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

PEHSU Pediatric Environmental Health Specialty Units

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

Background: What environmental threats?

The Faroes Statement: Human Health Effects of Developmental Exposure to Chemicals in Our Environment - 2007

"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.* **102**73–75

Importance of establishing biologic plausibility

Mechanism identification may suggest likelihood of clinical significance

and suggest potential for prevention

Biologic Plausibility (example…)

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.

Environmental Health Perspectives 114:1636–1642 (2006). doi:10.1289/ehp.9081 available via http://dx.doi.org/ [Online 17 August 2006]

Air Pollution and Pregnancy

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.

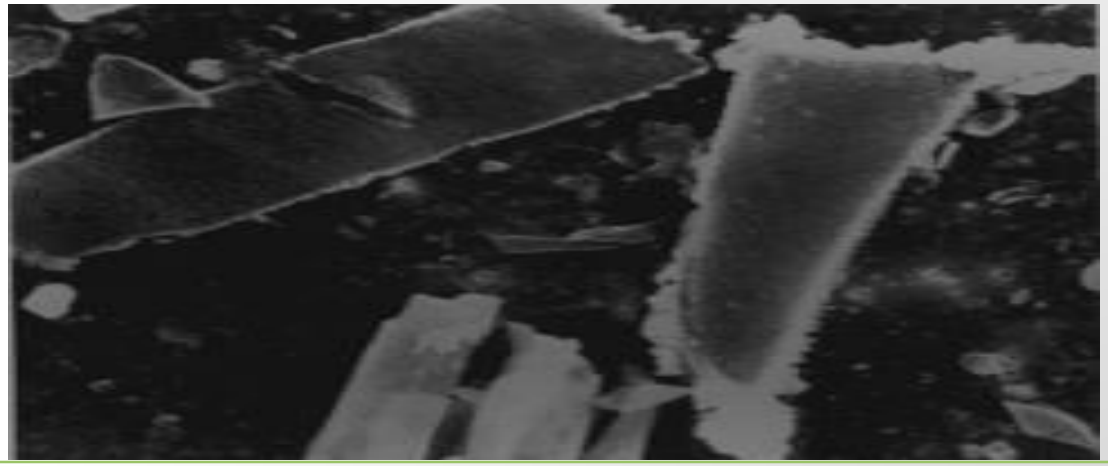
Air Pollution: Exposure Sources and Risk Factors

Pollutant	Exposure Sources	Risk Factors
Carbon monoxide	• Car exhaust • Industrial emissions • Cigarette smoke	Interferes with the blood's ability to absorb and transport oxygen
Ozone	• When other pollutants react in sunny conditions	
Nitrogen dioxide	• When automobile and industrial emissions combine with oxygen	
Particulate matter	• Combustion from automobiles and industry • Tire wear	

Recall particulate matter?

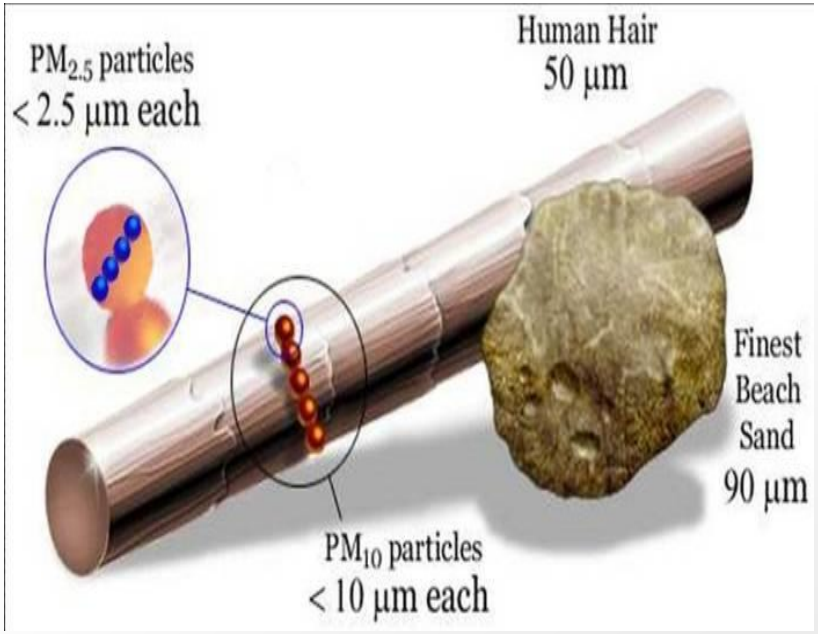
- Particulate matter, also known as **particle pollution or PM**, is a complex mixture of extremely small particles and liquid droplets. Particle pollution is made up of a number of components, including acids (such as **nitrates and sulfates**), **organic chemicals, metals**, and soil or dust particles (*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.



