trials that study the effects of pesticide exposure on humans would be unethical. Table 3 shows some of the potential reproductive health effects of pesticides. An example of a known reproductive health effect in animals is decreased egg production and embryo viability in birds associated with exposure to atrazine, a chemical used to control grasses and weeds in cornfields.[7] Examples of known reproductive effects in humans include early pregnancy loss associated with exposure to ethylene oxide, a chemical used as a sterilant to kill bacteria, mold, and fungi; impaired neurological development associated with exposure to organophosphates; and reduced male fertility associated with exposure to the herbicide dibromocholorpropane (DBCP).[8] The effects in humans were found in several epidemiological studies that demonstrated fairly consistent associations and evidence of exposure-risk relationships after controlling for potential confounding factors.

Table 3: Potential Reproductive Health Effects of Various Pesticides[9-11]

Female	Male	Offspring
• Reduced fertility • Early pregnancy loss • Late pregnancy loss • Premature birth • Reproductive system effects	• Reduced fertility • Genetic alterations in sperm • Reduced number of sperm • Damage to germinal epithelium • Altered hormone function	• Low birthweight/small for gestational age • Developmental defects

Counseling Patients on Pesticide Exposure

Health care providers should educate patients about the many steps they can take to prevent exposure to pesticides at home. Providers also should advise patients who work in occupations such as pest control, landscaping, agriculture, gardening, or construction about limiting or mitigating pesticide exposure at the workplace. Providers can recommend the following points to reduce patients' exposures to pesticides:[12,13]

- Prevent pest problems in the home and thus reduce the need for pesticides. Ways to prevent pest problems include:
  - — Fix leaky plumbing and remove sources of water, which attract pests.
  - — Use tightly sealed containers for food, food scraps, and garbage.
  - — Avoid leaving pet food out overnight.
  - — Seal cracks in baseboards, walls, and floors to prevent access to the home.
  - — Keep floors and surfaces clean.
  - — Use alternatives to pesticides.
- Reduce pesticide exposure from food:
  - — Peel or thoroughly wash fruits and vegetables.
  - — If possible, buy organic foods and produce.

Additional Provider Resources on Pesticides:

- Pesticide Action Network: Pesticide Database

Additional Patient Resources on Pesticides:

- The Environmental Working Group: the "Dirty Dozen" list (see Figure 7) of the 12 most commonly contaminated fruits and vegetables.

Figure 7: The Dirty Dozen Food List[14]

Case Study: *Kate*

Kate is a 29-year-old woman who recently experienced a pregnancy loss at 10 weeks' gestation. There were no signs of any problems with the pregnancy. She is currently working toward a degree in landscape design and works part-time at a plant nursery. She asks you whether pesticides could have caused the miscarriage.

The first step you take is to complete an environmental history to assess Kate's exposure to pesticides and other reproductive toxicants. You ask Kate about other potential sources of pesticide exposure. She tells you that because of financial constraints while she's in school, she and her husband now choose conventionally grown rather than organic produce. They use pesticides on their house plants to control aphids but don't use any in their vegetable garden. They do not have any pets. You ask her to find out more about the specific chemicals she's exposed to at home and at work.

Kate returns the next week and tells you that the nursery owner said they primarily use the herbicide propazine. At home, Kate and her husband use an insecticide to kill roaches.

You tell Kate that it is impossible to know what caused the pregnancy loss. You explain that as many as 40 percent of all conceptions end in pregnancy loss, many occurring before a woman realizes she is pregnant.[15] However, there are some steps she can take to reduce her exposure to potentially harmful chemicals by addressing occupational exposures and pesticides in the home. You help Kate rank her options, first addressing occupational exposures, because these are probably the most significant, then reducing pesticide exposure in the home. You recommend the following:

To reduce workplace exposure, you recommend that Kate:

- By law, employers are responsible for maintaining a safe work environment and must provide information and education about hazardous chemicals in the workplace. You inform Kate of these rights and refer her to an occupational health expert and resources for additional help and information.
- Take steps to minimize exposure by washing exposed skin, changing out of work clothes at the workplace, laundering work clothes separately, and leaving work shoes at the entryway of the home.

To reduce pesticide exposure in the home, Kate should:

- Switch to less toxic methods for controlling insects on houseplants, such as citrus spray.
- If possible, buy organic produce. If not, choose conventionally grown fruits and vegetables that are less likely to be contaminated and wash thoroughly or peel produce.

This case study illustrates the need to consider all areas of potential pesticide exposure when conducting an environmental health assessment. Although the link between pesticide exposure and the pregnancy loss is not certain, it is prudent to recommend precautions to reduce exposure, especially during pregnancy.

The next chapter covers an environmental substance to which many people are exposed: methylmercury.

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Methylmercury

This chapter focuses on methylmercury, an environmental contaminant that has documented adverse effects on fetal development.

The Reproductive Impact of Methylmercury

Methylmercury is considered a developmental toxicant that is found primarily in predatory marine and freshwater fish. However, there are many health benefits from consumption of fish and seafood, which can make providing guidance to patients on fish and seafood consumption complicated. The National Academy of Sciences, in its 2000 review, supports continued fish intake.[1] The report states, *"Because of the beneficial effects of fish consumption, the long-term goal needs to be a reduction in the concentrations of methylmercury in fish rather than a replacement of fish in the diet by other foods. In the interim, the best method of maintaining fish consumption and minimizing mercury exposure is the consumption of fish known to have lower methylmercury concentrations."*

Sources of Methylmercury

The most common source of methylmercury exposure in the United States is seafood that has become contaminated with the heavy metal.[2] There are both geophysical and human causes of environmental mercury contamination, in particular, pollution from coal-fired power plants.[3] Airborne mercury from these power plants and other sources falls to the earth and accumulates in streams, lakes, oceans, and wetlands. Inorganic mercury is converted to organic methylmercury by bacteria in aquatic sediments. Methylmercury is a particularly toxic form of the chemical that bioaccumulates, or collects in greater concentration than in the surrounding environment, as smaller fish are consumed by larger fish that are consumed by even larger fish in the food chain.[4] In general, methylmercury concentrations are highest among large predatory marine fish that have lived longer, because of the greater accumulation of methylmercury in their bodies compared with younger, smaller fish.[4] However, some small predatory freshwater fish can be highly contaminated with methylmercury as well.

