Air Pollution and Birth Outcomes: There’s something in the air
Objectives

- List the **air pollutants** known to increase risk for adverse pregnancy outcomes

- Describe the **uncertainties** related to the studies on environmental exposures and pregnancy outcomes

- Be able to **counsel** pregnant and pre-conception patients on reducing risk due to air pollutants
The periods of embryonic, fetal and infant development are remarkably susceptible to environmental hazards. Toxic exposures to chemical pollutants during these windows of increased susceptibility can cause disease and disability in infants, children and across the human lifespan.

Among the effects of toxic exposures recognized in the past have been spontaneous abortion, congenital malformations, lowered birthweight and other adverse effects.”

2007 Nordic Pharmacological Society. Basic & Clinical Pharmacology & Toxicology. 10273–75
Mechanism identification may suggest likelihood of clinical significance and suggest potential for prevention.
Exposures to airborne particulate matter and adverse perinatal outcomes: a biologically plausible mechanistic framework

The literature indicates that the effects of PM on LBW, PTD, and IUGR may manifest through the cardiovascular mechanisms of oxidative stress, inflammation, coagulation, endothelial function, and hemodynamic responses.

Pregnant women exposed to high levels of nitrogen dioxide, carbon monoxide and particulate matter are at an increased risk of experiencing restricted fetal growth and low birthweight. (Preidt 2009)

An association between air pollution and birth defects and **altered fetal growth and altered parturition** is biologically plausible.

**BUT….** Remember that other environmental and risk factors must be considered and are difficult to rule out during research studies. Some of these may include **smoking, maternal health as well as behaviors and other exposures** that may be encountered at work and/or during extracurricular activities.
<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Exposure Sources</th>
<th>Risk Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon monoxide</td>
<td>• Car exhaust</td>
<td>Interferes with the blood’s ability to absorb and transport oxygen</td>
</tr>
<tr>
<td></td>
<td>• Industrial emissions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cigarette smoke</td>
<td></td>
</tr>
<tr>
<td>Ozone</td>
<td>• When other pollutants react in sunny conditions</td>
<td></td>
</tr>
<tr>
<td>Nitrogen dioxide</td>
<td>• When automobile and industrial emissions combine with oxygen</td>
<td></td>
</tr>
<tr>
<td>Particulate matter</td>
<td>• Combustion from automobiles and industry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Tire wear</td>
<td></td>
</tr>
</tbody>
</table>
Particulate matter, also known as particle pollution or PM, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles (http://www.epa.gov/pm/).

PM is characterized according to size due to the variation of health effects associated with particles of different diameters.
Recall particulate matter?

- **Fine particles (PM2.5):**
  - Arising from exhaust from:
    - cars and trucks (especially those with diesel engines)
    - open burning
    - Wildfires
    - tobacco smoke
    - fireplaces and woodstoves
    - Cooking
    - dust from roads and construction
    - agricultural operations
    - coal and oil-burning boilers
    - power plants
    - some industrial processes, including oil refining and pulp and paper production.

- **Coarse particles (PM10)**

http://www.epa.gov/ne/airquality/pm-what-is.html
“The Shared Pathoetiological Effects of Particulate Air Pollution and the Social Environment on Fetal-Placental Development”


(add to this the heritable epigenetic effects of environmental exposures – the result is a community-based perpetuating cycle of disparity in reproductive outcome)
The Effects, The Outcomes
The Effects, The Outcomes –
recall susceptible periods in development

<table>
<thead>
<tr>
<th>AGE OF EMBRYO (IN WEEKS)</th>
<th>FETAL PERIOD (IN WEEKS)</th>
<th>FULL TERM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 dividing zygote, implantation and gastrulation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 CNS</td>
<td>CNS</td>
<td></td>
</tr>
<tr>
<td>3 heart</td>
<td>heart</td>
<td></td>
</tr>
<tr>
<td>4 eye</td>
<td>upper limbs</td>
<td></td>
</tr>
<tr>
<td>5 heart</td>
<td>eyes</td>
<td></td>
</tr>
<tr>
<td>6 ear</td>
<td>lower limbs</td>
<td></td>
</tr>
<tr>
<td>7 palate</td>
<td>teeth</td>
<td></td>
</tr>
<tr>
<td>8 external genitalia</td>
<td>palate</td>
<td></td>
</tr>
<tr>
<td>9 brain</td>
<td>external genitalia</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>ear</td>
<td></td>
</tr>
<tr>
<td>20-36</td>
<td>Full Term</td>
<td></td>
</tr>
</tbody>
</table>