http://www.epa.gov/ne/airquality/pm-what-is.html

- **Coarse particles are (PM10)**

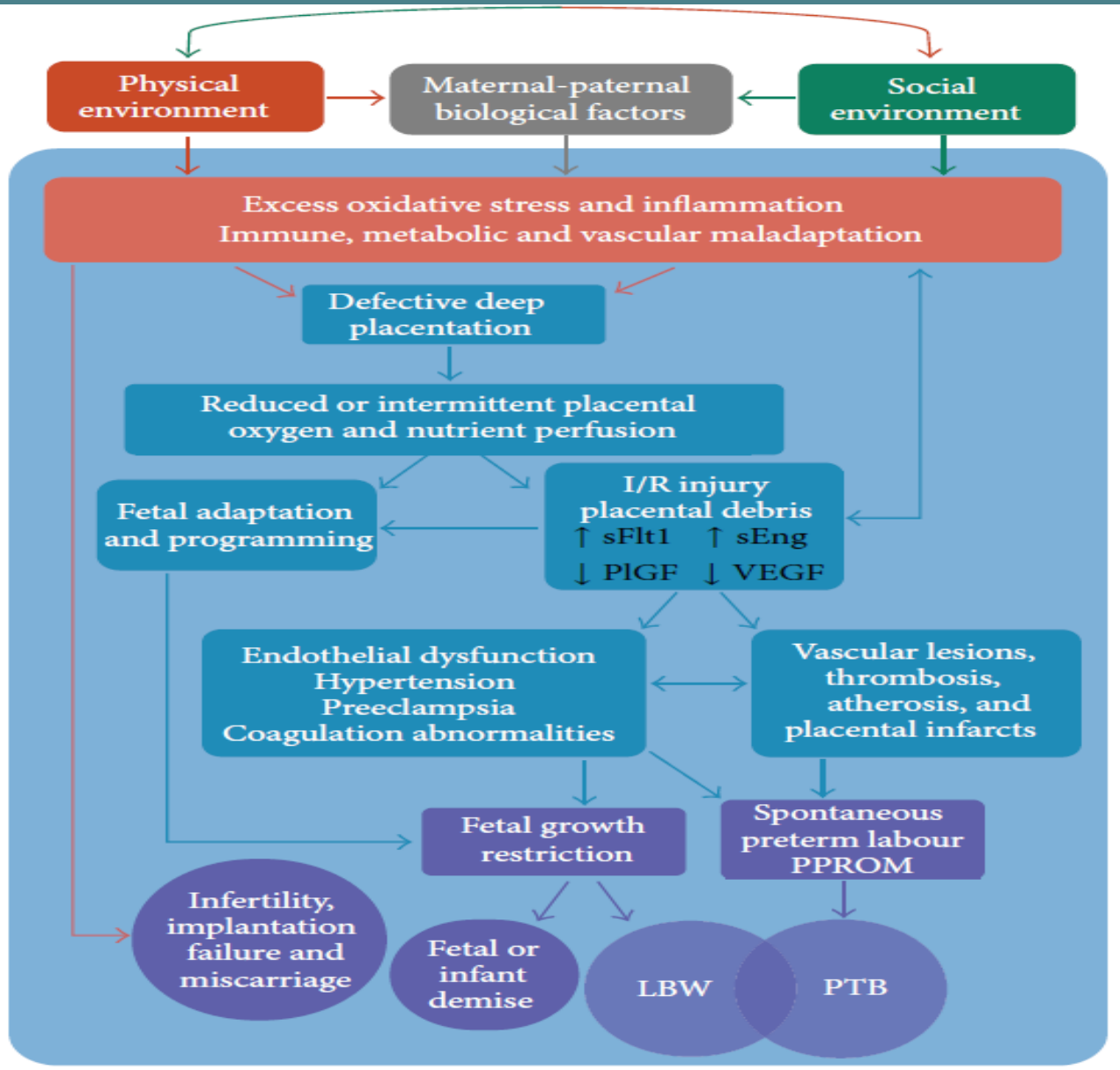
Populations of Concern

BIOLOGIC PLAUSIBILITY

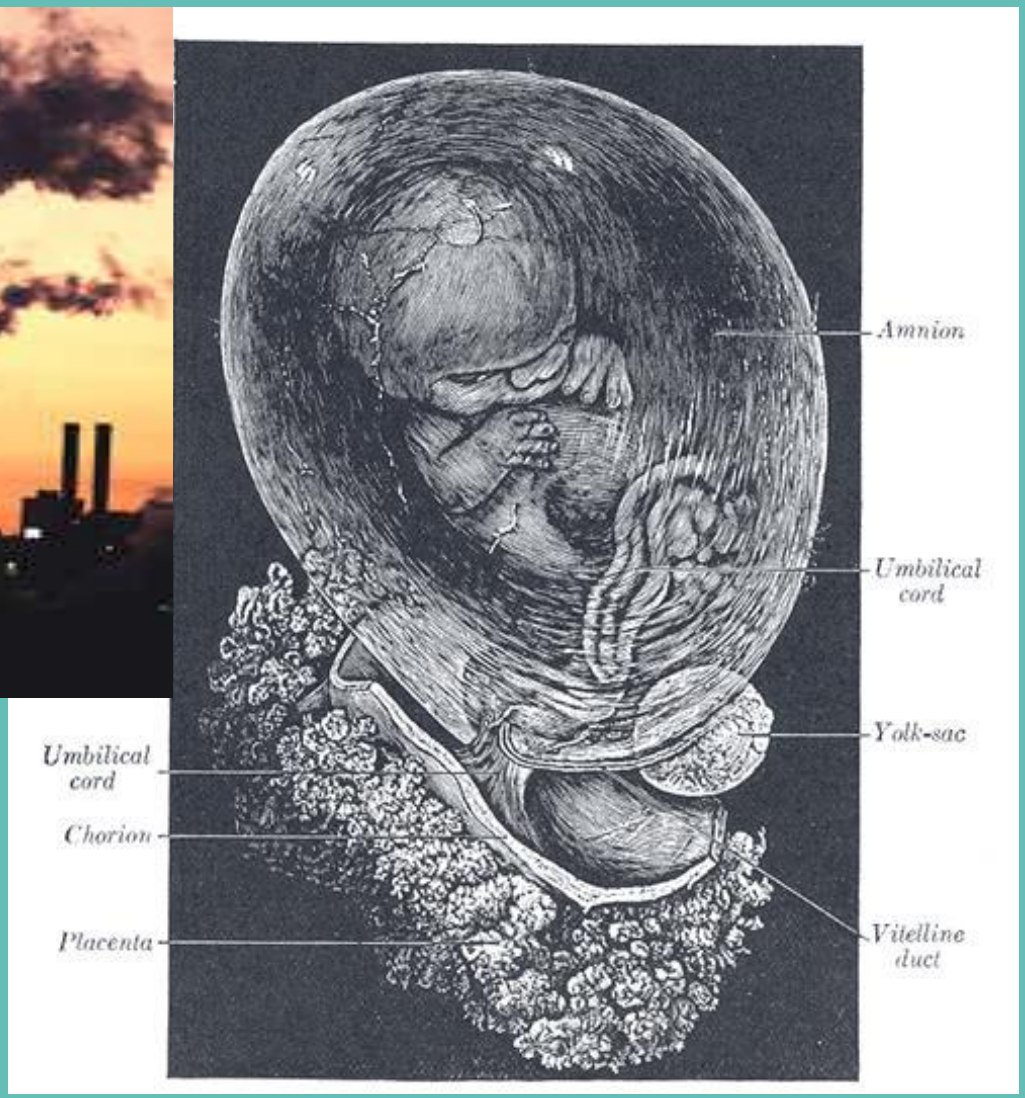
"The Shared Pathoetiological Effects of Particulate Air Pollution ***and the Social Environment*** on Fetal-Placental Development"

Erickson and Arbour. Journal of Environmental and Public Health Volume 2014 (2014)

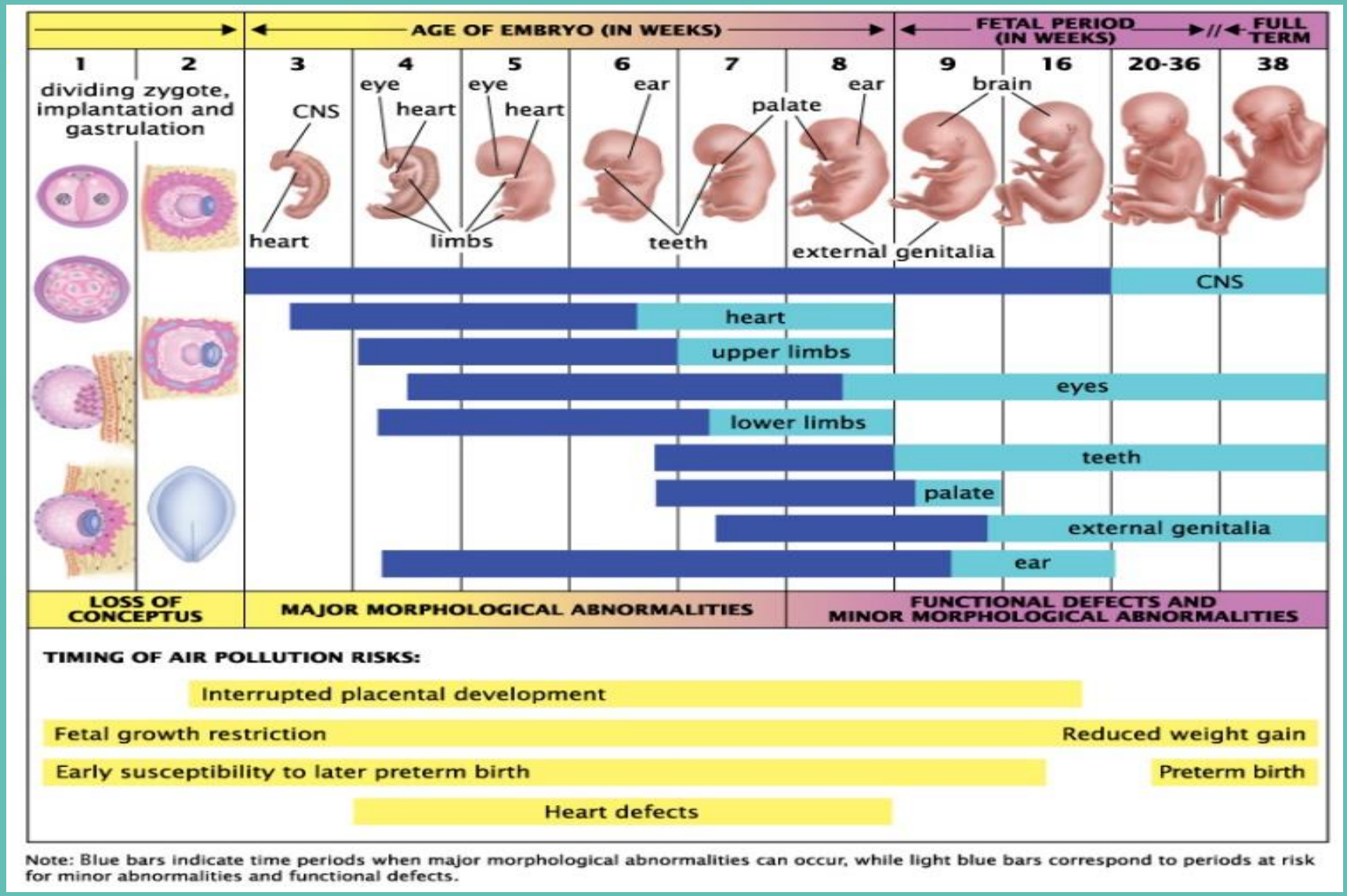
(add to this the heritable epigenetic effects of environmental exposures – the result is a community-based perpetuating cycle of disparity in reproductive outcome)



The Effects, The Outcomes



The Effects, The Outcomes – recall susceptible periods in devl0pment



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.

Background and Context - Rapid Fire Lit. Review

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).*

Background and Context - Rapid Fire Lit. Review

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)*

Background and Context - Rapid Fire Lit. Review

- 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.

*https://www.google.com/?gws_*

rd=ssl#q=+UCLA+School+of+Public+Health+using+CBDMP+Registry+fetal+cardiac

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.

Error or Potential Errors in Studies on Air Pollution Exposure During Pregnancy

- The definition of or identification of the outcome varies in studies and is inexactly measured (eg. 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.

