13 Talking With Patients and the Public About Endocrine-Disrupting Chemicals

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Contents

1 Communication of Environmental Health Risks
2 Communicating with the Individual Patient
3 Responding to Common Questions About Environmental Exposures
4 Communicating with Groups
5 Communicating with a Broader Audience
6 Principles of Risk Communication
7 Resources

1. COMMUNICATION OF ENVIRONMENTAL HEALTH RISKS

Health care providers often discuss issues of risk and uncertainty with patients in the context of surgery, diagnostic tests, immunizations, or treatment. Communication of potential risks and benefits before making a voluntary decision is the foundation of informed consent *(1)*.

Communication about environmental health risk differs from medical informed consent in that the hazard usually involves involuntary exposure, may be unfamiliar, provides no benefit to those exposed, and there often is much less known about the potential risks. Health care providers may not know where to find information to answer questions related to environmental health generally, or endocrine disruption specifically. Even when scientific information is available about the health effects of chemical exposure, it is almost never enough to answer questions pertaining to individual risk (as opposed to population risk) and rarely addresses issues related to the long-term effects of poorly quantified exposure during vulnerable periods of development of the fetus, young child, or adolescent *(2)*.

Despite the paucity of relevant information, health care providers have an important role to play in communication of risks associated with endocrine disruptors and

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other environmental toxicants. There is widespread concern among the general public about environmental health risks, especially risks to infants and children *(3)*. Patients frequently come to their health care provider's office with questions about environmental hazards. A survey of pediatric patients found that exposure to "environmental poison" leads the list of issues that parents worry about but that pediatricians rarely gave advice on this topic *(4)*.

There are three major settings in which health care providers may need to communicate with people about environmental health risks. The most obvious setting is the clinic or office, where discussions occur about personal risk to specific individuals. Second, health care providers are sometimes called upon to provide information in workplaces, schools, or community settings, where there is a potential environmental risk to a group of people, or a perceived cluster of disease. Third, health care providers may occasionally be called upon to address the public at large and to comment on the public health significance of scientific findings. The latter situations may involve conversations with the media or policymakers.

This chapter will present a framework for conversations in all three of the general settings outlined above. The key components for successfully communicating about environmental health issues include (i) anticipating the general categories of questions that may arise, (ii) preparing approaches to common specific questions, (iii) understanding the principles of risk communication in the environmental health context, and (iv) rapidly gathering information from reliable sources to help answer questions that arise.

2. COMMUNICATING WITH THE INDIVIDUAL PATIENT

In the patient care or community setting, environmental health concerns tend to focus on questions about individual risk. People bring worries about specific exposures or illnesses to their personal physician or to a meeting at their workplace or school or in their community. Because the science on endocrine disruptors and other environmental health hazards does not pertain to individual risk, the challenge to the health care professional is substantial. Even assuming that the physician is familiar with the scientific data relevant to the issue in question, there remains the challenge of translating a combination of results from sources such as *in vitro* receptor-binding assays, laboratory rodent studies, ecological epidemiology, and occasionally limited human epidemiological research into something relevant to a patient's individual situation. This problem is further complicated by difficulties in exposure assessment, the fact that most people are exposed to mixtures, and uncertainties about the different effects of chemicals at different times during the lifespan. The resulting conversation must therefore move away from a focus on trying to "answer the question" toward a more open discussion of scientific uncertainty, risk, and prevention.

2.1. Categories of Questions

There are three major categories of questions that health care providers may encounter in the office or community setting. These categories include

(1) Anticipatory guidance: Patients often come to their physician with questions or concerns about potential environmental hazards in the absence of any specific medical complaints. These concerns may be sparked by an article in the newspaper, something

on the Internet, a conversation with a friend, or an observation they have made in their home or community. Often, physicians do not know the answers to these questions and may feel frustrated by their inability to respond. In addition to responding to questions patients bring, physicians have the opportunity to provide anticipatory guidance on environmental health issues such as endocrine disruption, yet rarely do so.

(2) Future risk: Patients may present after a known exposure in the workplace or community. They are interested in understanding the future health risks faced either by themselves or by their family related to this exposure. The specific concerns may relate to whether they will develop cancer, they will have reproductive problems, or their child will be healthy. In addition, patients are often interested in ways they can take action to lower their risk. In the context of body burden monitoring for endocrine-disrupting chemicals, patients may want to know how to interpret personal biomonitoring results and how they can eliminate the chemicals from their bodies.

(3) Causation: Individuals who have experienced a disease or other health problem may wish to know whether the disorder was likely to have been caused by an environmental or occupational exposure. In some cases, there is an interest in determining causation within a legal framework, and in other cases the question may be more general. Nonetheless, the challenge remains in determining the likelihood that any individual case of an illness may have been caused (entirely or in part) by a historical exposure.

It is impossible to prepare for all questions that may occur related to endocrine disruptors within these three categories. In general, the questions that arise under anticipatory guidance are easier to predict and should fall within the routine purview of the primary care practitioner. Questions about future risk after an exposure or questions of causation may require referral or consultation with a specialist, or additional focused research to formulate a response.