LOSS OF CONCEPTUS

MAJOR MORPHOLOGICAL ABNORMALITIES

<table>
<thead>
<tr>
<th>FUNCTIONAL DEFECTS AND MINOR MORPHOLOGICAL ABNORMALITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interrupted placental development</td>
</tr>
<tr>
<td>Fetal growth restriction</td>
</tr>
<tr>
<td>Early susceptibility to later preterm birth</td>
</tr>
<tr>
<td>Heart defects</td>
</tr>
</tbody>
</table>

Note: Blue bars indicate time periods when major morphological abnormalities can occur, while light blue bars correspond to periods at risk for minor abnormalities and functional defects.
What are the most commonly reported fetal effects from air pollutant exposure?

- **Decreased placental size and quality**
  - Animal studies have suggested that volumes of placental compartments and the calibers of maternal blood spaces were reduced (Veras 2008).

- **Fetal growth delay**
  - Studies using ultrasound measurements of fetal growth found strong associations between fetal growth delay and maternal PM exposure during mid-pregnancy (Hansen 2008).

- **Small for Gestational Age (SGA)**
  - Fine particulate matter exposure, PM 2.5, is associated with low birthweight, preterm birth, and SGA births (Shah 2011).
  - Coarse particulate matter exposure, PM10, is associated with SGA births (Shah 2011).
Continued……most commonly reported fetal effects from air pollutant exposure.

- **Low birthweight – preterm birth**
  - Exposures of pregnant women to higher levels of certain PM2.5 chemical constituents originating from sources such as oil combustion and road dust are associated with lower birth weight (*Glinianaia 2004*)

- **Stillbirth**
  - Air pollution in Ohio associated with stillbirth, a geospatial cohort study – effect of PM 2.5 (*Defranco 2015*)

- **Patent ductus arteriosus and major defects**
  - Recent evidence illustrates a statistically significant association between coarse particulate matter and patent ductus arteriosus (*Strickland 2009, Ritz B 2002*). Various major defects (*Stingone J, et al. Environmental Health Perspectives. volume 122 number 8, August 2014*)
In a study done by the UCLA School of Public Health using CBDMP Registry data, it was found that the risk of birth defects increased among women exposed to elevated amounts of ozone and carbon monoxide in the second month of pregnancy.

The second month of pregnancy is when significant heart and organ development occurs. Therefore, it is not surprising to find that women who are exposed to high levels of these two pollutants may have an increased risk of having a child born with a heart defect.

The study found that some of these heart defects were conotruncal heart defect, pulmonary artery/valve defect and aortic artery/valve defect. The study did not take into account other prenatal exposures such as smoking, vitamin use and maternal health.

But not surprisingly – VARIABILITY and INCONSISTENCY in the literature persists.
Error or Potential Errors in Studies on Air Pollution Exposure During Pregnancy

- Particulates grossly classified as PM$_{2.5}$ and grossly measured as a “mass” exposure quantity in ug/m$^3$ carry along different exposure substances in differing ratios in different regions or countries that vary across time.

- Classifying exposure at a specific site does not assure the location of the individual exposed pregnant person for any particular period of time (even if known home address – people do work)

- Individuals and cohorts in particular environmental, social and medical contexts differ in their acquired as well as genetic susceptibility to the effect of the exposure

- Actual amount of air with a particular toxin level breathed by individuals across pregnancy is hardest to measure. In particular in global studies – indoor air pollution varies widely and by family role.
The definition of or identification of the outcome varies in studies and is inexactly measured (e.g. in autism in preterm birth studies) – Even when meticulously measured, the condition that is measured and compared in frequency of occurrence may be measured with variety of different tools.

Study designs vary from population based cohorts (suited to look at multiple outcomes) to case-control studies (best suited to look at multiple exposures), and from prospective to retrospective.