Preterm Birth Associated

Exposure to airborne particulate matter during pregnancy is associated with preterm birth: a population-based cohort study

Emily DeFranco[1,2*], William Moravec[2], Fan Xu[3], Eric Hall[1], Monir Hossain[4], Erin N. Haynes[3], Louis Muglia[1,2] and Aimin Chen[3]

Reference: *DeFranco et al. Environmental Health (2016) 15:6*

Preterm Birth Associated

- 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

	$PM_{2.5} < 15\ \mu g/m^3$		$PM_{2.5} \geq 15\ \mu g/m^3$		
	n	% Preterm	n	% Preterm	*p*-value
First trimester	175,649	8.34	49,272	8.87	<0.001
Second trimester	185,883	8.47	39,038	8.43	0.835
Third trimester	181,665	8.08	43,256	10.05	<0.001
Entire pregnancy	200,259	8.27	24,662	9.99	<0.001

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

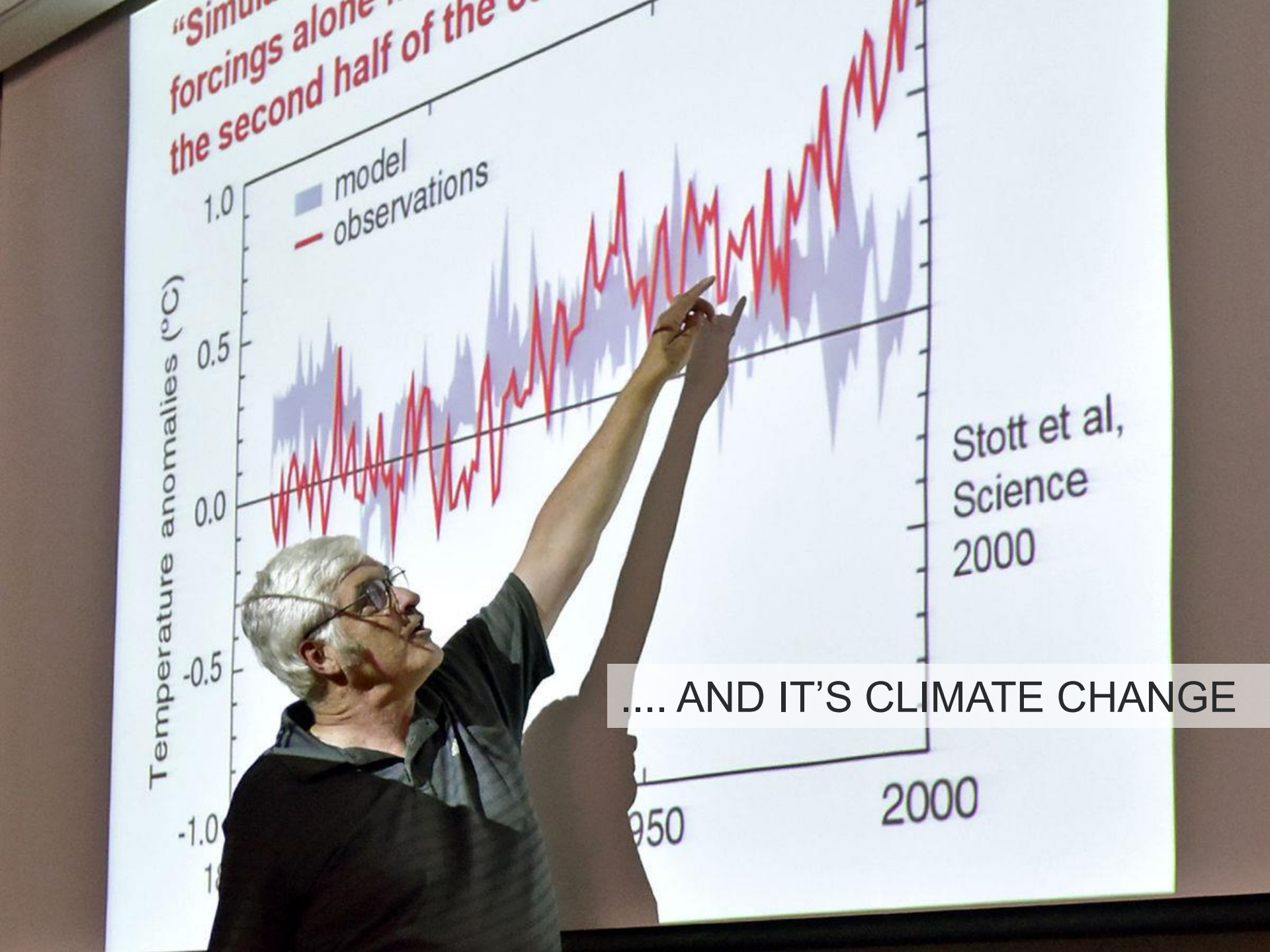
Preterm Birth *IS* Associated

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…


forcings alone
the second half of the
model
observations
Temperature anomalies (°C)
1.0
0.5
0.0
-0.5
-1.0
950
2000
Stott et al,
Science
2000
.... AND IT'S CLIMATE CHANGE

Air Quality Impact of 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, HighConfidence]*

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]*.

Air Quality Impact of Climate Change

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]*.