As shown in Figure 8, which is based on National Health and Nutrition Examination Survey (NHANES) data collected from 1999 to 2004, there is a significant positive correlation between reported intake of seafood and blood mercury level.[2]

For example, children born to women living in the Faroe Islands who consumed a heavy diet of contaminated seafood during pregnancy were found to have lower scores in IQ, language development, visual–spatial skills, gross motor skills, memory, and attention.[5] When those children reduced their consumption of the heavily contaminated seafood, several of the observed neurological deficits improved.

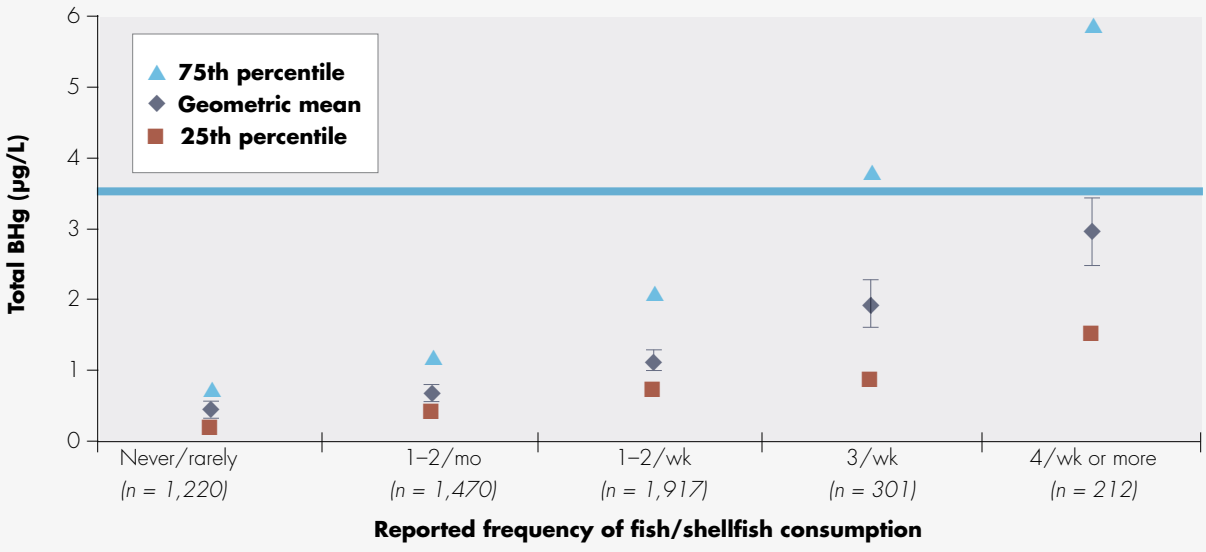

Figure 8: Fish Intake and Blood Mercury Level[2]

Seafood intake—and blood mercury levels—vary across the United States. Figure 9 demonstrates that both intake and blood mercury levels are highest in the Northeast region of the country.[2] A study based on NHANES data found that Asian ethnicity and higher income also were associated with greater seafood intake and higher blood mercury levels. A 2008 New York Times journalist reported that sushi purchased in Manhattan was found to have high levels of methylmercury.[6] Sushi obtained at five of the 20 restaurants tested had mercury levels high enough to meet criteria for the Food and Drug Administration (FDA) to take legal action to remove the products from the market. This example illustrates how important it is for providers to consider the risk of methylmercury exposure in all women.