Estimation of PM$_{2.5}$ has ranged from local monitoring stations data with the assumption of (various) proximity limited inclusion of pregnant subjects, to remote distance assessment and modeling of potential exposure on the ground.
Exposure to airborne particulate matter during pregnancy is associated with preterm birth: a population-based cohort study

Emily DeFranco¹²*, William Moravec², Fan Xu³, Eric Hall¹, Monir Hossain⁴, Erin N. Haynes³, Louis Muglia¹² and Aimin Chen³

Study Purpose: Test the hypothesis that exposure to fine particulate matter in the air (PM2.5) is associated with increased risk of preterm birth (PTB).

Methodology: Geo-spatial population-based cohort study, using live birth records from Ohio (2007–2010) linked to average daily measures of PM2.5, recorded by 57 EPA network monitoring stations across the state. Geographic coordinates of the home residence for births were linked to the nearest monitoring station using ArcGIS. Association between PTB and high PM2.5 levels (above the EPA annual standard of 15 μg/m3) was estimated using GEE, with adjustment for age, race, education, parity, insurance, tobacco, birth season and year, and infant gender.
Preterm Birth Associated

• Key Results: Pregnancies with high PM2.5 exposure through pregnancy had increased PTB risk even after adjustment for coexisting risk factors, adjOR 1.19 (95 % CI 1.09–1.30). Assessed per trimester, high 3rd trimester PM2.5 exposure resulted in the highest PTB risk, adjOR 1.28 (95 % CI 1.20–1.37).

Table 3 Preterm birth rate by PM$_{2.5}$ levels in Ohio 2007 – 2010 and trimester of exposure in pregnancy

<table>
<thead>
<tr>
<th></th>
<th>PM$_{2.5}$ &lt; 15 μg/m$^3$</th>
<th></th>
<th>PM$_{2.5}$ ≥ 15 μg/m$^3$</th>
<th></th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>% Preterm</td>
<td>n</td>
<td>% Preterm</td>
<td>n</td>
</tr>
<tr>
<td>First trimester</td>
<td>175,649</td>
<td>8.34</td>
<td>49,272</td>
<td>8.87</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Second trimester</td>
<td>185,883</td>
<td>8.47</td>
<td>39,038</td>
<td>8.43</td>
<td>0.835</td>
</tr>
<tr>
<td>Third trimester</td>
<td>181,665</td>
<td>8.08</td>
<td>43,256</td>
<td>10.05</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Entire pregnancy</td>
<td>200,259</td>
<td>8.27</td>
<td>24,662</td>
<td>9.99</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

% preterm represents the rate of birth <37 weeks of gestational age among the study cohort of singleton non-anomalous live births.
Conclusions/Significance:

Exposure to high levels of particulate air pollution, PM2.5, in pregnancy is associated with a 19% increased risk of PTB; with greatest risk with high 3rd trimester exposure. Although the risk increase associated with high PM2.5 levels is modest, the potential impact on overall PTB rates is robust as all pregnant women are potentially at risk.

Strengths: local monitoring and birth address data.
There’s something in the air…
.... AND IT’S CLIMATE CHANGE
Exacerbated Ozone Health Impacts

**Key Finding 1:** Climate change will make it harder for any given regulatory approach to reduce ground-level ozone pollution in the future as meteorological conditions become increasingly conducive to forming ozone over most of the United States [**Likely, High Confidence**].

Unless offset by additional emissions reductions of ozone precursors, these climate-driven increases in ozone will cause premature deaths, hospital visits, lost school days, and acute respiratory symptoms [**Likely, High Confidence**].

Health2016.globalchange.gov
Increased Health Impacts from Wildfires

**Key Finding 2:** Wildfires emit fine particles and ozone precursors that in turn increase the risk of premature death and adverse chronic and acute cardiovascular and respiratory health outcomes [*Likely, High Confidence*].