Health2016.globalchange.gov

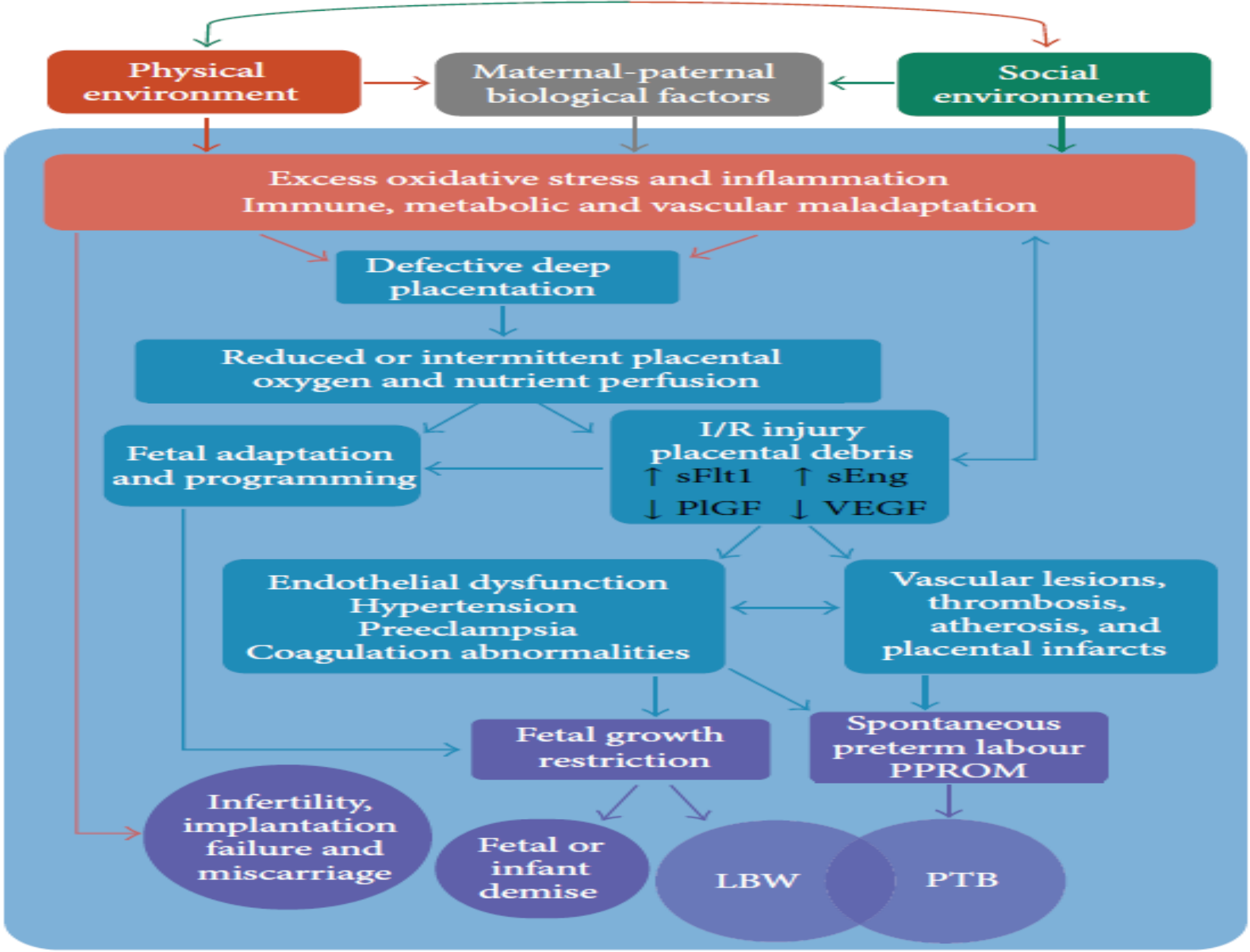
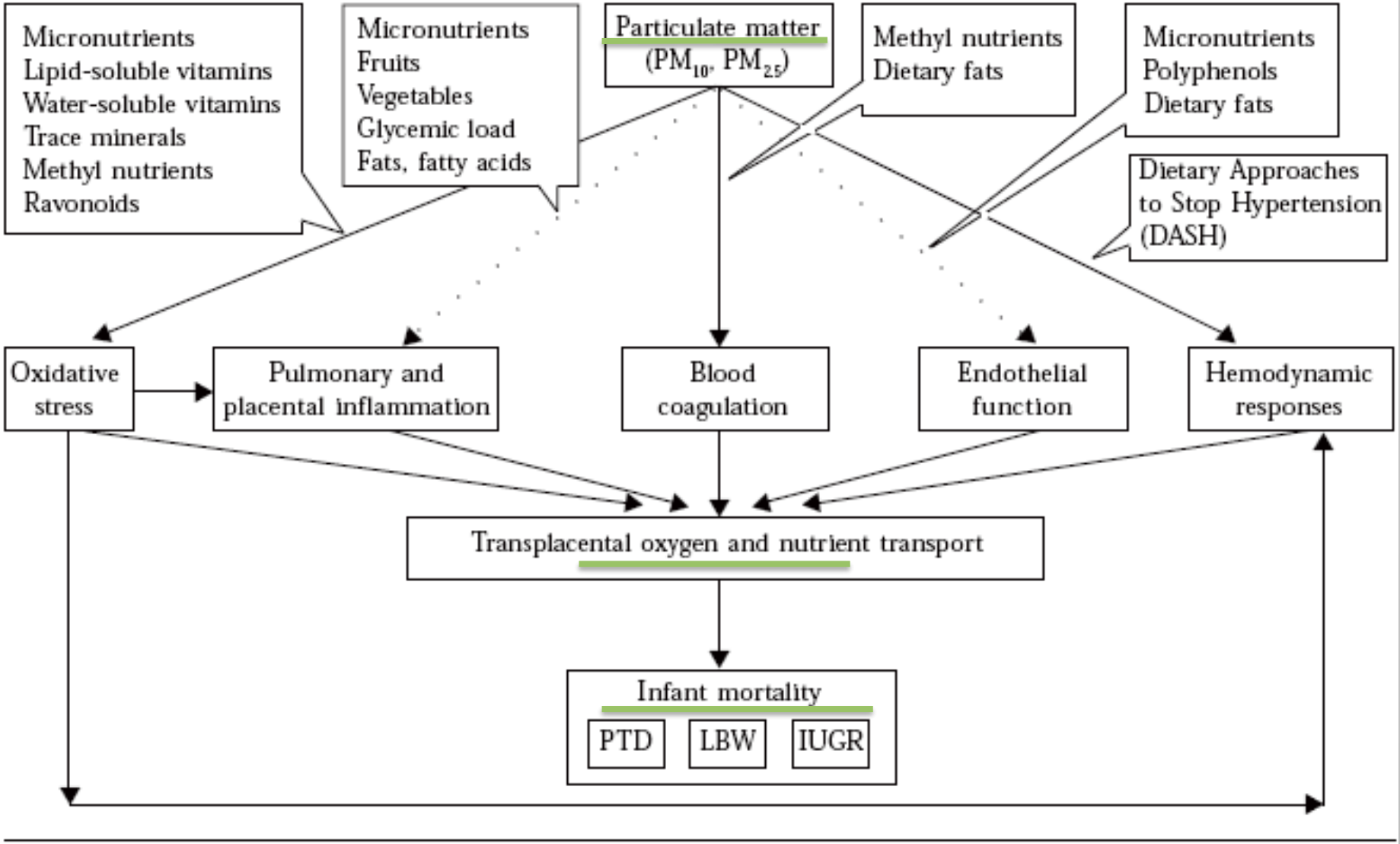

Physical environment
Maternal-paternal biological factors
Social environment
Excess oxidative stress and inflammation
Immune, metabolic and vascular maladaptation
Defective deep placentation
Reduced or intermittent placental oxygen and nutrient perfusion
Fetal adaptation and programming
I/R injury
placental debris
↑ sFlt1 ↑ sEng
↓ PlGF ↓ VEGF
Endothelial dysfunction
Hypertension
Preeclampsia
Coagulation abnormalities
Vascular lesions, thrombosis, atherosis, 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.



http://previews.figshare.com/44117/preview_44117.jpg (accessed 1/18/16)

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

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 C80, 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.

quotes from : Ciência & Saúde Coletiva, 12(6):1591-1602, 2007

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. “

quotes from : Ciência & Saúde Coletiva, 12(6):1591-1602, 2007

What about whole communities at risk ?

Race/ethnicity

Residential segregation

Residential location

Neighborhood resources

Community stressors

Structural factors

Environmental hazards and pollutants

Community stress

Exposure

Individual stressors
Individual coping
Appraisal process

Internal dose

Individual stress

Biologically effective dose

Health effect (disparities)

Community-level vulnerability

Individual-level vulnerability

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 Socicety and others have called for a precautionary approach

Parting Thoughts:

“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):

..image slide 1: http://assets.inhabitots.com/wp-content/uploads/2013/06/autism-linked-to-air-pollution.jpg (accessed Jan 18, 2016)