3. RESPONDING TO COMMON QUESTIONS ABOUT ENVIRONMENTAL EXPOSURES

It is difficult to predict what environmental health concerns or questions a health provider may encounter. Some questions can be anticipated because of their ongoing prevalence in the news media, popular press, or on the Internet. Others may be based on specific community concerns. The questions that an individual patient asks of their health provider may be very similar to those asked in a public meeting. Likewise, whether speaking to an individual or group, the clinician's response to these questions is often very similar. The overall approach involves having some knowledge of the toxicity of the contaminant of concern, assessing the route and likelihood of exposure, and being able to communicate a science-based approach to reducing unnecessary exposures. Furthermore, health providers also can offer advice to groups or individuals about reducing exposure to other contaminants they were not previously aware of.

Patients often have concerns regarding exposures in their home or work environment without a specific associated complaint or illness. Health professionals can easily and efficiently answer common questions focusing on healthy food and drinking water during a routine office visit. It is useful for health care providers to prepare science-based responses for common questions, either in written form available as a handout to patients in the office or for discussion when such questions arise. Approaches to some illustrative situations are addressed in this section.

3.1. Common Office Questions

A young mother comes with her toddler for a routine check-up. At her weekly playgroup meeting, she was told that and it was the local tap water was polluted and suggested she have a water filtration system installed in her home or drink only bottled water. She lives on a limited budget and wonders if she should be concerned.

Before investing in a water filter, check the local water utility company's annual water quality report. (For help interpreting water quality reports, this web site can help: http://**www.safe-drinking-water.org/rtk.html**) In most cities, healthy adults can drink tap water without concern. Pregnant women and young children may be more vulnerable to some contaminants in water, such as lead or trihalomethanes. People who have private wells should get their water tested for common contaminants. If any pollutants are identified in drinking water, a filter that is appropriate for removal of the specific contaminants can be chosen. Different types of filters take out different contaminants, so there is no "one size fits all" solution (see Box 1 for information about water filtration systems).

Bottled water is not necessarily a better alternative to filtered water. About one-quarter of bottled water is ordinary tap water that has been filtered and packaged. Bottled water quality is actually subject to less stringent regulatory standards than tap water *(5)*. Bottled water also can contain residues of the plastic it is bottled in. Some bottled water was found to contain bisphenol A, a known endocrine disruptor in animal studies *(6)*.

Box 1: Types of water filtration

In general, there are two types of water filters, point of entry and point of use. All filtration systems require regular maintenance for proper functioning.

(1) *Point of entry units* are more expensive, are installed in the pipes outside the home, and treat all the water before it enters the house;
(2) *Point of use filters* such as countertop filters (e.g., filter pitchers), faucet filters, and under-the-sink units generally use activated charcoal to remove bad tastes and odors and chemical contaminants. Charcoal water filters are simple to install, relatively economical, and effectively remove many toxins found in the environment and comprise the majority of filters in use;
(3) For many people, an activated carbon filter bearing NSF Standard 53 certification will filter out most pollutants of concern, including endocrine disruptors such as heavy metals and pesticides. However, some contaminants that are suspected endocrine disruptors, such as arsenic or perchlorate, may not be removed by charcoal filters;
(4) In reverse osmosis filtration, water is forced through a membrane and then filtered through charcoal; a method that removes most contaminants, including arsenic and perchlorate. However, this filtration system wastes a lot of water and is much more expensive.

A Vietnamese child comes to your office for a well-child check. His father asks you if it is OK for the family to eat fish caught in the local bay where he fishes everyday. He saw a warning sign the last time he was there but had problems reading it. The family eats the fish at least 4 times a week.

Fish contains many beneficial nutrients, including omega-3 fatty acids, which are important for brain development in the fetus *(7)*. However, certain types of fish are known to contain high levels of endocrine disruptors such as mercury, polychlorinated biphenyls (PCBs), and dioxins. The Environmental Protection Agency (EPA) and Food and Drug Administration (FDA) have advised pregnant women, women of reproductive age, and young children to avoid eating commercial fish high in mercury including tilefish, king mackerel, shark, and swordfish. Tuna (especially ahi, bigeye, and canned albacore) also contains high levels of mercury and consumption should be limited before and during pregnancy. Several organizations have issued lists of fish that are high or low in mercury *(8,9)*.

Freshwater fish caught in waters contaminated with PCBs or mercury should not be consumed at all. Contaminated fresh water fish are identified by state fish advisories (http://**www.epa.gov/ost/fish/**) fish that may have high levels of PCBs, include bluefish, striped bass (wild), farmed or Atlantic salmon, and croaker *(9)*. When cooking fish, the fatty portions should be removed to reduce exposure to contaminants that accumulate in fat, such as PCBs.

A middle-aged woman comes in for her yearly check-up. She will be babysitting her grandchildren for much of the summer and her daughter-in-law insists that they eat only organic food. She wonders if this is really necessary.