Climate change is projected to increase the number and severity of naturally occurring wildfires in parts of the United States, increasing emissions of particulate matter and ozone precursors and resulting in additional adverse health outcomes [*Likely, High Confidence*].
Excess oxidative stress and inflammation
Immune, metabolic and vascular maladaptation

Defective deep placentation

Reduced or intermittent placental oxygen and nutrient perfusion

Fetal adaptation and programming

I/R injury
placental debris
↑ sFlt1  ↑ sEng
↓ PI GF  ↓ VEGF

Endothelial dysfunction
Hypertension
Preeclampsia
Coagulation abnormalities

Vascular lesions, thrombosis, atherosclerosis, and placental infarcts

Fetal growth restriction

Spontaneous preterm labour
PPROM

Infertility, implantation failure and miscarriage

Fetal or infant demise

LBW  PTB
Figure 1. Proposed biologic framework for exploring possible effect modification of PM–birth outcomes by maternal nutrition.
Reasonable, specific individual dietary behavioral advice based on most consistently proposed and supported mechanism of biological effect of PM – oxidative stress, inflammatory subcellular and tissue inflammation:

- Assure vitamin pre-conceptional supplementation - “fat-soluble carotenoids and vitamin E, water-soluble vitamin C, and methyl nutrients including the B vitamins pyridoxine (B6), cyanocobalamin (B12), and folate. Carotenoids may protect against oxidant damage.”

- Assure adequate folate through supplementation – coagulation balance support as well as mechanisms as yet certainly determined to reduce fetal anomaly.

- Dietary awareness and counsel – Food diary and cultural assessment - Reduce trans- and -saturated fatty acids and increasing omega-3 fatty acids (choose healthy Fish) are also associated with a reduced inflammatory status.

- Support endothelial function through Micronutrient antioxidants - representing β-carotene subfractions derived from vegetables and fruits – a balanced, portioned diet.

Implications for Practice
(and for ACTION) - INDIVIDUAL DEFENSE – a mechanistic framework

- Encourage a DASH diet – “The favorable effects of fruits and vegetables, low-fat dairy products, and reduced sodium suggested by Dietary Approaches to Stop Hypertension (DASH) indicate the possible role for micronutrients in reducing the risk for pre-pregnancy hypertension. Several mechanisms of polyphenols have been researched, including their antioxidant functions.”

- Eat more fruits and vegetables: “Fruits and vegetables contain a myriad of different components of varying antioxidant capacity, thus offering a range of possibilities for altering PM induced oxidative effects. Based on the NHANES III findings, grain consumption is inversely associated with an elevated CRP concentration.

- And finally, keep encouraging use of olive oil, mushrooms, cruciferous vegetables, and nuts - “associated with a favorable homocysteine profile. Adding vegetables may reverse the PM induced increases inflammatory response. High intakes of refined grains, and processed meat and low consumption of cruciferous and yellow vegetables may exacerbate the inflammatory processes.”

What about whole communities at risk?
ACTION we can take as a interdisciplinary group – potentially affecting over-exposed cohorts

- Advocacy – patient level through screening practices in your institutions and offices: Develop simple, efficient, patient-centered process to understand your patients’ environmental threats (self-report/survey/waiting room activities)

- Advocacy- community level through capacity building within interested groups of patients and community leaders.
  - Determine “who cares” in your patients’ communities
  - Partner with concerned community organizations (Little Village Environmental Justice Organization in Pilsen here in Chicago)

- Advocacy – policy level through support of AAP, ACOG, SMFM initiatives to respond to environmental threats

- Continue at policy level to support recent efforts to add obstetricians to the working panels of docs in the federally supported regional PEHSU’s (…….. A commercial break)
Call to ACTION – this is what I recommend to the Clinicians

- Participate – through projects and collaborations, build new knowledge of level of effects and successes of interventions

- Join the ACOG / SMFM interest groups/ communities – create new ideas

- Get involved in local community-based initiatives that foster patient level, community institutional level cooperation to gather information, interpret results and plan for action

- Take the opportunity to Learn More – EPA/CREHM web-based education

- Recognize that different environments, different populations, present different problems, and combine to create disparity in health outcomes.
Ultimately, evidence based recommendations to prevent harmful environmental exposures need to involve policy change.

In the meantime, medical associations such as ACOG, ASRM, and Endocrine Society and others have called for a precautionary approach
“An important outcome of pregnancy is no longer just a healthy newborn but a human being biologically predisposed to be healthy from birth to old age.”