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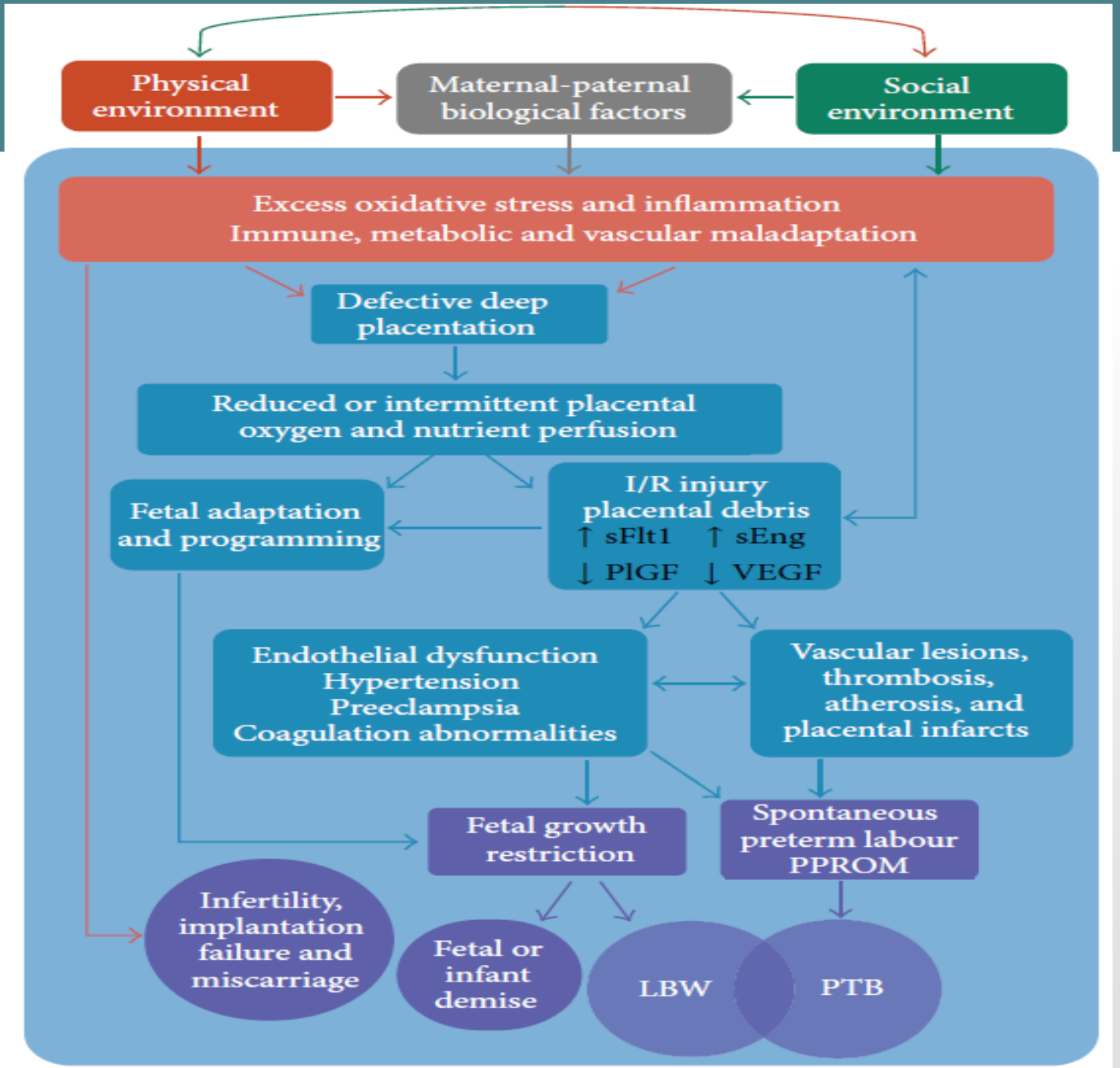
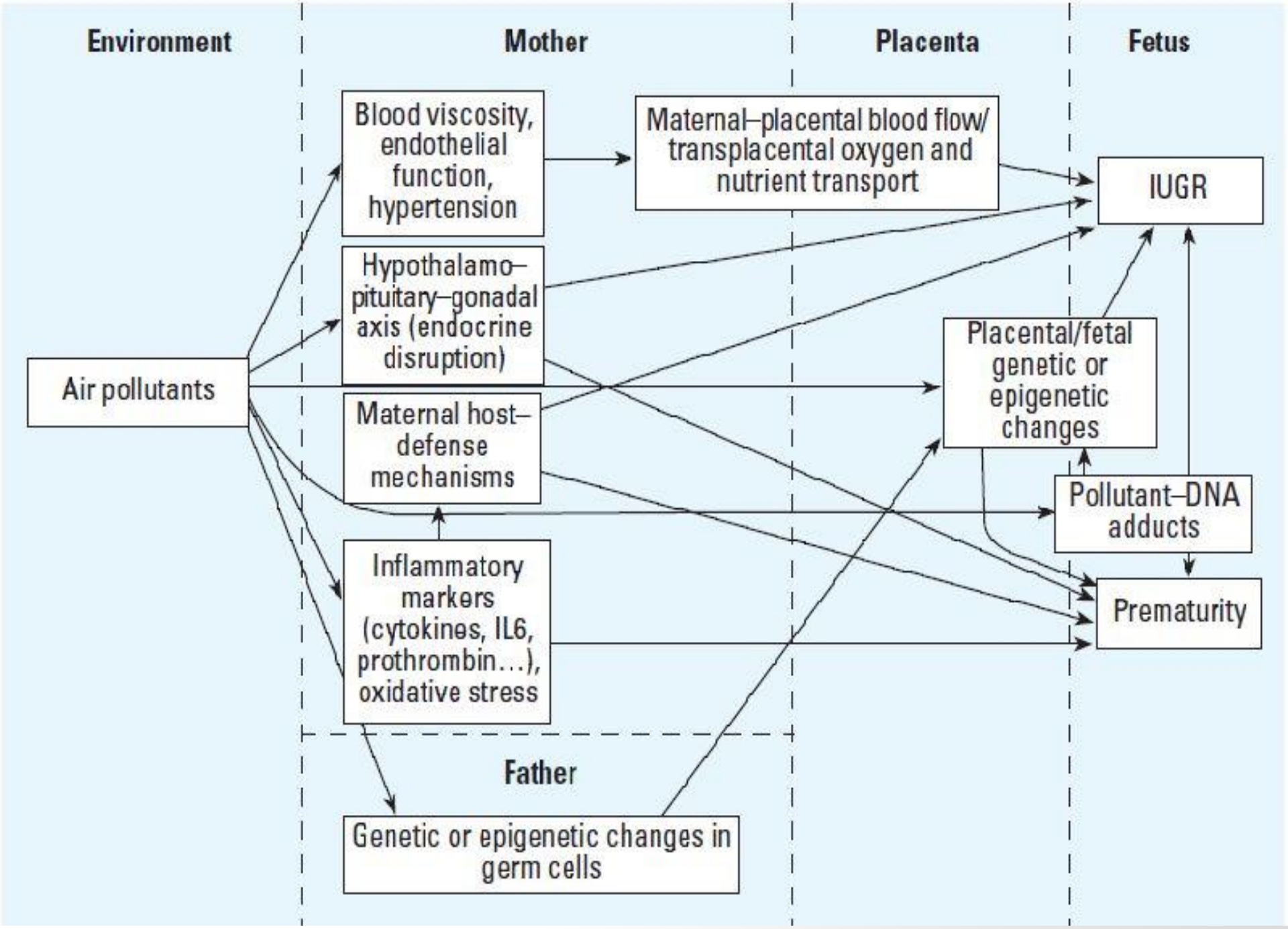
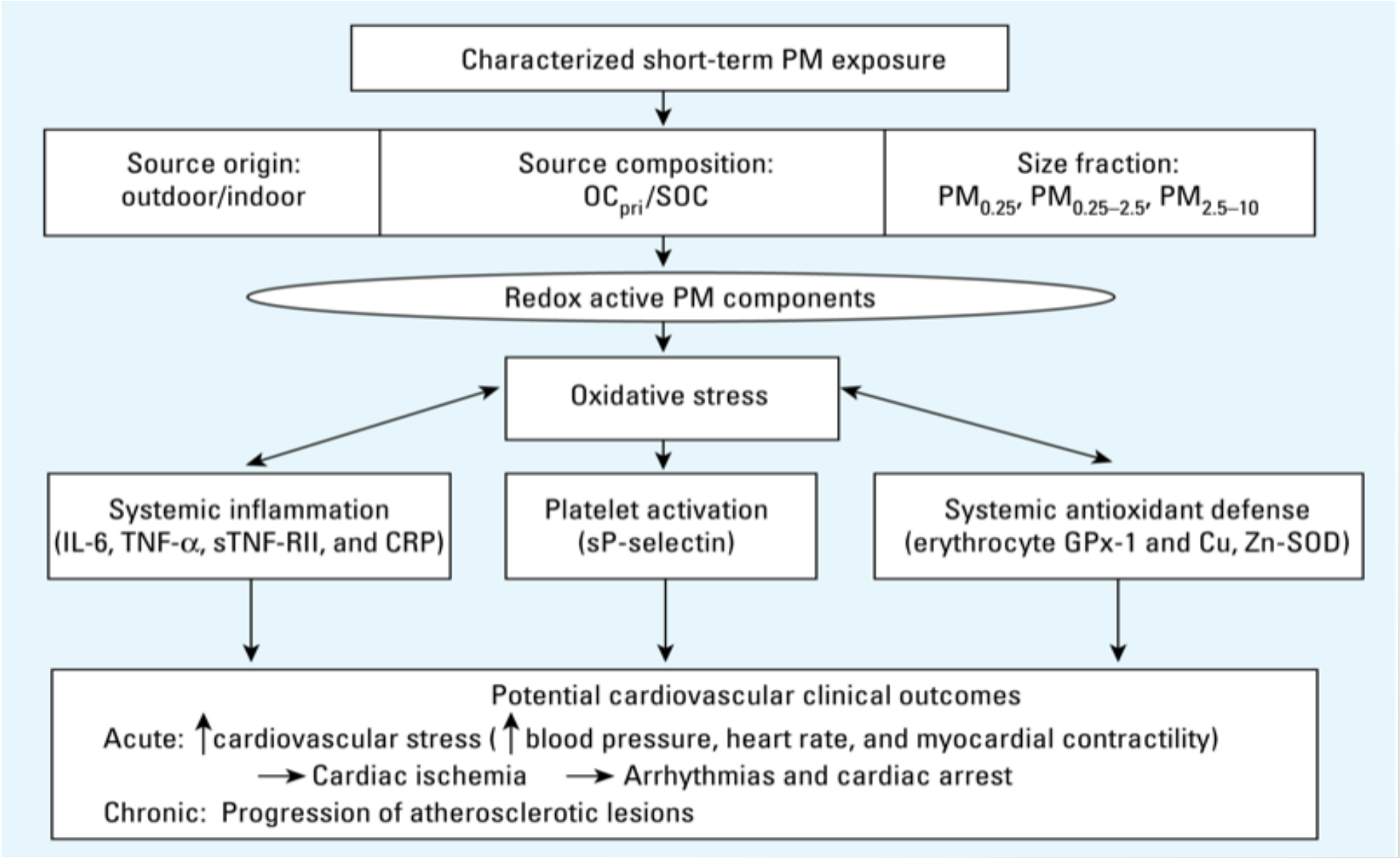