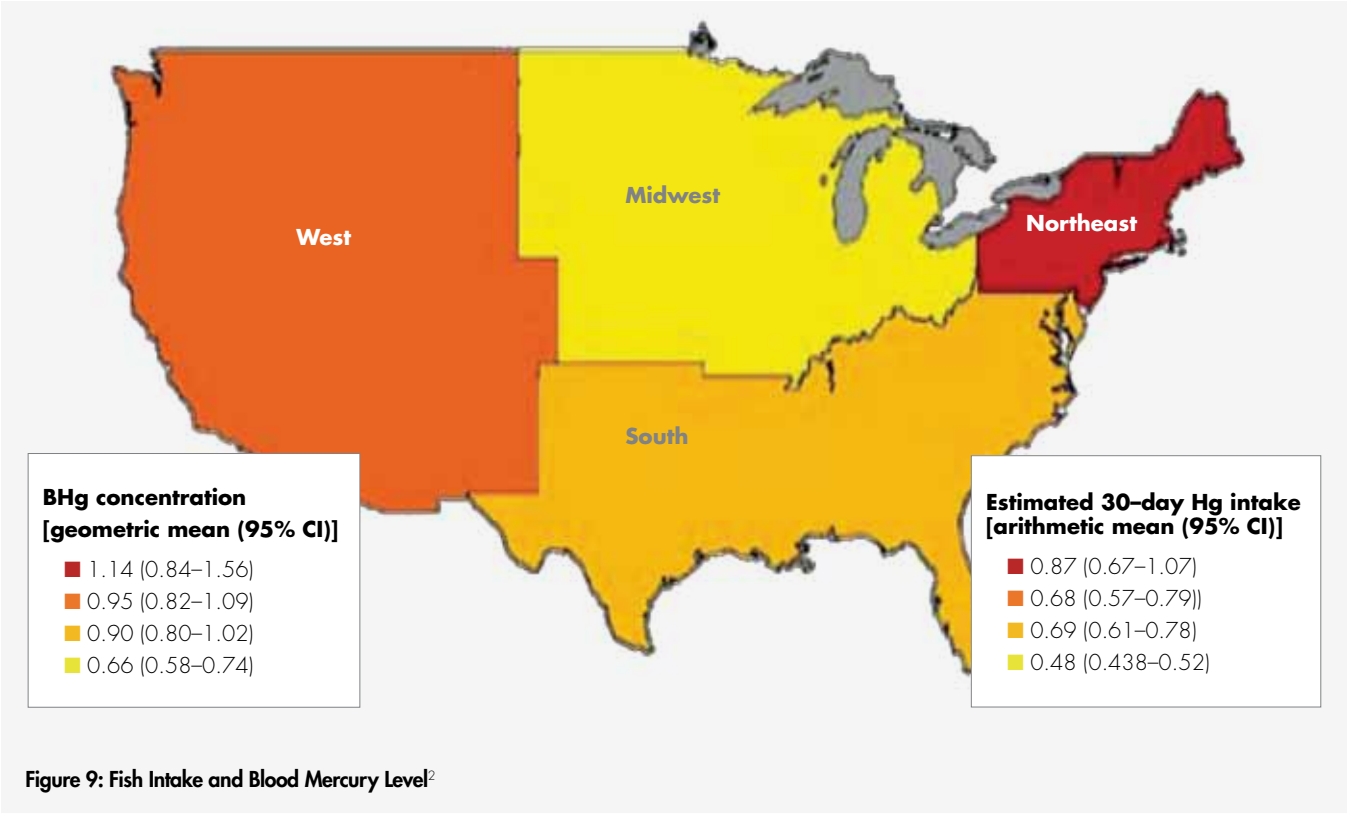

Figure 9: Fish Intake and Blood Mercury Level[2]

Minamata Disease, which was first identified in Minamata, Japan, in 1956, demonstrated a direct link between high-dose mercury exposure and severe neurological symptoms. Methylmercury discharged from a chemical factory into the Yatsushiro Sea contaminated fish and shellfish in the local area.[7] Local residents and fishermen began exhibiting symptoms that suggested mercury poisoning, such as paresthesias, blurred vision, concentric vision, deafness, dyskinesia, seizures, coma, and in some cases, death.[8] Deficits in neurologic development were seen in children whose mothers were exposed when pregnant. Urine tests revealed high levels of methylmercury in affected individuals, and testing of wastewater from the factory showed methylmercury contamination. The company—Chisso Corporation—only ceased polluting in 1968, when the method of mercury production previously used became outdated. In 1969, the company was forced into court. Later, researchers determined that the company had consistently released methylmercury into the bay from 1932 until 1968, despite the growing evidence of adverse effects.[9] The Minamata tragedy led scientists to explore the possibility that adverse health effects would be seen at far lower exposures than those experienced in Minamata.

Recommendations for Fish Intake

Recommendations for fish intake must balance two factors: the nutritional benefits of seafood and the risks associated with methylmercury exposure. The FDA advises that children and pregnant women avoid eating shark, swordfish, king mackerel, and tilefish, because they are large predatory marine fish that are excessively contaminated with methylmercury.[10] In some locations, freshwater fish also are highly contaminated. Safer choices are trout, shrimp, salmon, tilapia, and sardines (see Table 4). The FDA also recommends that pregnant women and children eat no more than 12 ounces per week of these fish.[10] The Natural Resources Defense Council, an environmental action group with a strong scientific foundation, advises that in addition to the guidelines on species selection and servings per week, pregnant women and children eat no more than two cans of light tuna per week, or two-thirds of a can per week of white albacore tuna.[11] The Environmental Working Group, a consumer advocacy group, recommends that pregnant women choose fish species carefully, and it uses scientific guidelines from the FDA—not the FDA consumption advisory—to calculate the maximum amount of tuna that can be consumed safely.[12] The group proposes that the FDA consumption advisory could expose women to unsafe levels of mercury, if their only intake of seafood is tuna.

Table 4: Recommendations for Seafood Species[10]

Species to Avoid	Safer Species
• Shark	• Trout
• Swordfish	• Salmon
• King mackerel	• Tilapia
• Tilefish	• Sardines
• Albacore tuna	• Shrimp

Counseling Patients on Fish Consumption

In many states, freshwater fish have extremely high levels of methylmercury. Clinicians should be familiar with the situation in their region to better advise all women of reproductive age—whether pregnant or not—about safe fish consumption. They can access information about the safety of fish in local waters through fish advisories from the Environmental Protection Agency and state health departments.

Providers can recommend the following points about safe fish consumption:

- Patients should continue to eat fish but should select species carefully; limit weekly consumption of the "less safe" species to reduce the risk of methylmercury exposure.
- Because polychlorinated biphenyls (PCBs), another seafood contaminant, accumulate in fatty tissue, individuals should trim the fat from fish before cooking.[10,11,13]
- When eating out at restaurants, patients should use the same preventive tactics as at home: avoid species high on the food chain, such as shark, swordfish, and king mackerel (referring to wallet cards, like the Seafood Watch Pocket Guide, may help) and trim fat from the fish before eating.

Additional Provider Resources on Fish Consumption:

- ARHP Quick Reference Guide for Clinicians: Fish Consumption to Promote Good Health and Minimize Contaminants

Additional Patient Resources on Fish Consumption:

- ARHP fact sheet: Health Matters: Healthy Fish, Healthy Families
- Environmental Working Group: Tuna Calculator
- Natural Resources Defense Council: Mercury Contamination in Fish (includes a mercury calculator)

Case Study: *Lori*

Lori is a 32-year-old woman who is 30 weeks pregnant. She has two small children at home and is a school teacher. At her prenatal visit, she asks you about an article she read recently in a women's magazine. The article stated that children of mothers who ate fish during pregnancy had higher IQ scores than children of mothers who avoided fish. Lori is confused. She has avoided all fish since she learned she was pregnant because of concern about mercury contamination. What do you tell her?

You could begin by telling Lori that scientific reports have continued to show the value of omega 3 fatty acids, which are abundant in seafood. These fats appear to be especially important to healthy neurological development. For this reason, Lori may want to add seafood back into her diet, although with caution. She also could obtain these nutrients by taking distilled fish oil capsules. Other sources of omega 3 fatty acids include many green vegetables, canola oil, walnuts, flaxseed, and flaxseed oil. In addition, wild Alaskan salmon is a good source of omega 3 fatty acids and low in methylmercury contamination.