On Exposure to Toxic Environmental Agents

ACOG/ASRM
Thank you
SUPPLEMENTARY SLIDES
References (expanded or otherwise not listed):


References


Excess oxidative stress and inflammation
Immune, metabolic and vascular maladaptation

Defective deep placentation

Reduced or intermittent placental oxygen and nutrient perfusion

Fetal adaptation and programming

I/R injury
placental debris
↑ sFlt1 ↑ sEng
↓ PGF ↓ VEGF

Endothelial dysfunction
Hypertension
Preeclampsia
Coagulation abnormalities

Vascular lesions, thrombosis, atherosclerosis, and placental infarcts

Fetal growth restriction

Spontaneous preterm labour
PPROM

Infertility, implantation failure and miscarriage

Fetal or infant demise

LBW

PTB


http://prhe.ucsf.edu/prhe/pdfs/Huffling%20prenatal-preconception%20assessment.pdf

Toxic environmental chemicals: the role of the reproductive health professional http://prhe.ucsf.edu/prhe/clinical_resources.html


Pathophysiology of PM Effect

Characterized short-term PM exposure

Source origin: outdoor/indoor
Source composition: OC\textsubscript{pri}/SOC
Size fraction: PM\textsubscript{0.25}, PM\textsubscript{0.25–2.5}, PM\textsubscript{2.5–10}

Redox active PM components

Oxidative stress

Systemic inflammation (IL-6, TNF-α, sTNF-RII, and CRP)
Platelet activation (sP-selectin)
Systemic antioxidant defense (erythrocyte GPx-1 and Cu, Zn-SOD)

Potential cardiovascular clinical outcomes
Acute: ↑cardiovascular stress (↑ blood pressure, heart rate, and myocardial contractility)
→ Cardiac ischemia → Arrhythmias and cardiac arrest
Chronic: Progression of atherosclerotic lesions
What about whole communities at risk?

Considering that we have limited or expensive options to choose our air or change it, these are less optimal or universally applicable interventions

The American Lung Association recommends three steps to protect yourself indoors: Use a heat recovery ventilator or an energy recovery ventilator to quietly provide the fresh filtered air you need while quietly removing stale polluted air.

Seal leaks in the building shell to block entry of unfiltered outdoor air during the heating and air conditioning seasons. NOTE: Sealing leaks also blocks entry of dust and insects.

Use space and water heating systems that cannot put combustion gasses into the building interior. AND JUST STAY IN on bad days.

Contribute to cleaner air by personal choices - choosing cleaner sources of energy more efficiently. For instance, carpooling or taking public transportation, maintaining automobile emissions controls on one’s cars, walking or biking to work or school can make a difference. Limiting the use of fireplaces (use seasoned wood) or wood and coal burning stoves, and seeking out more efficient heating and cooling systems can also contribute to cleaner air.

COMMUNITIES at risk???
Ross, Michael G., and Mina Desai. Gestational programming: population survival effects of drought and famine during pregnancy. *Am J Physiol Regul Integr Comp Physiol* 288: R25–R33, 2005; doi:10.1152/ajpregu.00418.2004.—The process whereby a stimulus or stress at a critical or sensitive period of development has long-term effects is termed “programming.” Studies in humans and animals convincingly demonstrate that environmental perturbations in utero may permanently change organ structure and metabolism and/or alter homeostatic regulatory mechanisms among the offspring. These programmed changes may be the origins of adult diseases, including cardiovascular disease, obesity, and diabetes. Through-

In summary, gestational programming appears to have contributed to species adaptation and population survival. These developmental responses and processes are still functional in humans and have likely contributed to the current epidemic of hypertension, obesity, and diabetes. A concerted scientific
Environmental exposures affect the genome.

The **genome of the placenta reacts** differently than the embryo with respect to the molecular mechanisms that alter DNA expression. Placental DNA remains demethylated after the methyl scrubbing process that occurs at fertilization, leaving it particularly vulnerable.