Physical environment
Maternal-paternal biological factors
Social environment
Excess oxidative stress and inflammation
Immune, metabolic and vascular maladaptation
Defective deep placentation
Reduced or intermittent placental oxygen and nutrient perfusion
Fetal adaptation and programming
I/R injury
placental debris
↑ sFlt1 ↑ sEng
↓ PlGF ↓ VEGF
Endothelial dysfunction
Hypertension
Preeclampsia
Coagulation abnormalities
Vascular lesions, thrombosis, atherosis, and placental infarcts
Fetal growth restriction
Spontaneous preterm labour
PPROM
Infertility, implantation failure and miscarriage
Fetal or infant demise
LBW
PTB


Environment
Mother
Placenta
Fetus
Blood viscosity, endothelial function, hypertension
Maternal–placental blood flow/ transplacental oxygen and nutrient transport
IUGR
Hypothalamo–pituitary–gonadal axis (endocrine disruption)
Placental/fetal genetic or epigenetic changes
Air pollutants
Maternal host–defense mechanisms
Pollutant–DNA adducts
Inflammatory markers (cytokines, IL6, prothrombin…), oxidative stress
Prematurity
Father
Genetic or epigenetic changes in germ cells

Pathophysiology of PM Effect



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

ute to cleaner air by personal choices - choosing cleaner sources of gy more efficiently. For instance, carpooling or taking public ning automobile emissions controls on one's cars, walking or biking to ke a difference. Limiting the use of fireplaces (use seasoned wood) ng stoves, and seeking out more efficient heating and cooling ibute to cleaner air.

OMMUNITIES at risk???

Biologic Plausibility and mechanism of fundamental heritable change through fetal environmental exposures

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

Kappil M, Li Q, Li A, et al. In utero exposures to environmental organic pollutants. Environmental Epigenetics, 2016, Vol2:1-7

PEHSU
Pediatric Environmental Health Specialty Units

A network of experts in reproductive and children's environmental health

PAER

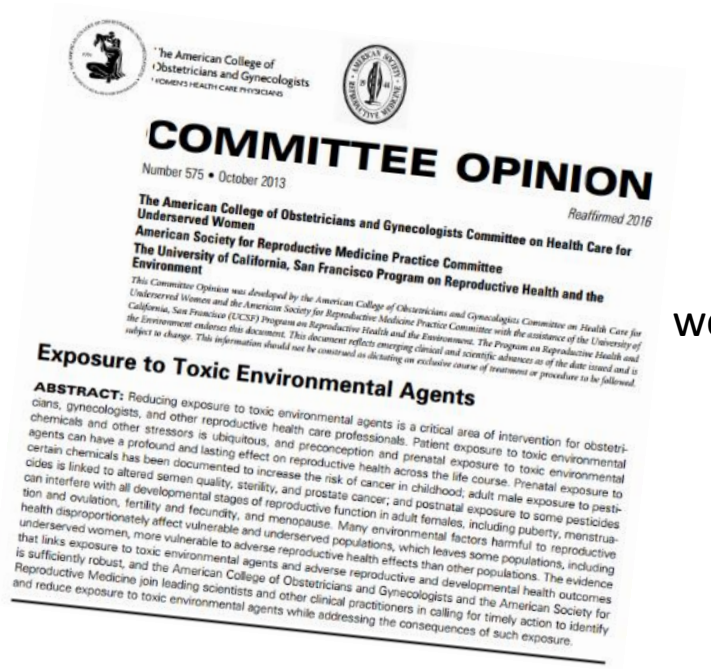
A Web-Based Tool for Prenatal Assessment of Environmental (Toxicologic) Risk

Charles McKay MD FACMT, FACEP
PEHSU West Office
American College of Medical Toxicology

PEHSU Pediatric Environmental Health Specialty Units

- 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



COMMITTEE OPINION

Number 575 • October 2013

Reaffirmed 2016

The American College of Obstetricians and Gynecologists Committee on Health Care for Underserved Women

American Society for Reproductive Medicine Practice Committee

The University of California, San Francisco Program on Reproductive Health and the Environment

Exposure to Toxic Environmental Agents

ABSTRACT: Reducing exposure to toxic environmental agents is a critical area of intervention for obstetricians, gynecologists, and other reproductive health care professionals. Patient exposure to toxic environmental chemicals and other stressors is ubiquitous, and preconception and prenatal exposure to toxic environmental agents can have a profound and lasting effect on reproductive health across the life course. Prenatal exposure to certain chemicals has been documented to increase the risk of cancer in childhood; adult male exposure to pesticides is linked to altered semen quality, sterility, and prostate cancer; and postnatal exposure to some pesticides can interfere with all developmental stages of reproductive function in adult females, including puberty, menstruation and ovulation, fertility and fecundity, and menopause. Many environmental factors harmful to reproductive health disproportionately affect vulnerable and underserved populations, which leaves some populations, including underserved women, more vulnerable to adverse reproductive health effects than other populations. The evidence that links exposure to toxic environmental agents and adverse reproductive and developmental health outcomes is sufficiently robust, and the American College of Obstetricians and Gynecologists and the American Society for Reproductive Medicine join leading scientists and other clinical practitioners in calling for timely action to identify and reduce exposure to toxic environmental agents while addressing the consequences of such exposure.

- 2014: ATSDR Directive
  - Evolution of ebook product to app to web-based tool
- 2014-2016: PEHSU Technical Writer De
- 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

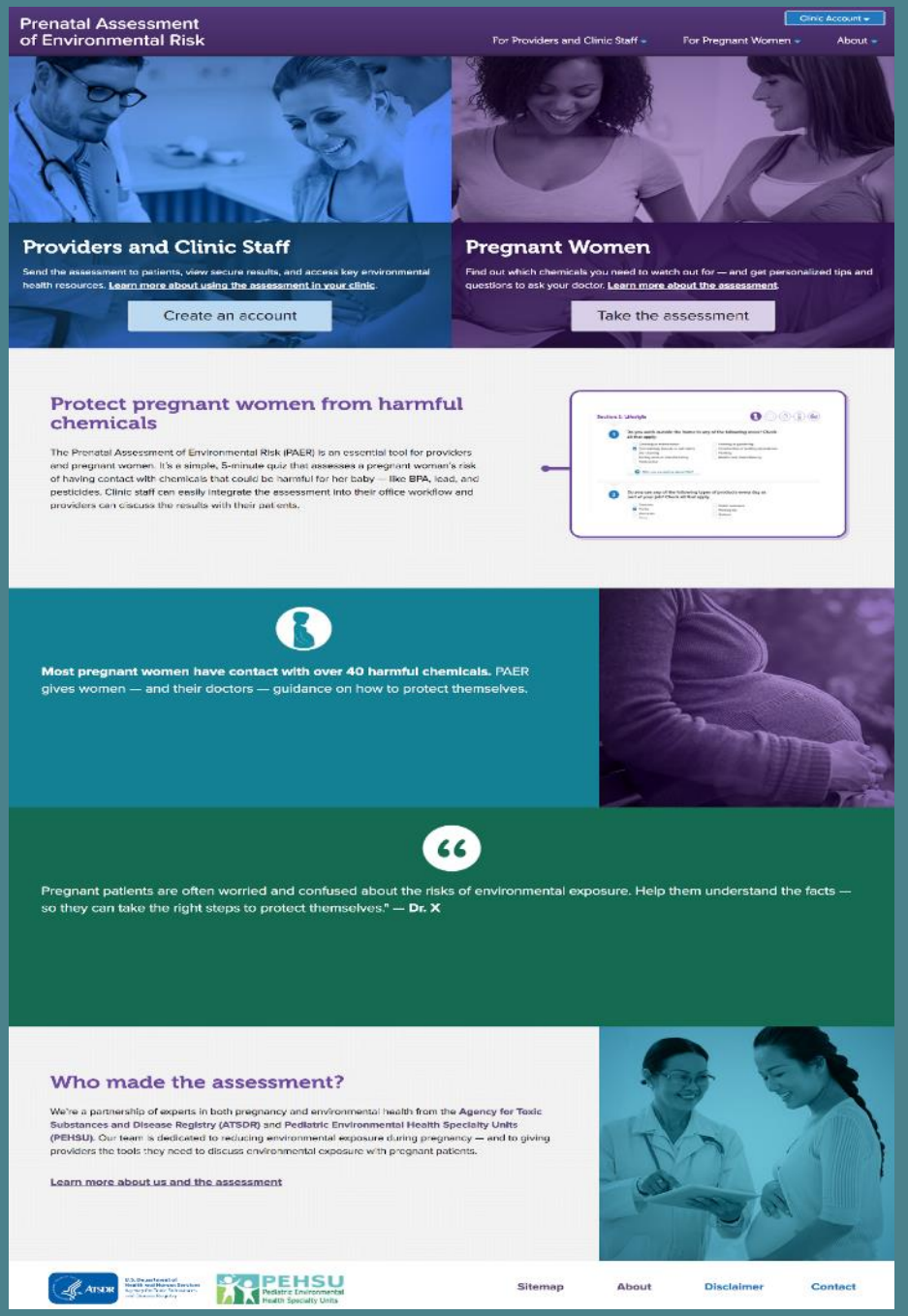
- Lead
- Organic Mercury in Food
- Carbon Monoxide
- Radon
- Environmental Tobacco Smoke
- Chemical Flame Retardants
- Pesticide Residues in Food
- Specific Pesticide Varieties: Glyphosate
- Plasticizers
- Organic Solvents: Personal Care Products