Many foods contain pesticide residues. Some pesticides are known or suspected endocrine disruptors and although the levels are often low, consumption should be limited as a precautionary measure. Peeling or washing can reduce some surface residues, although peeling can also remove some nutrients and fiber. The outer leaves of vegetables such as lettuce and cabbage should be discarded. Organic foods or pesticide-free foods can be more expensive and are not always readily available. Reviews of government residue-testing data suggest that certain foods—such as apples, bell peppers, celery, imported grapes, cherries, peaches, potatoes, pears, raspberries, spinach, and strawberries—tend to be high in pesticide residues and should be priorities for purchasing organically, whereas others—such as asparagus, avocado, bananas, broccoli, sweet corn, onions, and peas—rarely contain residues even if grown conventionally. More information on pesticide residues is available at http://**www.foodnews.org/walletguide.php**. Patients should be encouraged to eat a variety of fruits and vegetables to provide a variety of nutrients and to limit exposure to a single pesticide.

A pregnant woman comes to your office concerned about the plastic toys she has received as gifts from well-meaning friends and family. She has tried to have only natural products in her home and has heard plastic toys are toxic. She feels guilty throwing them away but does not want to give them to someone else if they are toxic. She also was given many plastic baby bottles and wonders if they are safe to use.

Many soft plastic toys are made from polyvinylchloride (PVC), which often contains phthalates to soften the plastic and make it more pliable. Testing has shown these chemicals are not "bound" to the plastic but leach out of it over time *(10)*. Chewing and sucking on toys during play may increase the rate at which these toxic chemicals are

released and increase children's exposure to them. There are many different types of phthalates, but those found in most consumer products are either known or suspected endocrine disruptors. In the past several years, US toy manufacturers have voluntarily agreed to remove phthalates from "mouthing toys" such as teethers and rattlers but not from other plastic toys that might end up in a child's mouth. Some soft plastic toys are sold as "phthalate-free". As a precautionary measure, use of soft toys, especially those that are heavily mouthed, should be avoided in small children under the age of 3 years.

Many baby bottles are made from polycarbonate—a resin made with bisphenol A. Bisphenol A is an endocrine-disrupting compound, and there are concerns that human exposures are occurring at levels known to cause effects in animal studies *(11)*. Bisphenol A is known to leach from polycarbonate plastic bottles, including drinking water bottles and baby bottles, especially as the plastic ages or if it is washed in harsh detergents or bleach *(11)*. Although they are not always marked, the type of plastic used to manufacture a bottle or children's cup can be identified by the number inside the recycling triangle, often found at the bottom of a container. Polycarbonate (recycling symbol #7) bottles are generally clear and rigid. When a baby bottle must be used, it is preferable to choose an alternative, such as glass or the plastics polyethylene or polypropylene (recycling symbols #1, #2, or #5).

3.2. Special Concerns and Issues Around Breastfeeding and Infant Formula

A pregnant woman who is near her due date is in for a check up. She has been preparing for her new baby and has many questions about breast feeding. She is concerned because she recently read that many chemicals have been found in breast milk. She worries about the effects of passing these contaminants onto her new baby and wonders if it would be better to use formula.

Breast milk has been found to contain many contaminants including endocrine disruptors such as PCBs, dioxins and furans, pesticide residues, flame retardants polybrominated biphenyls (PBBs) and polybrominated diphenyl ether (PBDEs) and the plasticizers phthalates and bisphenol A *(12–14)*. Providers should reassure their patients that despite this issue, the benefits of breast feeding outweigh the risks of contamination. Breast-feeding may even protect a baby against the adverse effects of exposures that occurred *in utero (15)*.

Because of the benefits to baby and mother, the American Academy of Pediatrics recommends breast feeding for at least the first 6 months of life. Breast milk provides vital nutrients and antibodies that are passed from the mother to infant. These help prevent infections and promote growth of the brain and nervous system. Some studies have also shown that breast-fed babies are less likely to develop chronic illnesses as adults such as asthma and cancer. *(16)* Breast-feeding also is beneficial to the mother as it promotes bone strength, weight loss, and reduces the chances of pre-menopausal breast and ovarian cancer *(17)*.

Baby formula is not an equivalent substitute for breast milk. Formula is lacking in many of the vital trace nutrients and antibodies found in breast milk. Studies have demonstrated that formula-fed babies get sick more often than breast-fed babies *(18)*. While formula may not contain many of the contaminants found in breast milk, such as PCBs and

dioxins, infant formula may contain other toxins such as manganese, lead, or cadmium *(19–21)*. In addition, exposure to toxins can occur if infant powder formula is diluted with water contaminated with pesticides, heavy metals, or microorganisms. Soy formulas are a particular concern because of very high levels of plant-derived estrogens (phytoestrogens) in soy products. The amounts of phytoestrogens are 2200–4500 times greater in soy milk than in breast milk and the long-term health effects are not very well studied *(22)*.

3.3. Questions About Future Risk that may Arise After an Exposure

A young woman comes to her annual physical with questions about her mercury level. She recently participated in a study that measured hair mercury levels and sent the results to the participants. She is hoping to become pregnant in the next 6 months and is worried that her mercury level is too high and will harm the baby. She wonders what she can do to lower her mercury body burden.

Patients may present with specific concerns about a known exposure in their workplace or home or may have testing results for contaminants in their body. They may be worried that an exposure will harm them or their children and may specifically wonder if they are at an increased risk for adverse pregnancy outcomes or developing a particular disease such as cancer. For the health care provider, addressing these concerns often requires obtaining more history from the patient about the exposure—including the specific chemical(s) of concern, the dose, timing, route of exposure, number of exposures, and whether there were any associated symptoms that might herald a substantial exposure. An example of an environmental exposure history for a typical pregnant or breast-feeding woman is summarized in Table 1.