You might ask Lori to describe her fish intake prior to pregnancy. Did she eat canned tuna? If so, what kind? Did she eat sushi? Swordfish? Did she eat fish locally caught for sport? How many servings of seafood did she eat each week? The answers to these questions can help you guide Lori in making safer choices about seafood species and amounts. Finally, give Lori resources, like those provided in this monograph, to help her plan and monitor her seafood intake and that of her children.

The next chapter covers exposures to synthetic chemicals in the workplace.

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Chemical Exposures in the Workplace

This chapter focuses on exposures to synthetic chemicals in the workplace.

Workplace exposure is an important way that patients come into contact with reproductive and developmental toxicants. Workplace exposure to such chemicals is not limited to employees of chemical manufacturing plants or other facilities that directly involve the use of chemicals. Exposure to substances with developmental and reproductive health effects can occur in all types of occupations, including but not limited to health care, farming, nail and hair styling, professional home cleaning, and landscaping. Individuals also may be exposed in the home or through hobbies to the same reproductive and developmental toxicants that are found in the workplace. For example, solvents, which increase the risk of adverse pregnancy outcomes, are used in a number of workplace settings and are also found in a variety of consumer products such as paint strippers and hobby-related products such as paint or ink.[1]

The Reproductive Health Impact of Chemical Exposures

A number of adverse reproductive effects can occur as a result of exposure to toxicants in the workplace, and exposure to toxicants can affect the reproductive health fertility of both men and women. For example, women exposed to hazardous substances may experience hormonal changes that can lead to subfertility, and men may exhibit abnormal sperm morphology or a reduced sperm count.[2]

Many occupations may result in exposure to reproductive toxicants. Some of the occupations that are more likely to involve exposure are obvious—pest control technicians, for example. Table 5 lists examples of occupations that have a higher risk for exposures to toxic substances. Individuals in these occupations should be made aware of the potential for adverse effects and encouraged to take steps to mitigate exposure.

Other occupations with potential for exposure are less obvious. In fact, it is impossible to predict with complete accuracy which work settings are likely to exposure individuals to reproductive toxicants; these chemicals could be present in settings that one wouldn't expect, such as a patient's home or an academic or office building. For this reason, it is important for patients to consider whether they are or have been exposed to chemicals, fumes, or potentially problematic substances, no matter their workplace setting.

Benzene:

An Example of a Reproductive and Developmental Toxicant

Known reproductive toxicants include heavy metals such as methylmercury and chemical compounds such as benzene. Benzene is an aromatic liquid or vapor. In the past, it was used as a solvent in various materials including inks, glues, and paint remover. It is now used as a precursor in the synthesis of plastics and dyes. In addition, gasoline contains benzene. For this reason, workers who clean or remove underground fuel storage tanks may be exposed to the toxicant. Exposure to benzene has been linked to aplastic anemia, cancer, and adverse reproductive effects.[3] In the United States, other solvents, such as toluene and naphthalene, are used increasingly to replace benzene. Because of the widespread use of these solvents, individuals may encounter them in a variety of settings, including the workplace and the home. For example, gasoline, household aerosols, paints, paint thinners, adhesives, nail polish remover, and solvent-based cleaning products may contain toluene.[4] Naphthalene is used in moth repellents, coal tar products, and certain dyes and inks.[5]

Table 5: Examples of Occupations with Higher Risk of Exposure to Toxicants[3]

Arts & Media	Logging, Forest & Conservation
Assembling & Fabrication	Material Moving
Cleaning & Pest Control	Metalworking & Plasticworking
Construction	Miscellaneous Production (e.g., electronics manufacture)
Crop & Livestock Production	Nail and Hair Salons
Engineering, Sciences & Education	Printing
Extractive Industries (i.e., mining)	Textile, Apparel & Furnishings
Farm Work	Utilities & Transportation
Fishing & Hunting	Welding, Soldering & Brazing
Food Processing	Woodworking
Food Service	
Grounds Maintenance	
Health Services	
Installation, Maintenance & Repair	

Providers must weigh the benefits of intervention with the potential challenges associated with job loss or discrimination. An incidental exposure may not be of concern when viewed against the consequences of a job loss. However, significant exposure to a toxicant must be addressed and mitigated. If a provider identifies a reproductive or developmental hazard, he or she should refer the patient to an occupational health expert who can assess the hazard and provide knowledgeable counseling about the risks and the individual's legal rights. By law, employers are responsible for maintaining a safe work environment and must provide information and education about hazardous chemicals in the workplace. Providers can inform patients of these rights and refer them to occupational health experts and resources for additional help and information.

Case Study: *Jennifer**

Jennifer is a nulliparous, 30-year-old healthy woman who presents to your office for her annual well-woman exam. She was recently married and is contemplating pregnancy within the next year. She has no complaints except for occasional headaches, which occur sometimes at work but never on weekends.

Jennifer has worked as a lab technician at a local polymer manufacturer for the past 6 years. She is concerned about possible chemical exposure at work. For protective equipment she uses eye protection, an apron, and latex gloves. There is no ventilation hood in the lab. The primary chemical she works with is N-methylpyrrolidone (NMP), a chemical used to dissolve a wide range of other chemicals. She is exposed to NMP on a weekly, and often daily, basis.

Jennifer's exam is normal. The pregnancy test that you order is negative. You pull up the material safety data sheet (MSDS) for NMP online, which you review with Jennifer. The MSDS mentions no adverse reproductive effects, and Jennifer is relieved. However, knowing that MSDS entries are often incomplete and inaccurate with regard to information on the reproductive effects of the chemical, you investigate NMP in more detail on the Internet. You learn that in 2001, NMP was listed as a known reproductive toxicant in the state of California on the basis of animal studies.[6] You search the developmental and reproductive toxicology database at the TOXNET Web site and find several entries, including a case of a pregnancy loss in a lab technician exposed to NMP.