- Primary Concerns of 39 Repro Tox PEHSU Consults Mapped onto PAER Focus Areas

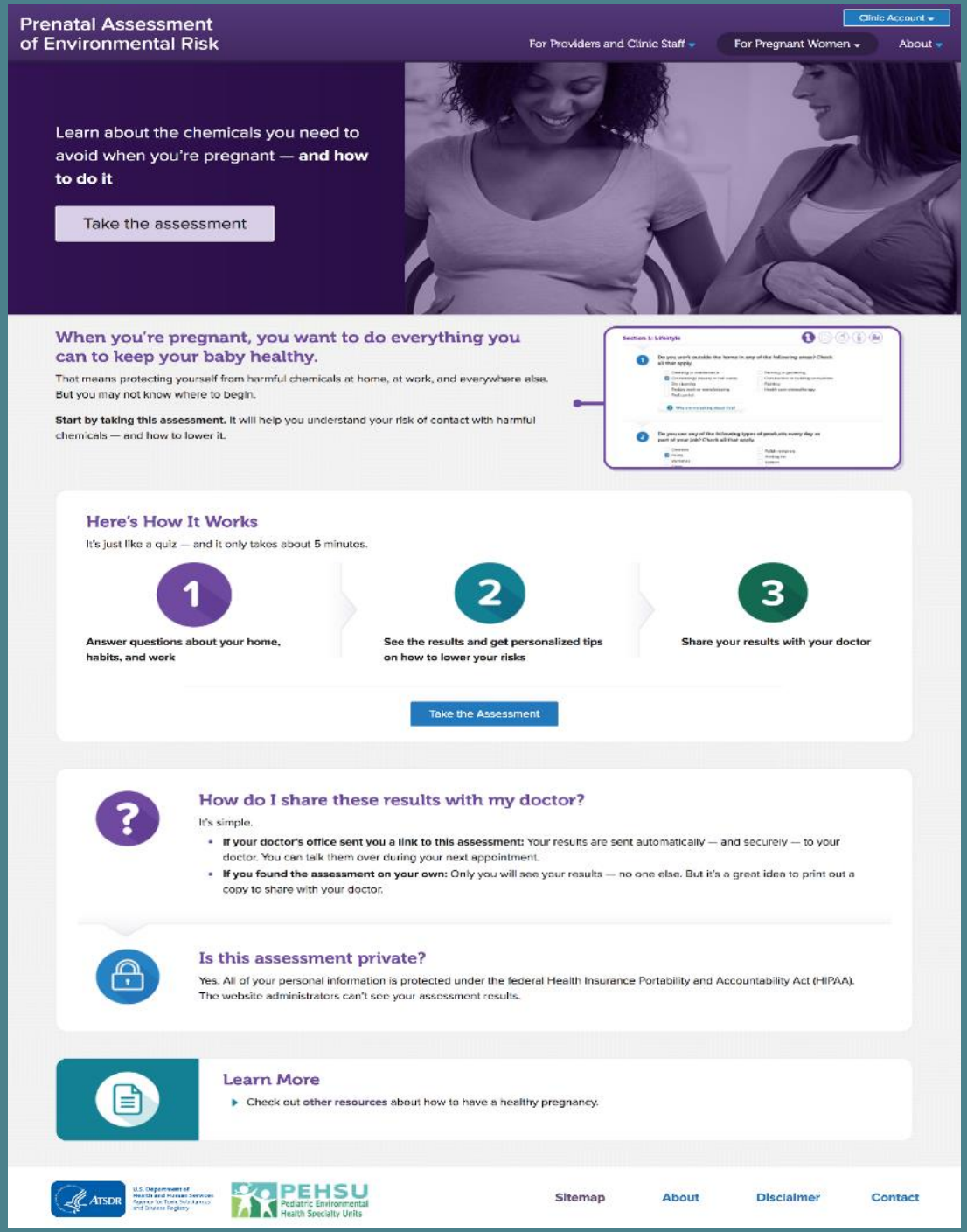
PAER Tool Focus Areas	Number of Cases
Organic solvents (including benzene and VOCs)	4
Air pollution: CO	1
Air pollution: ETS	0
Personal Care Products	0
Lead	8
Flame Retardants (PFCs)	2
Pesticides	0
Mercury	5
PCBs	0
Plastics (including BPA and phthalates)	0
Unassigned concerns: Indoor Air Contaminants, 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	20

- 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."

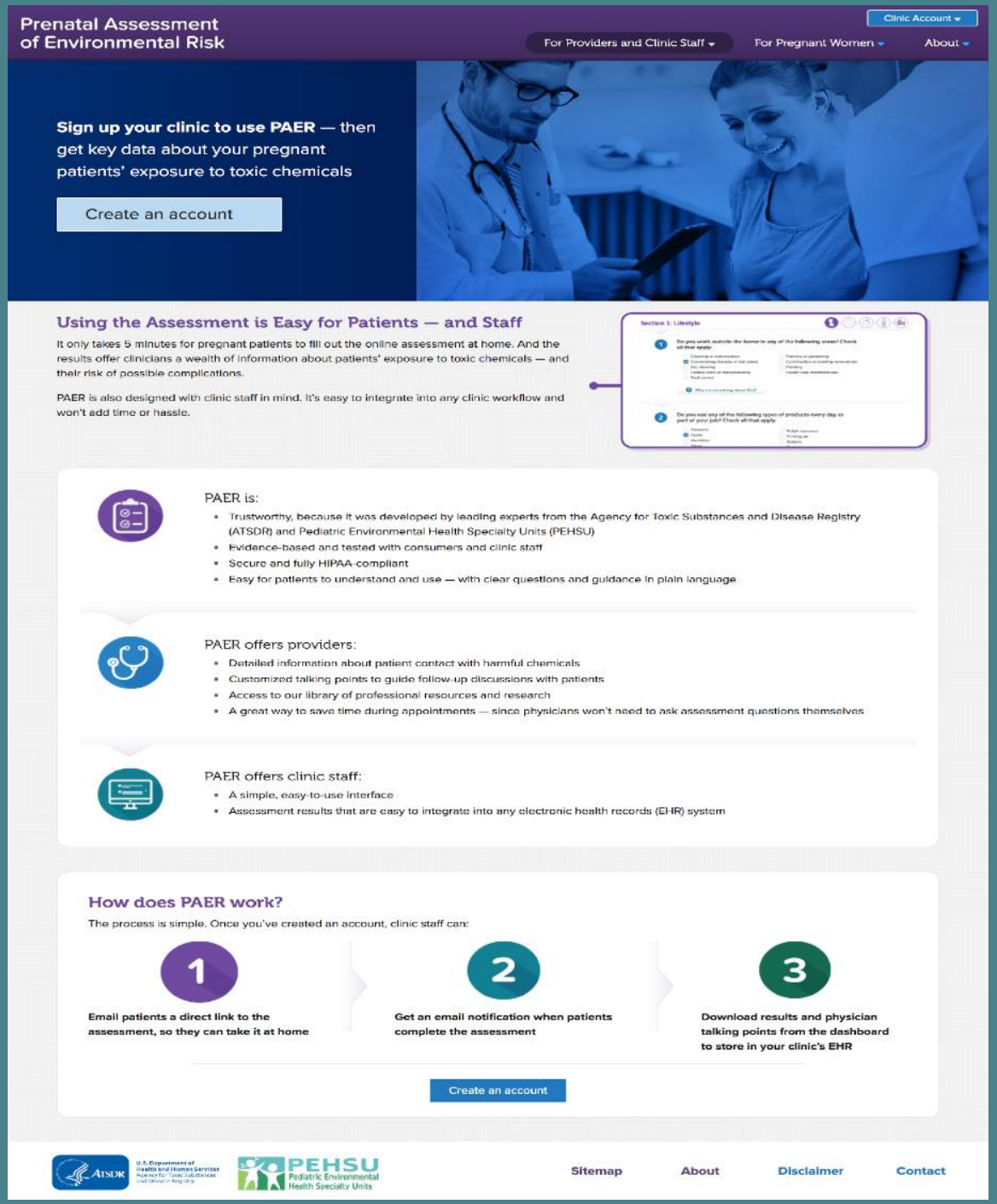
Prenatal Assessment Of Environmental Risk (PAER)