It is often impossible to quantify or predict how much greater risk a person faces from an environmental exposure. In most situations, the exposure happens only once or a few times, is at a low concentration, and it is not likely to substantially increase the risk of adverse effects above that seen in the general population. In addition, there is often little or nothing that can be done in retrospect about the exposure incident. Providers can use this opportunity to offer reassurance and to educate the patient on how to reduce future exposures.

On the contrary, some exposures occur at higher doses or on an ongoing basis—for example, in an industrial or agricultural environment where higher concentrations of chemicals or pesticides may be used. In these situations, the provider will need to obtain a more thorough exposure history and more information about the toxicity of the chemical to address the specific patient concerns. In the case of a reproductive toxicant, any indication that an exposure may be significant or recurrent may warrant closer monitoring, additional testing, or precautionary action to remove the patient from the exposure.

Some people may ask about undergoing special treatments to reduce the level of contaminants in their body. Some common treatments include chelation therapy, special diets, or medicines. In general, most of these treatments are not effective, can have serious side effects, and should be regarded with caution. Chelation therapy can be used appropriately for treating acute, severe metal poisoning. However, it is not generally accepted for use to decrease body burdens because of past exposures, especially in adults with no symptoms of toxicity. All chelating agents have side effects; most

Table 1
Environmental Exposure History [a]

Work/hobbies
What is your occupation? What are your hobbies?
Are you exposed to any of these substances at work, home, or school? Fumes, vapors, dusts, pesticides, painting materials, strong odors, lead, mercury, or other metals?
Have you ever felt sick after contact with a chemical?
Have you ever been in the military or worked on a farm?
Do you wear personal protective equipment at work or while doing hobbies?
Do your symptoms get better away from work/hobbies?
Residence
Was your home built before 1978? If so, has it been tested for lead paint? If your home has lead paint, is it flaking? Have you done any recent remodeling?
Where does your drinking water come from?
Have you had your water tested for lead?
If you have a private well, has the water been tested?
What is the occupation of your spouse or others at home? (toxicants can be brought home on clothing)
Do you know of any major industrial emissions in your neighborhood (hazardous waste sites, dry cleaners, auto repair)?
Do you live in an agricultural area?
What kinds of chemicals are in your home/garage?
Do you use pesticides? In your home? Garden? On pets?
Do you have a mercury thermometer in your home?
Do you use any traditional healing or cultural practices?[b]
Do you ever smell chemical odors while you are at home?
Do your symptoms get better away from home?
Diet
What kind of fish do you eat? How often do you eat fish?
Do you or anyone in your home fish in local waters?
Do you eat foods high in animal fat (fast food, ice cream, cheese, whole milk, fatty meats)?
Do you grow your own vegetables? (possibility of contaminated soil)
Do you take any dietary supplements?[b]

[a] An example of questions that might be asked of a pregnant or nursing woman to identify current or past exposures, reduce or eliminate current exposures, and reduce health impacts.

[b] May involve exposure to heavy metals such as mercury or lead.

commonly, these include abdominal discomfort, nausea, liver damage, neutropenia, decreased blood pressure, and allergic reactions. In addition, chelators may bind other divalent mineral cations essential for normal physiologic function.

In the case of mercury, the half-life of the metal in the human body is about 60 days. Appropriate management of an asymptomatic patient with a confirmed elevated mercury level would include advice about avoiding mercury from fish and a review of other possible sources of mercury exposure. Repeat testing to assure that the level is declining is also useful. A woman of reproductive age may be counseled to delay pregnancy for 6–8 months as a precautionary measure.

When there is concern about an exposure that may result in adverse effects, consultation with a specialist in occupational/environmental medicine or toxicology may be warranted. In all situations, patient education on how to prevent and reduce future exposures is essential.

3.4. Questions of Causality After an Adverse Health Event

A migrant farmworker was recently diagnosed with testicular cancer. His job involves mixing and applying pesticides, and he does not always wear protective equipment. He wonders if the pesticides could have caused his cancer.

Patients may approach their health provider with concerns that a past exposure is related to a specific condition, such as infertility or cancer loss. In some cases, the patient is simply struggling to understand a bad health outcome; in other situations, a legal case may be pending. This is often a challenging case for a physician as most health outcomes have multi-factorial causes, including, in some cases, chemical exposures.

Although health providers may not be able to give an immediate answer, they can take a thorough history to determine whether the exposure was substantial (Table 1), give education about the health condition and the associated etiologies, discuss the uncertainty and challenges in determining individual risk, and provide guidance on how to avoid future exposure. Referral to an appropriate consulting specialist may be necessary for complex exposures and determination of causality.

3.5. Precautionary Anticipatory Guidance that Clinicians can Offer

People are routinely exposed to a wide variety of chemicals, some of which are endocrine disruptors. Endocrine disruptors may be in the food people eat, the water they drink, the air they breathe, and in consumer products.

