The clinical content of preconception care: environmental exposures

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Environmental origins of disease risk and harm to health have been increasingly acknowledged for numerous outcomes, in both adult and pediatric populations. Adverse reproductive and developmental effects have also been linked to environmental exposures. In addition to the current queries about a patient's alcohol and smoking history, key determinants of a future pregnancy outcome should also be elicited during the preconception visit. These determinants include: (1) mercury intake via fish consumption; (2) nitrate exposure from well water sources; (3) exposure to chemical, physical, or biologic hazards on the job; and (4) lead and other toxic exposures—possibly from hobbies or the use of lead-glazed dinnerware in the home. Eliciting a detailed environmental history permits tailored recommendations to optimize the woman's health and that of her future pregnancy.

Key words: environment, exposure, lead, mercury, preconception

Links between environmental exposures and risk of disease or other health harm have been increasingly acknowledged for numerous outcomes ranging from cancer development to childhood asthma. Adverse reproductive and developmental effects have also been linked to environmental exposures. The Institute of Medicine (IOM) describes a patient's environment as comprising 3 sectors—the home, the community, and the workplace—wherein chemical and physical hazards may be encountered via various media such as contaminated soil, water, and air.[1,2] Although the American College of Obstetrics and Gynecology (ACOG) Ante Partum Record already includes environmental history queries regarding smoking and alcohol use,[3] a broader review of the patient's home, community, and work life must be added to gain a more complete picture. Diet history including fish consumption can be considered under the "home" environment and drinking water source under "community." Specifics of work duties and agents handled enable tailored recommendations to optimize the woman's health and that of her future pregnancy. Routine assessment of hobbies, habits, and home and work environments might identify exposures associated with adverse reproductive consequences that can be minimized during the preconception period. Although the effects on human pregnancy of many of the chemicals in occupational use are unknown, several classes of elements and compounds—such as heavy metals and organic solvents—have been implicated in a variety of reproductive disorders.

Recommendation. It is prudent to educate women for whom pregnancy is a possibility about environmental hazards, and to provide them with the facts available about the teratogenic potential or reproductive toxicity of any chemical or environmental agent to which they are exposed. *Strength of recommendation:* A; *quality of evidence:* III.

Mercury

National norms exist for mercury levels in both blood and urine collected during the National Health and Nutrition Examination Survey (NHANES) conducted by Center of Disease Control (CDC).[4] Measures of mercury exposure in women of childbearing age generally fall below levels of concern. Several scenarios, however, if elicited during history taking at the preconception visit, merit follow-up and possibly intervention. Exposure to methylmercury is of particular concern because it is a well-established human neurotoxin and the developing fetus is most sensitive to its adverse effects.[5-7] Methylmercury bioaccumulates through the food chain so that concentrations are highest in large predatory fish. Exposure occurs primarily through consumption of seafood, freshwater fish, and shellfish.[8-12] Thus, consumption of fish high in mercury, which has been organified and concentrated through the food chain and is found in highest concentrations in large game fish, is of concern during the preconception period. The 2004 United States Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) issued a joint consumer advisory regarding methylmercury in fish and shellfish, advising pregnant women, those likely to become pregnant, and those breastfeeding to avoid any consumption of shark, swordfish, King mackerel, and tile fish.[13] Other fish consumption (such as tuna) should also be limited but is allowed in up to 2 meals of 6 ounces each per week. Counseling about fish consumption is especially important in nonmeat eating patients and those who supplement a meager diet with fish that the family catches (subsistence fish eaters). The National Academies of Science's IOM has issued a more recent recommendation on seafood con-

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Received June 17, 2008; revised Oct. 3, 2008; accepted Oct. 13, 2008.

Reprints not available from the authors.

Conflicts of Interest: Melissa A. McDiarmid, MD, MPH; Paula M. Gardiner, MD, MPH; and Brian W. Jack, MD have no conflict of interest including grants, honoraria, advisory board membership, or share holdings.

0002-9378/$34.00

doi: 10.1016/j.ajog.2008.10.044

sumption,[14] updating the 2004 EPA/FDA advisory. Generally, the IOM agrees with the EPA/FDA advisory but is a bit more cautious with portion size recommendations for pregnant women, those who could become pregnant, and those breastfeeding, stating that a "reasonable intake" of fish with lesser mercury content is 2 meals weekly of 3 ounces each (a typical can of tuna contains 7 ounces), but the 12-ounce total intake recommended by the EPA/FDA advisory can be "safely consumed."

Active controversy regarding dietary sea food limitation reigns in the literature due to the documented benefit of essential fatty acids in the maternal diet to both mother and the fetus.[15] A reasonable approach here is to recommend alternative sources of dietary fatty acids such as purified fish oil.

Recommendation. Women of childbearing age who may become pregnant should avoid consumption of shark, swordfish, King mackerel, and tile fish. Other fish consumption (such as tuna) should also be limited but is allowed in up to 2 meals of 3 ounces each per week. Many state government agencies issue fish advisories and bans relating to mercury concentration in locally caught fish. In addition the maternal diet may be supplemented with essential fatty acids from nonseafood sources. *Strength of recommendation:* B; *quality of evidence:* III.