On the basis of the information from the Internet and the toxicology database, you refer Jennifer to an occupational health specialist. You receive a note from the specialist after Jennifer's consultation. She has recommended the use of additional safety precautions at Jennifer's workplace, including a ventilator hood, a well-fitted respirator, neoprene rather than latex gloves (the former are more resistant), and continued use of the apron and eye protection.

The occupational health specialist asks you to explore with Jennifer the options for transferring out of the lab to a less toxic work environment, bearing in mind her legal rights and the potential for job loss or discrimination. You write a letter to Jennifer's employer identifying NMP as a potential reproductive toxicant, highlighting the importance of avoiding reproductive toxicants, and the need to transfer Jennifer to a job without such exposure while she is trying to get pregnant and during pregnancy.

The employer transfers Jennifer to a position with less toxic exposure and invests in additional safety equipment for Jennifer and other employees. Had no other jobs been available, Jennifer might have decided to continue in the same job with improved protection. After the transfer, Jennifer's headaches resolve.

This case illustrates that exposures to reproductive toxicants can occur at the workplace. With understanding and appropriate information, health care providers can advocate for their patients and make specific workplace recommendations that reduce the risk of exposure to reproductive toxicants.

**Case study adapted from GENERATIONS AT RISK: REPRODUCTIVE HEALTH AND THE ENVIRONMENT, published by The MIT Press.*[7]

Counseling Patients on Exposures to Industrial Chemicals

When counseling patients about exposures to industrial chemicals, providers should:

- Ask about the patient's occupation, including the setting, job-related tasks, and any known chemical exposures.
- Ask about potential chemical exposures, including specific questions to uncover exposures that the patient might mistakenly believe are insignificant (e.g., "Does your worksite use fumigation to deal with pests?").
- Recommend that patients try to become familiar with all chemicals used or encountered in their work setting and learn about the potentially toxic properties of these chemicals.
- Direct patients to appropriate sources of information about chemicals (see Resources for Providers and Patients chapter).
- Instruct patients on steps to take to mitigate exposure or refer them to an occupational health expert who can suggest exposure-reducing strategies (e.g., substitute a safer chemical, wash exposed skin, change from work clothes before leaving the workplace, wash any exposed clothes separately to prevent contamination of other clothing).
- Check that patients have access to and are using appropriate protective gear.
- Advise patients to avoid contact with clothes that others in the household wear home if there is a potential for toxicant exposure.
- Advise patients to take extra care to avoid exposure if they are pregnant or planning pregnancy, because standard personal protective equipment may not be sufficient to guard from exposure to reproductive toxicants.

Additional Provider Resources on Industrial Chemicals:

Providers should use available resources to investigate the toxic properties of specific industrial chemicals to which their patients are exposed.

- For *general* toxicant information:
  - — The HazMat database: provides information about symptoms and conditions associated with toxicants and the occupational activities most likely to lead to exposure.
  - — Material safety data sheet (MSDS): these sheets provide general information about the health effects of exposure to a particular chemical. However, the MSDS entries are often incomplete and inaccurate with regard to information on the reproductive effects of the chemical; providers should not rely on the lack of mention of reproductive toxicity in the MSDS as an indication of safety. Providers and patients should check product labels (with the caveat that these may be inaccurate or incomplete) and toxicology databases for information about potential reproductive effects.
- For information specific to *reproductive* toxicants:
  - — California Proposition 65 Web site: List of chemicals recognized to cause cancer or reproductive toxicity; approximately 800 chemicals are listed
  - — Environmental Health and Toxicology Web site of the National Library of Medicine: Educational resources and links to databases that identify substances known to cause reproductive or other toxicity
  - — ReproTox: An online database for providers and consumers that presents information on more than 5,000 agents and exposures and their reproduction-related effects
  - — ToxNet Web site of the National Library of Medicine: Links to several databases that identify substances known to cause reproductive or other toxicity

The next chapter addresses some chemicals in plastics, including bisphenol A, an endocrine-disrupting chemical in some plastic bottles and in the lining of cans used for food and beverages.

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Bisphenol A and Other Chemicals in Plastics

This chapter focuses on some of the chemicals in plastics, including bisphenol A, which has been shown to have estrogen-like effects and to disrupt thyroid function in animals.

This monograph includes a discussion of the endocrine-disrupting chemical bisphenol A (BPA) for three reasons:

- Patients are requesting more information about plastics and BPA.
- Animal data suggest an increased susceptibility of the developing organism, which raises concerns about effect on the human fetus, especially during early gestation (when many women are unaware that they're pregnant). [1]
- BPA is under scrutiny by state and federal agencies, and clinicians may be asked to discuss the potential effect of BPA exposure on reproductive health with other health professionals, patient groups, policy-makers, and the media.

Do you know which of these food items is most likely to contain bisphenol A?

A. Canned vegetables

B. Fresh vegetables

C. Frozen vegetables

D. All of above

We'll get to the answer soon.

Sources of Bisphenol A

Bisphenol A is a chemical used in some epoxy resins and adhesives. BPA-containing resins are used in the lining of metal food and beverage cans, and the lining of such cans (e.g., soft drink, food, and infant formula cans) is a significant source of BPA in food items.[2,3] BPA is polymerized to make polycarbonate plastic. Polycarbonate is a hard clear plastic that is identified by the "other plastics" category for recycling, designated by a triangle with the number *7* often found on the underside of recyclable containers. BPA also may be added to other kinds of plastic. BPA can leach from plastic containers, devices, and medical equipment into food or beverages, especially when heated.

Now you know that the correct answer to the quiz question is A: canned vegetables are most likely to contain BPA. Food storage containers and hard plastic water bottles may contain BPA. Stretch film used in food packaging also may contain BPA.[4] Medical equipment, including endotracheal tubes, umbilical catheters, and plastic bags containing intravenous fluids, sometimes contain BPA.[3] Other potential sources of BPA include dust, PVC piping, cash register receipts, and dental composites and sealants.