Patients may not be aware of their ongoing exposures, and a visit to their health care provider can be an opportunity for patient education on topics they were not previously aware of. Instead of focusing the conversation on past exposures and unpredictable health outcomes, health care providers can use this opportunity to educate patients about prevention. The provider does not need to be an expert in environmental health to discuss environmental exposures. Simple, common sense guidance for reducing exposure to known or suspected endocrine disruptors can prevent unnecessary risks.

Provided here are a few topics that health providers can discuss with their patients during the course of a routine office visit. Not all topics can be covered in one visit, nor is there one best way to avoid all exposures. By starting the conversation, providers empower a patient with information and a course of action.

Dietary Advice. Eat more fruits, vegetables, grains, and reduce consumption of fatty animal products (beef, pork, and dairy). Eat a variety of fish and limit consumption of those known to be high in contaminants. Many endocrine disruptors, such as PCBs and dioxins, are lipophilic and accumulate in fat. Eating fatty foods can increase the body burden and fat accumulation of these chemicals in humans over years and even decades. When a woman breast-feeds, these contaminants are mobilized from fat and end up in breast milk. Therefore, animal fat intake should be reduced beginning in childhood.

Reducing Pesticide Exposure. Many pesticides are known or suspected endocrine disruptors. Pesticides are commonly used around the home and garden and on pets. Pesticides are also found in head lice treatments. To reduce pesticide exposure, choose non-chemical alternatives for home, garden, and pet use. If the use of a pesticide is necessary, use the least toxic alternative. For examples of some alternatives, see http://**www.pesticide.org/factsheets.html**. For insect and rodent control, baits and traps are the best approach in conjunction with sealing cracks and cleanliness. Least preferred are insecticide sprays or "bombs." Pregnant women and children should not mix or apply pesticides and should not be present in a home when treatments are applied. Head lice can be treated with nit combs or other non-toxic alternatives. Further discussion of reduction of pesticide exposure in the community is provided in Chapter 14 by Brenner and Galvez.

Reduce Exposure to Heavy Metals—Such as Lead and Mercury. Lead is still commonly found in the paint and pipes of older housing and can be found in the consumer marketplace in pottery with lead glaze, some costume jewelry, and personal care products such as hair dyes. People can reduce their exposure to lead by having their drinking water tested for lead, by having a professional remove any lead paint in their home, and avoiding use of products containing lead. Lead may be present in garden soil and can end up in vegetables or be tracked into the home on shoes.

In addition to dietary exposure, mercury exposure can occur through occupations, hobbies, magic-religious practices, and consumer products. The most common occupational exposure is in dentistry. Hobbies that may involve mercury include gold panning. Some Caribbean religious practices involve sprinkling metallic mercury inside the home or car as a purification ceremony. The resulting exposures to mercury vapor can be very high. Imported skin-lightening creams and acne remedies may contain inorganic mercury. Finally, thermometers, fluorescent lamps, and some types of batteries may all contain mercury. People should recycle lamps and batteries, and exchange their mercury thermometer for a digital one. Many communities sponsor collections of these products. Further evidence for heavy metals as endocrine-disrupting chemicals is found in Chapter 5 by Dyer.

Smoking. Both active and secondhand tobacco smoke exposure have been associated with many adverse reproductive outcomes, including infertility, low sperm counts, spontaneous abortion, low birth weight, and preterm labor. All couples should be advised to stop smoking and to avoid secondhand smoke exposure when attempting to become pregnant, while pregnant, or when there is an infant or child in the home.

4. COMMUNICATING WITH GROUPS

Although health care providers tend to focus on communication about environmental health issues with individual patients, health professionals are also often called upon to communicate with groups of people in a variety of settings, such as workplaces, schools, and communities. These types of communications are somewhat different than the discussions that occur in the medical office.

4.1. The Workplace Setting

An electronics company contracts with a local hospital for employee health services. In less than 1 year, three women working in one area of the manufacturing process

have spontaneous abortions, and the company requests that a physician from the hospital come speak to the employees to answer their questions about whether the miscarriages were related to chemical exposures at work.

Workplaces may be settings where people are exposed to significantly higher concentrations of industrial chemicals or pesticides than are usually encountered in the general environment. In addition, some chemicals used in workplaces are not found in the community, and the toxicity may be distinct. OSHA standards generally focus on preventing undue acute toxicity but rarely are set on the basis of chronic effects. In fact, for only four chemicals are the OSHA standards designed to protect against adverse reproductive outcomes *(23)*. No chemicals are regulated by OSHA specifically on the basis of endocrine effects. The working population in the USA now includes a large percentage of women, and it is not unusual for women to work during pregnancy or lactation.

Communicating with workers about workplace exposures requires a careful job history, some understanding of the workplace setting, collection of material safety data sheets (MSDS) for the products or chemicals handled, and an effort to gather as much information as possible about exposure pathways, duration, and magnitude. It is important to be aware that OSHA compliance does not necessarily imply that a workplace is safe, especially for pregnant women, and that MSDS information is frequently incomplete, especially for reproductive and developmental toxicity and endocrine disruption. In fact, one review of MSDS for lead and ethylene glycol ethers (both known reproductive toxicants) found that 60 % of the 700 MSDS surveyed failed to even mention reproductive effects *(24)*. Before communicating with a group of workers, it is helpful to tour the workplace and review the scientific literature on the chemicals used.