Lead

Lead is a known neurotoxin, especially for vulnerable populations such as young children and the fetus. Lead is most commonly found in lead-based paint, occupational settings, and contaminated soil. Hobbies may also provide a source of lead exposure, as may use of dishes and pottery with lead glaze (see below). Exposures, even early in pregnancy can pose a risk to the fetus. Lead levels of 10-15 μg/dL may lead to central nervous system (CNS) damage; hydroceles; skin tags; hemangiomas, lymphangiomas, and undescended testicles in males; miscarriage; and stillbirth. Adverse effects of elevated maternal blood lead levels (BLLs) during pregnancy include spontaneous abortion, intrauterine fetal demise, premature delivery, intrauterine growth restriction, and postnatal neurologic sequellae.[16] About 0.5% of childbearing-age women in the United States overall may have blood lead levels exceeding 10 mcg/dL.[17] In 1996, blood lead surveillance of women aged 18-45 years old in New York State found that 2% of BLLs exceeded 10 mcg/dL. Although there is no documented safe threshold for BLLs, the adverse effects of antepartum lead levels on the fetus in the range typically found in the United States have not been established. It is also difficult to interpret BLLs in pregnancy because of the potential for hemodilution and the frequent presence of coexisting anemia.[18] This, however, does not preclude measuring the BLL in a preconception or pregnant patient who gives a history suggestive of past or current exposure. The history of present or remote past exposure to lead suggests the need for a BLL and for monitoring of this level if found to be elevated during pregnancy and while breastfeeding.[19] This is due to the mobilization of lead stores from bone during pregnancy and lactation. Lead in breast milk is passed to the feeding infant, as well. If lead levels are elevated, calcium dietary supplements may minimize lead mobilization modestly,[20] and consultation with an occupational medicine specialist is reasonable to assist with management. Risk factors for lead exposure include occupational risks and home renovation. Lead may also be found in some cosmetics, especially from sources outside the United States.[21] The most common categories for occupational exposure include precision production, crafts, and repairs. A study from the New York City Health Department reported on incident BLLs $>$ 20 mcg/dL between 1996 and 1999 ($n = 33$), and found that levels were inversely associated with maternal age and length of time in the United States, and directly correlated with gestational age and pica behavior.[22]

How detectable is the condition? Prevention strategies for childhood lead poisoning include the identification of at-risk pregnant women. The CDC recommends the use of a questionnaire to assess children's risk of lead exposure; this questionnaire has been successfully adapted for use in pregnant women.[23] The New York State Health Department has used questionnaires and BLLs as part of routine screening in pregnancy since 1995.[24] Other states have subsequently adopted their approach.

How effective are the current treatments? Treatment such as chelation has been reported in pregnancy[25] but is reserved only for symptomatic women with very high levels of lead in their blood.

Impact of preconception care: For women of childbearing age who are not pregnant, no recommendations and little data exist. A risk-assessment questionnaire that incorporates questions about potential lead exposure may be useful in identifying areas of risk reduction for further counseling. Recommendations for women with affirmative responses should include screening of any children in the household, education about methods of environmental cleanup, removal from the exposure source, and nutritional counseling—such as increasing the amount of iron and calcium in the diet—to reduce absorption of ingested lead. These recommendations have been extrapolated from pediatric data and are not promoted by national organizations nor studied in this population.

Recommendations by other groups: No national organizations currently recommend screening pregnant women for elevated BLLs. The United States Preventive Services Task Force recommends against routine screening for elevated BLLs in asymptomatic pregnant women.[26]

Recommendation. There is insufficient evidence to recommend that all women should be screened for elevated lead for the purpose of improving perinatal outcomes. However, women exposed to high levels of lead or with a history of known high lead levels, including childhood lead poisoning, should be counseled on the risk of lead to the unborn child. For women with a history of high BLLs, it is reasonable to test the BLL and, if elevated, to initiate activities to lower the levels before conception. *Strength of recommendation:* C; *quality of evidence:* II-2.

Soil and water hazards

Hazards encountered in the soil, water, or air often originate from a current or former industrial source. Polluted sites that are tracked on the US EPA's National Priority Listed (NPL) site program[27] generally do not result in human health effects to the wider community but may threaten residents of a home in close proximity by allowing for soil or drinking water contamination. Although not uniformly true, many residents know when they are living near an NPL or toxic waste site. Documentation of chemical intrusion into soil or drinking water can be obtained from local health departments. Another community-based environmental hazard is the patient's source of drinking water. If the source of water is a private well, documentation of water quality should be sought. Private wells are not regulated for water quality by the EPA, in contrast to public water sources. Several reports of adverse pregnancy outcomes have been attributed to contaminated well water.[28]

Recommendation. During preconception visits, women should be asked if their well water has ever been tested or if there have been questions about their municipal water quality in the past. Any possible water quality problems should be investigated by the local health department and, if concerns are identified, women should use alternative sources of water for drinking and cooking. (Note: avoidance of water bottled in containers containing Bisphenol A [BPA], identified by the number 7 on the bottom of the bottle, is prudent) (see below). Depending on the contaminant and its concentrations, alternative locations for bathing may also be required. *Strength of recommendation:* B; *quality of evidence:* III.