Population studies have shown that BPA exposure is common in the United States. A 2008 study reported that almost 93 percent of individuals age 6 or older had detectable BPA levels in their urine.[3] Levels were higher in children than adults (see Figure 10). In addition, human studies have shown that interventions to reduce exposure to BPA do decrease blood BPA levels.

Testing in various countries has found BPA in canned foods, such as vegetables, soups, fruits, meat products, fish, and desserts.[7] Plastic baby bottles and liquid baby formula (i.e., not powdered) may also contain BPA.[6,7]

Scope of the BPA Problem

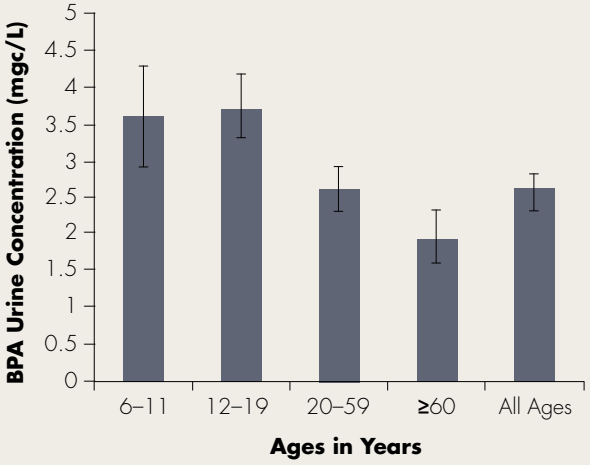

Figure 10: Scope of the BPA Problem[5-7]

Data on the Reproductive Health Impact of Bisphenol A

Laboratory research has demonstrated that BPA is an estrogen receptor agonist and blocks both androgen and thyroid hormone receptors.[8] Studies in animals have shown that BPA exposure is associated with early puberty in females, lower sperm counts, and increased susceptibility to reproductive tract cancers and altered brain development in males and females.[8-13] More recently, BPA has been associated with diabetes and cardiovascular disease in humans.[14]

Definitive data linking BPA exposure to specific pathological conditions in humans are not yet available. However, some of the adverse effects in animal studies are observed at levels of exposure close to those common in people. For this reason, clinicians, scientists, and consumer activists are concerned, even if the effects are not yet clearly documented in humans. Given the strength of the emerging data, many experts believe that it is prudent to recommend now that patients reduce BPA exposure and to provide clinicians with tools to help patients reduce their risk of exposure.

Other Chemicals in Plastics

In addition to BPA, other chemicals associated with plastics have raised concerns. These include phthalates and polyvinyl chloride (PVC). Phthalates are plastizicers, substances added to plastics or other materials to make them more pliable.[15] These chemicals are used to create building materials, packaging, and plastic toys. They also are ingredients in personal care products, such as cosmetics, shampoos, and perfumes, and in some pharmaceuticals. A small (n = 145) pilot study in humans recently showed that preschool boys whose mothers during pregnancy had higher urinary concentrations of two common phthalates were less likely to engage in typically male play (e.g., play fights) than boys whose mothers had lower urinary levels during pregnancy.[16] Previous research has shown that gender-related play behavior reflects the effects of endocrine-disrupting chemicals, such as PCBs.

Hundreds of studies in laboratory animals have shown that the developing male reproductive tract is particularly sensitive to exposure to some phthalates. The exposures that cause these effects are much lower than those necessary to cause effects in adults. Some adults are exposed to those phthalates at levels that approach those that cause effects in laboratory animals. Preliminary data from the first human studies have shown concerning reproductive health effects with phthalate exposure, relating to their endocrine-disrupting effects. One study found a smaller anogenital distance (AGD), which is the span between the anus and the genitals and a marker for feminization, in the male infants of women with higher urinary levels of phthalates.[17] Reduced AGD is a marker for prenatal exposure to androgen antagonists (anti-androgens). A follow-up study found that the serum levels of phthalates in the mothers of male infants with reduced AGD were actually lower than the Environmental Protection Agency's designated reference doses for these chemicals; in other words, these problems were manifesting in the offspring of women whose phthalate levels were within the range considered "safe."[15] Several preliminary studies have found inconsistent effects on birth—either delaying birth or increasing the chance of premature birth. Although one cannot make a firm conclusion about the clinical significance of these findings, the results suggest that exposure to phthalates may result in changes in reproductive tract development. Therefore, clinicians can exercise precaution and recommend ways their patients can limit exposure to phthalates.

Polyvinyl chloride, a type of plastic, is a polymer used to manufacture a variety of products including pipes, wire and cable coatings, building materials, and packaging materials.[18] It also is used in some household items, such as shower curtain liners, furniture and automobile upholstery, wall coverings, housewares, and automotive parts.[19] Depending on the application, other substances are often added. Phthalates make a polymer less brittle. Heavy metals are often added as stabilizers.[20] These substances can leach from PVC-containing products (e.g., if a child sucks on an object) or be released into the air (e.g., from new shower curtain liners).

Counseling Patients on Exposure to BPA and Related Chemicals

Individuals can take several practical steps to reduce exposure to BPA and other chemicals associated with plastics. Health care providers should recommend these action steps to patients while helping them keep a sense of perspective about exposures. Rather than become fearful about all the potential sources for exposure, patients can begin to take important steps to reduce their overall exposure to BPA and other plastics-associated chemicals about which there are legitimate concerns for reproductive toxicity.

Although providers must take into account patients' individual circumstances, they may want to recommend that patients:[21-23]

- Check the bottom of plastic food and beverage containers for numbers and avoid plastic containers numbered 3, 6, or 7 for food and drinking water (see Table 6);
- Limit canned foods and beverages or those stored in plastic containers; choose items in glass containers whenever possible;
- Eat fresh food when possible; choose frozen foods over canned foods;
- Use non-polycarbonate plastic or glass baby bottles;
- Drink from unlined stainless steel bottles, glass bottles, or plastic containers designated "PC free" or "BPA free" (note: these designations are not guarantees that the plastic is free of potentially harmful chemicals);
- Where possible, avoid storing food in plastic containers or plastic wrap. Glass containers are a good alternative;
- Avoid heating all plastics in microwaves; and
- As a matter of prudence, avoid PVC products (e.g., vinyl shower curtain liners) whenever possible, because they release phthalates and other chemicals into the air.