Although it can be very difficult to answer questions about causation, especially for multifactorial health outcomes such as spontaneous abortion, it is possible to use communication opportunities to offer precautionary guidance to the employer and workers about reducing exposures within the workplace. In this context, the hierarchy of controls for management of risk in the workplace specifies elimination of the hazard, such as by substitution of less toxic chemicals or processes whenever possible *(25)*. When elimination of the hazard is not possible, engineering controls that prevent worker exposure are far preferable to administrative changes (e.g., rotating workers through the most dangerous jobs) or to personal protective equipment (PPE) such as respirators (which can fail or may not be worn properly). If workers do need to wear PPE, it is important that they are properly trained in the reasons for its use and in proper use procedures. Because the workplace is a more controlled environment than the community, if an employer is willing to make the effort, it is often possible to substantially reduce or eliminate exposures. If exposure is truly prevented, then there is little need to worry about health risk.

4.2. The School and Community Setting

A worried mother calls about her child's preschool. The building is in a low-income predominantly African-American community and is situated next to a closed semiconductor wafer fabrication facility, which is now a designated Superfund site. During the cleanup process, workers accidentally ruptured an underground storage tank containing trichloroethylene (TCE). Soil gas testing and air testing at the preschool showed elevated levels of this chlorinated solvent. The parents are looking for a physician who can talk to them at a community meeting.

Conversations about environmental health risks in a community setting require that the health care provider consider and address the exposures or illnesses that have already occurred, the future risks to people in the local community, and the need for public health action to protect the health of the people in the community. Physicians are one of the most trusted and credible sources of information about environmental health risks *(26)*. It is important that health care providers listen to community concerns and respond with honesty. Blanket reassurances are rarely appropriate and rarely believed.

Understanding different perceptions of risk is important to help understand how to communicate about risk in a community setting. If the physician who is attempting to explain a risk does not realize that the community may perceive risks differently, the discussion is less likely to be productive and effective.

One important issue related to discussing risks in the community setting is the history of environmental injustice in the USA. Low-income communities of color have become increasingly concerned about a disproportionate and unfair burden of environmental risk in their communities. Even a relatively small risk may be seen in the context of a history of racial and socioeconomic discrimination in the distribution of environmental risks and is perceived as adding to an already unacceptable background of risk.

The most significant predictor for the location of hazardous waste facilities nationwide is the race of the local community *(27)*. Regulation of facilities in communities of color is also deficient, with fines imposed for pollution in non-white communities averaging 54 % lower, and timelines for listing sites on the National Priority List for cleanup 20 % longer *(28)*. Similar disparities have been reported for exposures to toxic air contaminants *(29)*. Low income communities and communities of color are also more likely to contain multiple environmental pollution sources. Reviews of research have shown that children of color suffer disproportionate burdens of disease with potential environmental aspects, including asthma, neurodevelopmental disorders, and childhood cancer *(30)*. In part because of these disparities, people living in these communities may see a single incident such as a ruptured chemical tank near a day care center as part of a bigger picture of environmental hazards and a history of environmental injustice. If the health care provider ignores the history and context behind an individual incident, the conversation can feel frustrating and confusing to all parties involved.

In many cases, the actual risk to people in the community is essentially unquantifiable. As a result, it may not be possible to assign a risk of an adverse outcome, even at a community level. Therefore, support and precautionary guidance may be the most useful information a health care provider can offer to a community. Whenever possible, vulnerable populations such as pregnant women and children should be removed from situations of potential exposure to endocrine disruptors or environmental toxicants. Likewise, environmental pollution should be cleaned up and minimized whenever possible.

5. COMMUNICATING WITH A BROADER AUDIENCE

Endocrine disruption is an environmental health issue that generally has effects at a population level rather than to identifiable individuals. For example, environmental agents that slightly lower average sperm concentration in the population, slightly increase the risk of cancer of hormone-sensitive tissues, or that cause children to reach

sexual maturity slightly earlier, are not likely to result in health effects that will be readily discerned at the level of the individual patient. This characteristic of endocrine disruptors creates particular difficulty for health care providers trying to communicate about this issue to their patients or even to small groups of people.

The population-level implications of endocrine disruptors can instead make it far easier for health care providers to communicate to a larger audience. In an expanded role, physicians and other health care workers can communicate about the broader public health implications of large-scale, subtle shifts in hormone-sensitive endpoints. Contexts in which such discussions might occur include comments to the media, policy discussions at medical and nursing societies, and health policy discussions at the local, state, and national level.

Although many health care providers are reluctant to make public statements about population risk, there are at least three reasons why they should consider doing so. First, the scientific basis for extrapolating the results of current endocrine disruptor research is far stronger when the extrapolation is at the population level rather than at the level of the individual patient; second, health care providers are a trusted and important voice that is rarely heard in public discussions about environmental health policy; and third, the foundation of medicine is prevention, and the most useful prevention activities around endocrine disruptors can occur at the population, rather than individual level.