Although not derived from the ambient environment, dietary exposure to BPA from canned food liners or water bottles is an emerging hazard generating conflicting recommendations from public health agencies. BPA, a high production (by volume) organic chemical compound with estrogenic properties is used as a building block of hard (polycarbonate) plastics and epoxy resins used in some food and drink containers. Recently the Center for the Evaluation of Risk to Human Reproduction (CERHR) of the National Toxicology Program issued a report based on an evaluation of the state of science regarding BPA. Although based largely on animal evidence, mechanisms of toxic action of BPA are shared with humans and the doses at which outcomes were observed occurred at those seen in humans. The NTP therefore issued a statement voicing "some concern" for effects on the brain, behavior, and prostate gland when the fetus, infants or children are exposed at current human exposure levels to BPA. They also determined there is "minimal concern" for effects on the mammary gland and an earlier onset of puberty for females exposed or fetuses, infants, and children at current human exposures to BPA.[29] Prudent practice would therefore suggest avoidance of exposure. This is accomplished by avoiding canned food packed in epoxy (white plastic container liners) and bottled water with the number 7 stamped on the bottom.

During the preconception visit women should be advised about BPA avoidance in their diet. *Strength of recommendation:* B; *quality of evidence:* II.

Workplace exposure

The workplace represents the principal opportunity for exposure to environmental reproductive or developmental toxicants. Although some chemicals are regulated by public health agencies, the majority of chemicals considered for regulation are not evaluated for reproductive endpoints. Therefore, many chemicals with unambiguous reproductive or developmental effects are still in regular commercial use and thus pose a risk to women before pregnancy. Several employment sectors with such toxicants in common use—including laboratory and clinical healthcare, printing, and dry cleaning—employ women in large numbers.[30] Healthcare especially presents exposure opportunities to undisputed reproductive and developmental toxicants, including hazardous anticancer and antiviral agents.[31] Aspects of other industrial sectors, including the use of pesticides and herbicides in the agricultural sector, the use of solvents and heavy metals in the manufacturing sector, and the use of solvents and inks in the printing sector, also present potential risks to underprotected workers. An initial evaluation of a patient's job-related exposures can be obtained by screening questions regarding employment and job sectors.[19,32] If there is a potential chemical, biologic, or physical agent hazard identified, then a more detailed assessment can be made by asking about frequency of exposure, duration, timing, and exposure route (inhalation, dermal contact, or ingestion). This assessment should include questions about the use of additional protective apparel or the use of a respirator for some job tasks. However, there are some jobs in which both governmental safety and health agencies and professional organizations recommend alternative duty (ie, different job duties without exposure to hazards of concern) for pregnant workers or those actively trying to conceive,[33] such as nurses who handle cancer chemotherapeutic agents[34] and workers with organic solvent exposure.[35] The work of the patient's partner should also be inquired about as secondary contamination of the household or maternal exposure opportunity is posed during laundering of work clothes.[36]

Recommendation. During preconception visits, women should be asked about the work environment. If potential exposures are identified, consultation with an occupational medicine specialist may assist in carrying out a more detailed investigation regarding recommendations for work modification. *Strength of recommendation:* B; *quality of evidence:* III.

Household exposures

A woman's residential activities and hobbies pose potential risks for her before pregnancy. Hobbies of concern include those involving solvents such as oil-based paints; heavy metals, such as lead, which are used in stained glass work; and paint-stripping agents that often contain methylene chloride, which metabolizes to carbon monoxide and can be toxic to the fetus.[37] Jewelry mak-

ing and metal tempering can involve the melting and soldering of metals and should also be avoided. Pesticides, herbicides, and rodenticides are among the chemical hazards most likely to be encountered in the home. Application of any of these should be avoided by the preconception patient. A home may be secondarily contaminated by a family member's soiled work clothes and shoes that are brought home and contain pesticides or other toxins. Painting projects with nonlatex-based paints that are solvent based and contain metals for pigment and antifoulant agents, common in exterior paints, should be avoided. Some home-rehabbing projects are also potentially hazardous. The use of heat guns to remove old paint and wallpaper from walls containing lead-based paint should be avoided.

Recommendation. During preconception visits, women should be asked about the home environment. If potential exposures are identified, consultation with an occupational medicine specialist may assist with a more detailed investigation regarding recommendations for modifying exposures. *Strength of recommendation:* A; *quality of evidence:* III.

Conclusion

Elements of the environmental history elicited during the preconception visit may identify key determinants of a future healthy pregnancy. Three sectors of a woman's environment—the home, the community, and the workplace—should be asked about to identify hazards to the pregnancy outcome. The workplace represents the principal source of exposure to toxicants with unambiguous reproductive and developmental effects. These toxicants are often found in industry sectors, such as healthcare, in which many women work. A woman's diet and drinking water source, as well as her hobbies, may also pose a threat to the pregnancy. Exposure opportunities identified in the preconception visit may allow tailored recommendations to be made to the patient to modify exposure and thus reduce the risk of an adverse outcome. ■

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