Table 6: Decoding Recycling Numbers[23]

Plastics to Avoid for Food and Beverage Use	Plastics Considered Acceptable for Food and Beverage Use
• No. 3: Polyvinyl chloride (PVC) • No. 6: Styrene (Styrofoam) • No. 7: Polycarbonate (BPA) (Note that some #7 plastics do not contain polycarbonate. Consumers should check the packaging for "polycarbonate" or "PC" or contact the manufacturer.)	• No. 1, 2, 4, 5

Additional Provider Resources on BPA:

- The Endocrine Society: Endocrine-Disrupting Chemicals: An Endocrine Society Scientific Statement

Additional Patient Resources on BPA:

- Environmental Working Group: Bisphenol A: Toxic Plastics Chemical in Canned Food
- Natural Resources Defense Council: Chemicals in Plastic Bottles: How to Know What's Safe for Your Family

Case Study: *Lauren*

Lauren is a 35-year-old woman who recently received a negative pregnancy test after nine months of trying to become pregnant. Her husband saw a news report about the possible effects of plastic water bottles on reproduction. Lauren asks you whether the plastic water bottles they use at home could have any relationship to her difficulty becoming pregnant.

You have previously completed a medical history on Lauren. You conduct an environmental health history using the CH_2OPS mnemonic. In particular, you ask about any exposures through the workplace, hobbies, or home pesticides exposures.

In discussing concerns expressed by Lauren and her husband, you should explain that it is impossible to assign blame to a particular environmental exposure, but she can take steps to reduce the chance of harmful exposures. These steps include switching to unlined aluminum water bottles that do not contain BPA.

This case illustrates the importance of taking an environmental history and tailoring guidance accordingly and the opportunity for health care providers to address potential environmental risks without becoming overly concerned about every possible exposure or prompting excessive concern in their patients.

The next chapter highlights helpful environmental health resources for providers and patients.

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Resources for Providers and Patients

This chapter lists environmental health resources for providers and patients.

For Providers

Many resources are available on environmental health and reproductive toxicants. Providers should investigate these resources for their own education and to have ready access to information for patients. A good starting place is **ARHP's Reproductive Health and the Environment Topic Area**. The site provides news articles, fact sheets, research updates, links to other organizations, and clinician resources, including:

- Links to the Environmental Impacts on Reproductive Health curriculum, Foundations of Science and Pesticide Exposure, in the Curricula Organizer for Reproductive Health Education (CORE);
- Quick Reference Guide for Clinicians: Fish Consumption to Promote Good Health and Minimize Contaminants;
- Environmental Reproductive Health Resources for Health Care Providers.

In addition to those already discussed in this monograph, a number of other clinician-oriented resources are available to educate and raise awareness, which will aid in patient counseling. Those resources include:

- The American College of Occupational and Environmental Medicine, a membership organization for physicians who specialize in the environmental health and safety of workers, workplaces, and environments;
- "Critical Windows of Development," an online tool provided by The Endocrine Disruption Exchange that shows a timeline of human embryonic/fetal development and features animal research data on low-dose EDC exposure and altered health outcomes;
- EnviRN, a Web site hosted by the University of Maryland School of Nursing, which supports nurses in promoting environmental health in homes, schools, workplaces and communities;
- The Environmental Working Group Web site, which includes several tools related to toxicant exposures through consumer products and food, as well as general information about environmental chemicals and contaminants;
- The Natural Resources Defense Council Web site, which has significant information about methylmercury and other chemicals;
- Physicians for Social Responsibility Web site, which includes a Pediatric Environmental Health Toolkit; and
- The University of California-San Francisco Program on Reproductive Health and the Environment, which works at the intersection of science, medicine, policy, and community.

Local environmental health specialists also may be helpful sources of information.

For Patients

There are many resources available for patients to help them better understand these issues and take steps to reduce exposure to toxicants. Below is a sample of resources health care providers could share with their patients.

The ARHP Reproductive Health and the Environment Topic Area provides valuable patient education resources, including:

- Health Matters patient fact sheets:
  - — The Connection Between Your Health and the Environment: Tips and Tools for Health and Home; and
  - — Healthy Fish, Healthy Families.

Several national organizations publish reliable patient education materials about topics related to environmental exposures:

- American College of Obstetricians and Gynecologists pamphlet, "Nutrition During Pregnancy," which includes information about seafood intake;
- Collaborative on Health and the Environment (CHE), which provides many of its resources in Arabic, French, Russian, and Spanish;
- The Campaign for Safe Cosmetics, which includes a product review that provides an evaluation of the safety of specific brands of consumer products;
- Environmental Working Group, who create valuable tools such as wallet cards, phone applications, and searchable databases;
- Healthy Child, Healthy World, who expand awareness and understanding of environmental hazards to children's health;
- The March of Dimes Web site, which covers seafood intake and other topics related to preconception care, including alcohol consumption and vitamins and minerals during pregnancy (also available in Spanish);
- The Natural Resources Defense Council Web site, including the Green Living section, which provides valuable consumer information;
- Planned Parenthood® Federation of America patient fact sheets on multiple exposures (available early 2010);
- Safer Chemicals, Healthy Families, a coalition of diverse groups united by their common concern about toxic chemicals;
- University of California-San Francisco's Program on Reproductive Health and the Environment's FASTEP Program: "Toxic Matters"—a brochure that provides guidance for patients on avoiding harmful environmental exposures;
- Women's Voices for the Earth, which engages women to advocate for the right to live in a healthy environment and provides materials in Spanish.