- **Recall general epigenetic mechanisms most investigated** -
  1. altered DNA methylation, 2. histone binding, 3. non-coding RNA action that disturb normal function, placental and fetal development

- The placenta is **the gatekeeper** – regulating IGF2, the flow of nutrients, flow of toxins…….. and the flow of environmental materials with epigenetic potential.

- Effects on the fetus are developmental, affecting maternal and fetal outcome, eventual adult disease and potential heritability of this acquired genomic damage

PAER
A Web-Based Tool for
Prenatal Assessment of Environmental (Toxicologic) Risk

Charles McKay MD FACMT, FACEP
PEHSU West Office
American College of Medical Toxicology
• Become familiar with the PAER Tool

• Promote the use of the PAER Tool for patients and clinicians to address concerns regarding environmental exposures during pregnancy

• Provide recommendations for PAER Tool improvements
• 2013: ACOG Statement

• 2014: ATSDR Directive
  • Evolution of ebook product to app to web-based tool

• 2014-2016: PEHSU Technical Writer Development Activity

• 2015-2017: Web-based Tool Development Communicate Health

• 2017: ACOG MOU

• 2017-?: Beta-testing and User Experience Improvements
• Assist clinicians in their interactions with pregnant patients to identify environmental exposures of concern and make recommendations regarding risk reduction steps
• Lead
• Organic Mercury in Food
• Carbon Monoxide
• Radon
• Environmental Tobacco Smoke
• Chemical Flame Retardants
• Pesticide Residues in Food
• Specific Pesticide Varieties: Glyphosate
• Plasticizers
• Organic Solvents: Personal Care Products
• Primary Concerns of 39 Repro Tox PEHSU Consults Mapped onto PAER Focus Areas

<table>
<thead>
<tr>
<th>PAER Tool Focus Areas</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic solvents (including benzene and VOCs)</td>
<td>4</td>
</tr>
<tr>
<td>Air pollution: CO</td>
<td>1</td>
</tr>
<tr>
<td>Air pollution: ETS</td>
<td>0</td>
</tr>
<tr>
<td>Personal Care Products</td>
<td>0</td>
</tr>
<tr>
<td>Lead</td>
<td>8</td>
</tr>
<tr>
<td>Flame Retardants (PFCs)</td>
<td>2</td>
</tr>
<tr>
<td>Pesticides</td>
<td>0</td>
</tr>
<tr>
<td>Mercury</td>
<td>5</td>
</tr>
<tr>
<td>PCBs</td>
<td>0</td>
</tr>
<tr>
<td>Plastics (including BPA and phthalates)</td>
<td>0</td>
</tr>
</tbody>
</table>

Unassigned concerns: Indoor Air Contaminants, Gases/Fumes, Methane, Fungus/Mold, Marijuana, Cleaning/Disinfectant Products, Asbestos, Copper, Environmental Factors (sun, ozone, etc.), Fluorescent lightbulbs, Formaldehyde, Isoflurane, Methotrexate, Laser light, Toxoplasmosis, Water Toxins
• Up to ten 20 minute interactive video/PPT CME modules will be sent to clinicians’ email upon request

• Objectives:
  • Discuss sources, routes of exposure for a given environmental toxicant
  • Distinguish low, moderate, and higher levels of exposure
  • Identify and communicate relevant risk reduction steps for a patient based on assessment of her/his exposure

• CME credit provided by the CDC Office of Continuing Education upon completion of module and post-test

• Bonus
  • A “focused literature snapshot” will highlight findings forming the basis for concern regarding prenatal/childhood exposure to the given substance
    • Assess a sampling of raw data that informs public health recommendations
    • Highlight one or more principles, such as: “extrapolation of experimental findings”, “applicability of epidemiologic findings to individual patients”, “the precautionary principle.”
Prenatal Assessment Of Environmental Risk (PAER)

Protect pregnant women from harmful chemicals

The Prenatal Assessment of Environmental Risk (PAER) is an essential tool for providers and pregnant women. It is critical for healthcare providers to understand the role of harmful chemicals in pregnancy and the best practices to prevent exposure. The PAER guides pregnant women and their healthcare providers in identifying and reducing exposure to these harmful substances.

Most pregnant women have been exposed to over 40 harmful chemicals. PAER guides women—and their doctors—on how to protect themselves.