In October of 2005, the governor of California signed legislation to require manufacturers of cosmetics to disclose any product ingredient that is on state or federal lists of chemicals that cause cancer or birth defects *(31)*. The legislation also allowed the state Department of Health Services to demand that manufacturers supply health-related information about other cosmetic ingredients and authorized a program to regulate these products to protect beauty salon workers. The legislation was sponsored by several breast cancer groups and was introduced because of studies that showed phthalates in cosmetics and (high) levels of certain phthalates in the urine of women of reproductive age *(32,33)*. The discovery that cosmetics may contain chemicals that are considered to be known endocrine disruptors and developmental toxicants raised significant public concern, especially when it became clear that these chemicals are generally not listed on the product label.

Health care providers played a role in the passage of this legislation. Physicians and nurses testified before committees in the California Senate and Assembly, and health organizations and individual health care providers sent letters of support. Some health care providers stated that it was easier for them to support broad public health protection and consumer information regarding phthalate exposure than to attempt to address this issue with each individual patient. Communications in the press emphasized that exposure of millions of women to phthalates on a daily basis could have subtle, long-term effects on the health of these women or their babies. However, it was also clear that the risk to any individual woman and child was unquantifiable and probably very small.

Communicating with the media or with policymakers requires a different set of considerations than communicating with individual patients or small groups of people. It is important to realize that the health care provider does not necessarily need to be an expert in toxicology or endocrine disruption to be a spokesperson on these issues, but there is a need to understand the basic state of the science, the level of scientific uncertainty, and the potential public health implications of the scientific data. Before speaking with a reporter or a policymaker, it is important to also review the policy

proposal at issue and to determine whether it seems like a reasonable, precautionary, science-based step toward protecting public health.

If the science and the policy seem reasonable, the next step is to either write out a statement of support or develop key talking points. Communications experts suggest identifying three or four major "messages" that summarize the main points that need to be conveyed. For the legislative scenario discussed above, examples of such messages could include

(1) Several phthalates have been linked to subtle abnormalities in fetal reproductive system development, so widespread exposure to women of reproductive age should be minimized whenever possible;
(2) The Centers for Disease Control and Prevention reports that women of reproductive age have high concentrations of certain phthalates in their urine, and these chemicals have been detected in cosmetics;
(3) Consumers should have a right to know about potential endocrine disruptors or developmental toxicants in products so they can make informed choices, especially during pregnancy;
(4) The Department of Health Services needs more information about chemicals in products to carry out its responsibility to protect the public health.

The talking points must be tailored both to the issue and to the perspective of the person who will be speaking publicly. Although it is useful to know the science supporting the points, and even to have anecdotes or stories to support the points, the overall messages should remain broad and clear to the non-scientific listener. Health care providers should take care to speak only within the talking points that they have developed to avoid making mistakes or going astray into issues that are either irrelevant or outside the speaker's area of expertise. It is generally possible to answer almost any question by restating a talking point, even if it means saying something such as: "I don't know the answer to your question, but the real issue here is . . . ." By pre-identifying a set of talking points within a scientific and policy comfort zone and staying within those points, the health care provider can assure both that the major issues will come through clearly in any news story or policy hearing and also that his or her credibility will remain intact.

6. PRINCIPLES OF RISK COMMUNICATION

Risk communication is the exchange of information about the nature, magnitude, significance, and control of a risk. Different groups of people view risks differently. Government agencies and industry scientists often engage in quantitative risk assessment that involves a series of steps (hazard identification, exposure assessment, dose–response assessment, and risk characterization) to generate a number that can be used for regulatory purposes *(34)*. Officials tend to use the resulting numerical regulatory limits to either dismiss a given chemical exposure as insignificant or take it seriously.

Health care providers are more likely to engage in qualitative risk assessment. A physician's exposure assessment, for example, is less likely to involve actual measurements or mathematical modeling of exposure and is more likely to involve questions about the frequency and duration of the exposure, coupled with a rough assessment of the magnitude of the exposure based on the medical history. Physicians however often

defer to governmental regulatory limits without necessarily scrutinizing the basis for the number.

The general public often distrusts quantitative risk assessment. This sentiment is not without foundation, as the process is limited by failure to account for multiple chemical exposures, failure to consider highly vulnerable groups (particularly fetuses and infants), the use of highly uncertain assumptions about species differences in extrapolating from high-dose toxicity studies in animals, and an absence of data on important health outcomes such as endocrine disruption or developmental toxicity. In addition, risk assessors often do not agree on which studies to include in their calculations, and different studies often find different levels of concern.

Risk is not an objective issue but rather has both scientific and social components, which are subject to interpretation. Historical and social context, as well as ethical issues, may lead to greater concern about some risks relative to others. Therefore a scientist's perception of risk is not necessarily "correct," and a lay person's perception is not necessarily "incorrect" *(35)*. It is important to approach questions of risk humbly with an understanding of the limitations of the science and the importance of the social context. It is also important to understand factors that contribute to different perceptions of risk to anticipate ways patients or communities may react to a hazard. Although each person probably perceives risk differently, extensive research has identified some common characteristics that influence risk perception: the nature of the hazard, the characteristics of the person perceiving the risk, and the social context in which the risk occurs *(36)*.