Conclusion

Environmental exposures have been linked to reproductive health effects and may affect future generations. These exposures may have more significance at critical points in an individual's lifespan. Health care providers can help by offering patients guidance, counseling, and resources. Specifically, providers can emphasize the importance of preconception care, incorporate an environmental and occupational history as part of the patient health history, become aware of risks in their community, work with community groups and policy makers to reduce exposure levels, and provide and refer patients to education and information resources. Helping patients reduce their exposures to reproductive toxicants *now* will increase the likelihood of continued reproductive health for themselves and their families.

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Post-Test

Please circle the best answer for each question.

1. The CH_2OPS mnemonic can be used to query about environmental exposures of which patient populations?

a. Pregnant women.
b. Couples considering pregnancy.
c. Male infants.
d. All of the above.

2. Which is an accurate statement regarding guidance for avoiding reproductive toxicants in the home?

a. Well water is generally safe, but community sources of water can be contaminated.
b. Patients should ensure proper ventilation when working on art projects that involve solvents.
c. Automotive care products can be a problem, but household detergents are almost always safe.
d. Chlorine bleach should be used liberally to disinfect the home.

3. Which statement is true about the reproductive health effects of pesticides?

a. Such effects occur only in agricultural workers and other individuals exposed to high levels of pesticides in their workplace.
b. Adverse effects may include premature birth and developmental defects.
c. Data from human trials have shown a direct causal link between several pesticides and reduced fertility in women.
d. Reproductive effects are seen in women; male reproductive health does not appear to be affected by pesticide exposure.

4. Bisphenol A (BPA):

a. Has anti-androgen effects.
b. Has adverse reproductive effects that have been clearly documented in humans.
c. Has been associated with early puberty in female animals.
d. Has known epigenetic effects.

5. Which is a way to reduce exposure to harmful chemicals in plastics?

a. If drinking tap water, use filtered water only.
b. Choose canned over frozen foods.
c. Avoid unlined stainless steel drinking bottles.
d. Avoid heating food in plastic containers.

6. Which is true about the current Toxic Substances Control Act (TSCA)?

a. Under TSCA, most chemicals are safe unless proven otherwise.
b. Pesticides are regulated under TSCA.
c. Personal care products are regulated under TSCA.
d. Most experts believe that the current regulatory toxicity testing methods are adequate.

7. Which is true about reducing exposure to synthetic chemicals in the workplace?

a. Significant exposures occur only within manufacturing plants.
b. Occupational health experts can accurately predict which work settings are likely to expose individuals to reproductive toxicants.
c. Changing from work clothes before leaving the workplace is recommended to mitigate exposure.
d. Standard personal protective equipment is generally sufficient to guard women from exposure to reproductive toxicants during pregnancy.

8. Which is a NOT an effective way to reduce of the need for and exposure to pesticides?

a. Leave pet food outside.
b. Peel or thoroughly wash fruits and vegetables.
c. Use citrus spray on houseplants.
d. Remove sources of water near the home.

9. Which is true about fish consumption during pregnancy?

a. Recommendations for fish intake must take into account the nutritional benefits of seafood.
b. It is hazardous and should be completely discouraged.
c. Methylmercury exposure can be effectively avoided by trimming the fat from fish before cooking.
d. Swordfish is at low risk for methylmercury contamination.

10. Consumption of which fish species should be avoided by pregnant women because of its high mercury level?

a. Swordfish
b. Shrimp
c. Salmon
d. Canned light (not albacore) tuna

To obtain credit, return the completed post-test and evaluation form by January 31, 2012 to:
Association of Reproductive Health Professionals, 1901 L Street, Suite 300, Washington, DC 20036, Fax: (202) 466-3826

Evaluation Form

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First Name: _____

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Your professional category (choose one):

❍ Health Professional Educator ❍ Nurse Practitioner
❍ Patient Educator/Counselor ❍ Pharmacist
❍ Physician Assistant ❍ Physician/Resident
❍ Registered Nurse ❍ Student
❍ Other (please describe): _____

Do you interact with patients? ❍ Yes ❍ No

Continuing Education Credits Claimed _____

1. On a scale from 1 to 5, with 5 being best, please rate how competent you are after this training to:

When counseling patients, use the CH_2OPS mnemonic to take a comprehensive environmental health history to assess exposures.	1	2	3	4	5
Name two adverse effects on reproductive health that may be caused by toxicants that patients typically use or to which they are commonly exposed.	1	2	3	4	5
List three strategies for reducing exposures to chemicals with potential adverse effects on reproductive health that can be used when providing guidance to a patient.	1	2	3	4	5
When seeing a female patient who is planning to conceive in the next six months, discuss the risks and benefits of fish consumption and identify consumption guidelines from a reputable source, such as the Food and Drug Administration or the Natural Resources Defense Council.	1	2	3	4	5

2. On a scale from 1 to 5, with 5 being best, please rate the following by circling the one most appropriate answer:

Importance of this topic for improving reproductive health care	1	2	3	4	5
Use of evidence-based material in educational content	1	2	3	4	5
Fairness and balance of content	1	2	3	4	5

3. What recommendations would you have for improving any of the criteria above? _____

_____

4. I intend to use the information I have learned from this publication to enhance my personal clinical practice.

❍ Yes ❍ No ❍ N/A

5. I anticipate the following barriers in using the information from this course. (check all that apply)

❍ Insurance barriers ❍ Coding barriers ❍ Institutional protocols ❍ Patient resistance ❍ Clinic/colleague resistance
❍ Lack of resources ❍ Lack of time ❍ I don't anticipate any ❍ I don't have a clinical practice
❍ Other (please specify): _____

6. What can ARHP do to assist you in making any desired changes and fully integrate this information into your practice? (check all that apply)

❍ Develop CME live sessions ❍ Develop CME web-based sessions ❍ Develop CME monographs/publications
❍ Develop Mobile CME (CME on your PDA) ❍ Develop CME via a podcast
❍ Provide networking opportunities with colleagues to learn how they have integrated this information
❍ Develop patient education brochure
❍ Develop patient education fact sheet Develop patient education online tool Develop patient education podcast
❍ Other (please specify): _____

7. What topics do you suggest for future medical education activities?

_____

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