"Pregnant patients are often worried and confused about the risks of environmental exposure. Help them understand the facts—so they can take the right steps to protect themselves." — Dr. X

Who made the assessment?

The partnership of experts in fetal pregnancy and environmental health from the Agency for Toxic Substances and Disease Registry (ATSDR) and the federal Environmental Protection Agency (EPA) and the California Department of Public Health (CDPH) is bringing this tool to healthcare providers. The PAER is a free online tool that offers recommendations to help pregnant women reduce exposure to harmful chemicals.

Lever more about us and the assessment
Clinic Entry Page View

Using the Assessment is Easy for Patients — and Staff
A short 3 minutes for pregnant patients to fill out the online assessment at home. And the results offer clinicians a wealth of information about patients’ exposure to toxic chemicals — and their risk of perinatal complications.

PAER is designed with clinic staff in mind. It’s easy to integrate into any clinical workflow and won’t add time or hassle.

PAER is:
- Trustworthy, because it was developed by leading experts from the Agency for Toxic Substances and Disease Registry (ATSDR) and Pediatric Environmental Health Specialty Units (PEHSUs)
- Evidence-based and tested with consumers and clinic staff
- Secure and fully HIPAA compliant
- Easy for patients to understand and use — with clear questions and guidance in plain language

PAER offers providers:
- Detailed information about patient contact with harmful chemicals
- Customized scoring points to guide follow-up discussions with patients
- Access to our library of professional resources and research
- A great way to save time during appointments — since physicians don’t need to ask assessment questions themselves

PAER offers clinic staff:
- A simple, easy-to-use interface
- Assessment results that are easy to integrate into any electronic health records (EHR) system

How does PAER work?
The process is simple. Once you’ve created an account, clinic staff can:

1. Email patients a direct link to the assessment, so they can take it at home
2. Get an email notification when patients complete the assessment
3. Download results and physician talking points from the dashboard to store in your clinic’s EHR

Create an account
Invite Patients to Take the Assessment

Copy or view our sample patient message — which includes a link to the assessment — and then paste it into an email to your patient. After a patient takes the assessment and submits, your clinic will be notified by email.

Review Recent Assessments

Download assessment results and customized guidance as a PDF or CDA. Then share it with the patient’s provider, so they can have a discussion about reducing environmental exposure during their next appointment.

2 patients have completed the assessment since your last login.

<table>
<thead>
<tr>
<th>Patient Name</th>
<th>Email</th>
<th>Date Received</th>
<th>Results</th>
<th>Patient Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arna Jones</td>
<td><a href="mailto:ajones@gmail.com">ajones@gmail.com</a></td>
<td>September 19, 2016</td>
<td>PDF</td>
<td>CDA</td>
</tr>
<tr>
<td>Margaret Phillips</td>
<td><a href="mailto:margaret123@yahoo.com">margaret123@yahoo.com</a></td>
<td>July 10, 2016</td>
<td>PDF</td>
<td>CDA</td>
</tr>
</tbody>
</table>

Learn More

- Access our professional resources to see background information on toxics, containing education links, and more
- Read the FAQ for professionals to get more details on the assessment and how we developed it
Harmful Chemicals Outside Your Home
Protect Your Baby When You're Pregnant

Take these easy, affordable steps to limit your contact with harmful chemicals. Even small changes can have big health benefits for you and your baby.

Keep fuel (like lawn mower gas) away from your home — in a shed, for example — instead of in a basement or attached garage. That way, you'll be less likely to breathe in chemicals in fuel (like benzene).

Get free Air Quality Index alerts.*
Then you'll know when to expect high levels of air pollution in your community.

When you're physically active you breathe in more air. That's why it's important to limit your outdoor physical activity when levels of air pollution are high. When air quality is poor, exercise inside that day instead.

Keep places where bugs and pests hide — like woodpiles or trashcans — away from your home. You will be less likely to need pesticides.

If you have a lawn, don't use lawn care products — they may have harmful pesticides. Instead, choose grasses and plants that are natural to your area and grow well without chemical sprays.