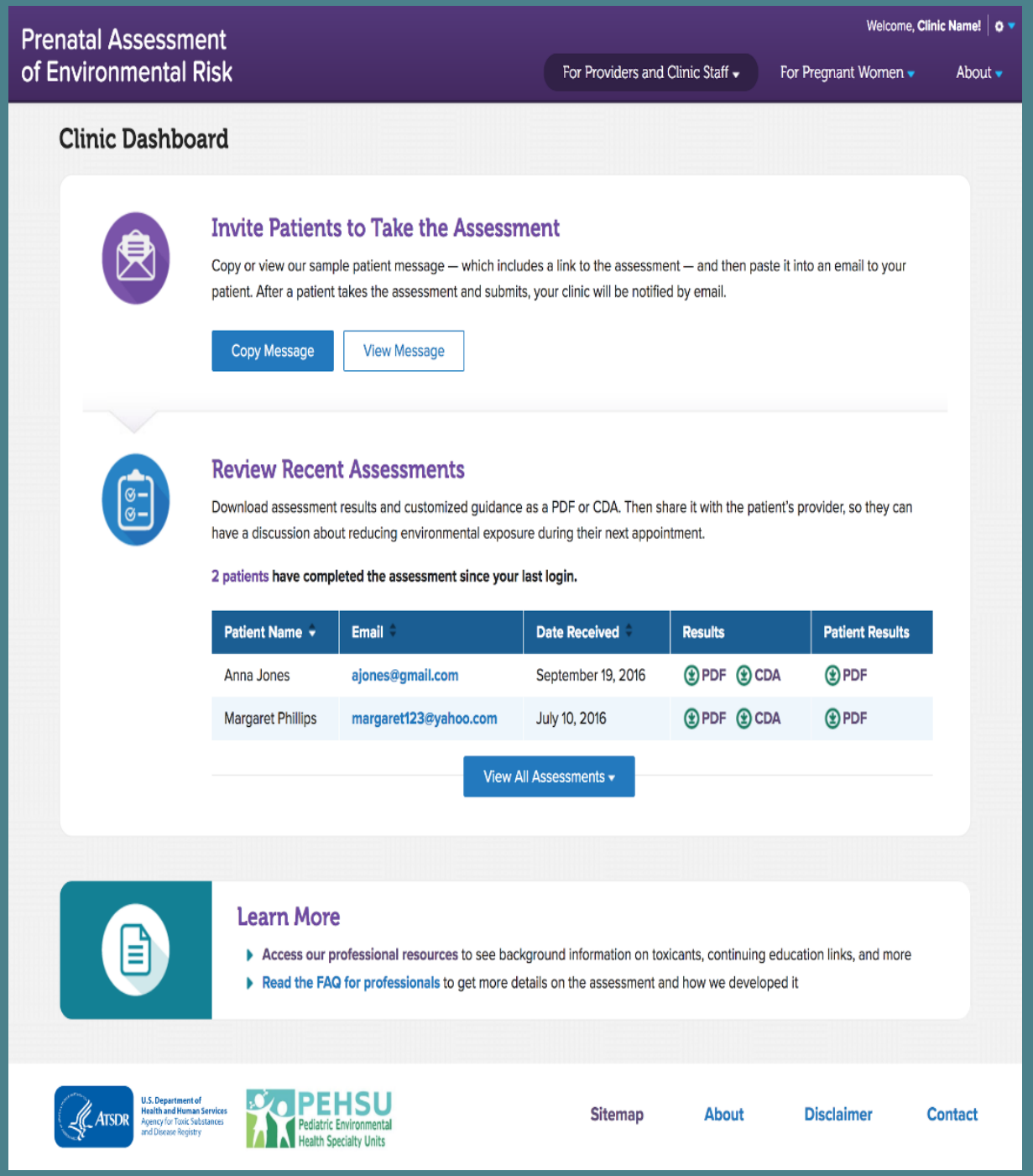
Patient Entry Page View



Clinic Entry Page View



Clinic Dashboard



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

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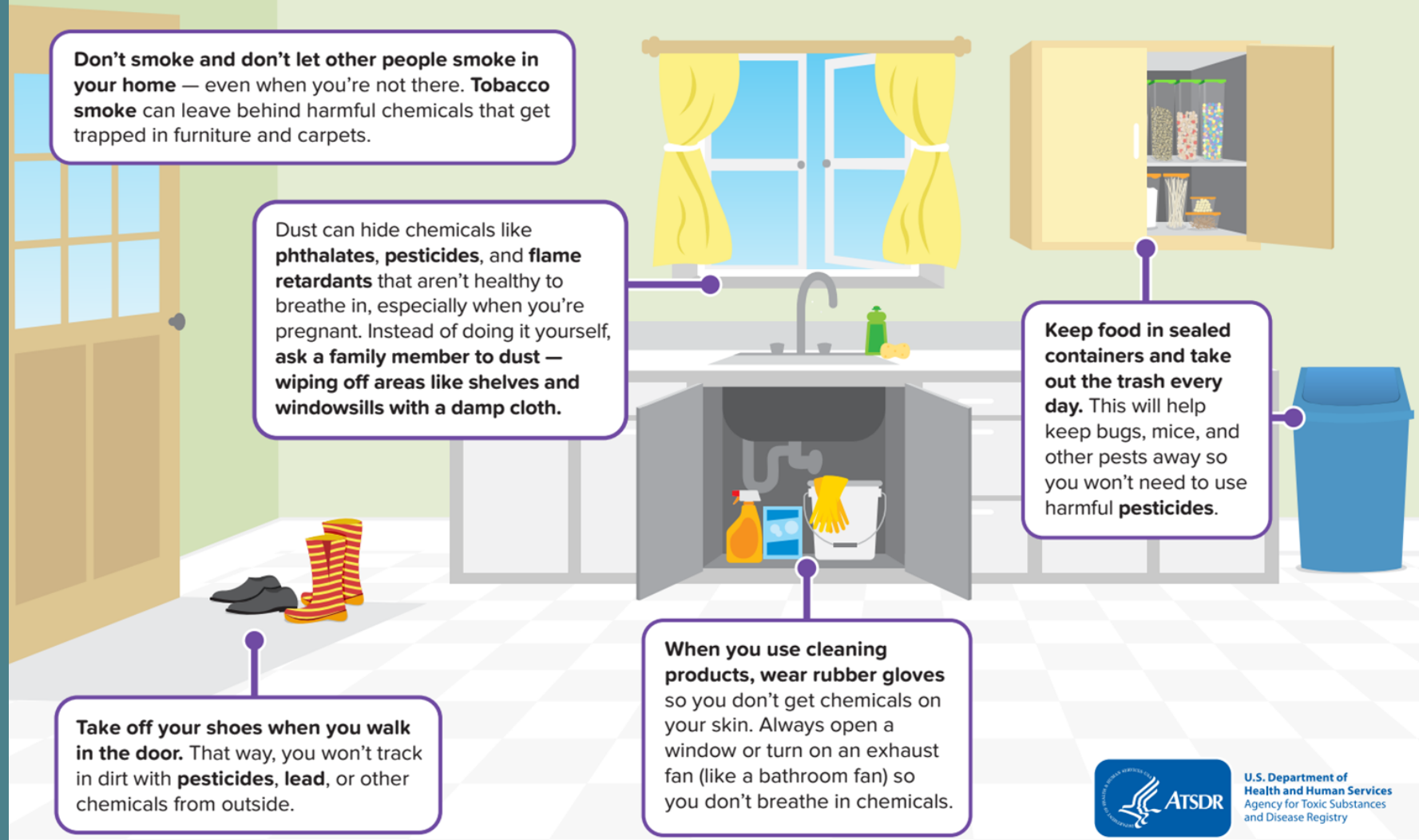
Agency for Toxic Substances and Disease Registry

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.**

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**.

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.

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.

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Harmful Chemicals in the Nursery

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.

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**.

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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**.

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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.

View References ▾

"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

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