Hazards that are seen as potentially catastrophic, although unlikely, are generally perceived as posing a greater risk than hazards that are more likely but would result in less serious or reversible outcomes *(37)*. For example, the risk from a nuclear power plant may be seen as greater than the risk from coal power plants, although the likelihood of emissions that are hazardous to health is higher from coal plants. Similarly, the risk of a dreaded outcome (such as cancer, birth defects, or brain damage) is often seen as worse than the risk of a disease that is less universally dreaded (such as liver, lung, or kidney disease) *(38)*. Unfamiliar hazards are generally seen as riskier than familiar hazards, and manmade hazards may be perceived as riskier than those that occur naturally. The population affected by the hazard is also important. For example, a hazard to infants is often judged worse than a similar hazard to adults *(39)*. Finally, hazards that are involuntary are almost always judged more serious than hazards that are faced by choice *(40)*. Thus, comparison of the risks associated with skiing or drinking alcohol with risks from a hazardous waste incinerator will not be seen as equivalent because the former are voluntary and under the control of the individual, whereas the latter is imposed from outside.

The social context of risk communication is extremely important to perceptions of risk. If the individual or organization imposing the risk is trusted by the community (i.e., a local company that has provided jobs in the community for many years and is well known to the community), the risk is often perceived as less than if the risk is imposed by an outsider. Similarly, the level of trust in government regulatory officials is important in the perception of risk *(41)*. Risks seen as unfair are often seen as larger than risks seen as fairly distributed *(42)*.

Communication about risk yields optimal results only when there is a back-and-forth dialogue. The affected people need to feel that their concerns have been heard

and addressed. In the most progressive view, those involved not only develop a good understanding of the risks but also search together for solutions that can mitigate their concerns *(43)*.

7. RESOURCES

Physicians who are faced with questions of environmental or occupational exposures in their patients need quick, reliable sources of information. Provided here are scientifically based resources that physicians can use to help in the care of their patients with exposures to contaminants, including endocrine disruptors.

7.1. Clinical Referrals

7.1.1. The Association of Occupational and Environmental Clinics (http://www.aoec.org)

Network of greater than 60 clinics and 250 individuals committed to improving the practice of occupational and environmental medicine. Has clinical directory for finding specialists in Occupational and Environmental Medicine: www.aoec.org/directory.

7.1.2. Pediatric Environmental Health Specialty Units (PEHSU) (http://www.aoec.org/pehsu.htm)

Provides education and consultation for health professionals, public health professionals, and others about the topic of children's environmental health.

7.2. Governmental Organizations

7.2.1. Centers for Disease Control and Prevention (CDC) (www.cdc.gov)

7.2.1.1. Agency for Toxic Substances Disease Registry (ATSDR) (http://www.atsdr.cdc.gov). The principal federal public health agency charged with responsibility for evaluating the human health effects of exposure to hazardous substances. Produces "toxicological profiles" for hazardous substances found at National Priorities List (NPL) sites: www.atsdr.cdc.gov/toxpro2.html

7.2.1.2. The National Institute for Occupational Safety and Health (NIOSH) (http://www.cdc.gov/niosh/homepage.html). Information on chemical safety, workplace health hazard evaluations, and reproductive health and occupational exposures.

7.2.2. The National Library of Medicine (http://www.nlm.nih.gov/)

Has links to databases including

PubMed (www.pubmed.gov)—references abstracts from thousands of biomedical journals.
ToxNet (toxnet.nlm.nih.gov)—network of databases on toxicology, hazardous chemicals, and environmental health.
Household Hazardous Substance Database (householdproducts.nlm.nih.gov/ products.htm)—links over 6000 consumer brands to health effects from MSDS and allows scientists and consumers to research products based on chemical ingredients.

7.2.3. The US Environmental Protection Agency (EPA)

Integrated Risk Information System (IRIS) (www.epa.gov/iris/) A database of human health effects that may result from exposure to various substances found in the environment.

7.3. Non-Governmental Organizations

7.3.1. The Collaborative on Health and the Environment (CHE, healthandenvironment.org) (http://health and environment.org)

Tracks emerging scientific evidence on links between diseases, disorders and disabilities, and possible environmental causes. Has produced many peer-reviewed overview papers on environmental causes of disease and a large database showing the associations between contaminants and human disease: database.healthandenvironment.org

7.3.2. Pesticide Action Network, North America (PANNA) (http://www.panna.org/)

Maintains a pesticides database: www.pesticideinfo.org/Index.html

7.4. Other Useful Websites

7.4.1. Our Stolen Future (http://www.ourstolenfuture.org)

Provides regular updates about the cutting edge of science related to endocrine disruption and information about ongoing policy debates, as well as new suggestions about what people can do to minimize risks related to hormonally disruptive contaminants.

7.4.2. The National Pesticide Information Center (http://npic.orst.edu/)

A cooperative effort of Oregon State University and the USEPA—provides on-line information about pesticide safety and toxicity. The organization also runs a toll-free hotline for pesticide questions (1 800 858 7378).

7.4.3. E.Hormone (http://e.hormone.tulane.edu)

Hosted and run by the Center for Bioenvironmental Research at Tulane/Xavier Universities—provides background and up-to-date information about endocrine disruption and other environmental signaling.

7.4.4. Em-Com (http://www.emcom.ca)

Information resource about endocrine-disrupting substances directed by a group of faculty at six Canadian universities.

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Endocrine-Disrupting Chemicals

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