*http://www.enviroflash.info/signup.cfm

U.S. Department of Health and Human Services Agency for Toxic Substances and Disease Registry

ATSDR
Harmful Chemicals at Home
Protect Your Baby When You're Pregnant

Take these easy, affordable steps to limit your contact with harmful chemicals. Even small changes can have big health benefits for you and your baby.

Don't smoke and don't let other people smoke in your home — even when you're not there. Tobacco smoke can leave behind harmful chemicals that get trapped in furniture and carpets.

Dust can hide chemicals like phthalates, pesticides, and flame retardants that aren't healthy to breathe in, especially when you're pregnant. Instead of doing it yourself, ask a family member to dust — wiping off areas like shelves and windowsills with a damp cloth.

Take off your shoes when you walk in the door. That way, you won't track in dirt with pesticides, lead, or other chemicals from outside.

Keep food in sealed containers and take out the trash every day. This will help keep bugs, mice, and other pests away so you won't need to use harmful pesticides.

When you use cleaning products, wear rubber gloves so you don't get chemicals on your skin. Always open a window or turn on an exhaust fan (like a bathroom fan) so you don't breathe in chemicals.

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Harmful Chemicals in the Nursery
Protect Your Baby When You’re Pregnant

Before you remodel or repaint the nursery, take steps to be safe.
- Old homes (built before 1978) may have lead paint. Sanding or scraping it creates lead dust that is dangerous to breathe in. If you live in an old home, ask your state or local health department about lead testing before you start remodeling.
- When repainting, choose low or no VOC paint, which has fewer harmful chemicals. Ask a family member to paint for you so you don’t breathe in the chemicals. Then stay out of the room until the paint smell is gone.

Choose baby bottles made of glass or stainless steel if you can. If you use plastic bottles, make sure they’re BPA-free.

Choose toys that are labeled nontoxic and look for the letters “ASTM” on the package or label. It means the toy has been tested for harmful substances like lead by the American Society for Testing and Materials.

If you can, use furniture made from solid wood. New furniture with particleboard or fiberboard may contain formaldehyde, a type of VOC.
Harmful Chemicals in the Supermarket
Protect Your Baby When You’re Pregnant

Take these easy, affordable steps to limit your contact with harmful chemicals. Even small changes can have big health benefits for you and your baby.

Buy fruits and vegetables to keep your unborn baby strong and healthy. **Always wash fresh fruits and vegetables** under running water before eating or cooking them — it helps lower the amount of pesticides.

Buy fish! It’s good for you and your baby. Try for 2 to 3 servings each week of fish that are lower in mercury, like shrimp, light tuna, salmon, pollock, or catfish.

**Skip fish that are higher in mercury**, like shark, swordfish, king mackerel, and tilefish from the Gulf of Mexico.

Watch out for recycling codes 3 and 7 on plastic containers because those types of plastic have BPA.

Go for fresh or frozen foods instead of canned — cans may have BPA.

U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry
Moving From Advocacy To Individual Counseling: Useful vs Fear/Overload

5 Reasons Providers Need to Assess Patients for Environmental Exposure

1. Toxic chemicals are everywhere — studies show that nearly all pregnant women have detectable levels of at least 43 environmental chemicals in their blood, and many of these chemicals can cross the placenta.
2. Some of these toxic chemicals — like mercury, PCBs, and phthalates — are typically found at levels associated with adverse effects.
3. Typical exposure to a single chemical may have minimal risks, but pregnant women are exposed to many — and they may have interactive or additive effects.
4. Studies show compelling associations between exposure to environmental chemicals and adverse outcomes like preterm birth, pregnancy loss, congenital defects, and adult disease (like cardiovascular disease and cancer).
5. Many patients are already worried about exposures — primed by sensational and often misleading media reports. Discussing the topic will help put them at ease.

“Reducing exposure to toxic environmental agents is a critical area of intervention for obstetricians, gynecologists, and other reproductive health care professionals.”
— American College of Obstetricians and Gynecologists, Committee Opinion, October, 2013

View References ▾
• What is Next for the PAER Tool?

• Beta-testing with clinicians

• Prioritizing and individualizing risk reduction steps

• Completing CME modules

• Evaluating use of PAER Tool

• Adding more modules based on PEHSU reproductive period concerns and user feedback