Pollution in People

Cord Blood Contaminants in Minority Newborns

ENVIRONMENTAL WORKING GROUP

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Executive Summary

A two-year study involving five independent research laboratories in the United States, Canada and the Netherlands has found up to 232 toxic chemicals in the umbilical cord blood of 10 babies from racial and ethnic minority groups. The findings constitute hard evidence that each child was exposed to a host of dangerous substances while still in its mother's womb.

The research, commissioned by the Environmental Working Group in partnership with Rachel's Network, marks the most extensive investigation of the particular environmental health risks faced by children of African American, Hispanic and Asian heritage.

The laboratory analyses represent the first reported detections in American newborns for 21 contaminants. Among them:

- **Bisphenol A (BPA)**, a derivative of the petrochemical benzene essential to the manufacture of tough polycarbonate plastic and epoxy resins that are fabricated into a wide variety of modern products, including metal food cans, hard plastic infant formula bottles, water bottles, safety helmets and glasses, television, computer and cell phone housings, compact discs and high performance coatings. BPA is a synthetic estrogen that researchers have found to disrupt the endocrine system, disrupt normal reproductive system development and diminish test animals' intellectual and behavioral capacity.
- **Tetrabromobisphenol A (TBBPA)**, a fire retardant for circuit boards that interferes with thyroid function and may inhibit the production of T cells the body uses to fight disease, undermining immune defenses against bacteria, viruses and cancer. TBBPA can break down to BPA, and when incinerated it creates brominated dioxins, which are considered likely human carcinogens.
- **Galaxolide and Tonalide,** polycyclic musks that are synthetic fragrances in cosmetics, laundry detergent and other scented products and that have been detected in numerous biomonitoring studies of pollution in people and in the aquatic environment.
- **Perfluorobutanoic acid (PFBA, or C4)**, a member of the perfluorocarbon (PFC) chemical family used to make non-stick, grease-, stain- and water-resistant coatings for consumer products, including brands Teflon, Scotchgard and Goretex. The most studied PFCs, the Teflon chemical PFOA and the Scotchgard chemical PFOS, are linked to cancer, birth defects and infertility. PFCs are extremely persistent in the environment. There is almost no toxicological data for PFBA in the public domain.
- **8 Previously Undetected Polychlorinated biphenyls** (PCBs). Developed as industrial lubricants, coolants and insulating materials, also used in caulk, PCBs were effectively banned in the late 1970s but are long-lasting in the environment. The U.S. government lists PCBs as probable human carcinogens. According to government and academic scientists, PCBs have been shown to disrupt the endocrine system and damage the immune system, and are toxic to the developing brain.

Some racial and ethnic minority communities in the U.S. experience disproportionate exposures to environmental pollution (Brulle and Pellow 2006). Whether through poverty or historical patterns of discrimination, some are more likely to live near busy roads, industrial sites and in older housing. These factors, combined with workplace exposures, diet and use of certain consumer products, may lead to greater contamination with chemicals. When combined with poor nutrition and health, the adverse effects of having a greater chemical body burden can be aggravated.

In spite of the acute need to understand prenatal exposures in all segments of American society, EWG could find no studies that examined the chemical body burden in the womb for minority children. This study is a first attempt to fill that void.

The 10 children in this study were born between December 2007 and June 2008 in Michigan, Florida, Massachusetts, California and Wisconsin. They are otherwise anonymous.

We have no way of knowing anything about the homes and neighborhoods into which they were born. This study tested for chemicals that can be found in virtually every American household. We did not test for chemicals, such as the byproducts of smoking or alcohol consumption, that would indicate behaviors by the mother that could in any way jeopardize the health of the child. We also did not test for chemicals from local pollution sources.

We cannot determine how chemical exposures in utero may vary from one community to another, but our results strongly suggest that the health of all children is threatened by trace amounts of hundreds of synthetic chemicals coursing through their bodies from the earliest stages of life.

What's Unique About EWG's Biomonitoring Research?

This study is EWG's eleventh biomonitoring investigation. To date, EWG studies have found 414 industrial chemicals, pollutants and pesticides in 186 people, from newborns to grandparents. Our goal is to quantify the pollution in people, or what we call the "human toxome," and to drive science and policy changes to protect public health.

The Centers for Disease Control and Prevention (CDC) has published biomonitoring study results involving thousands of people nationwide over the past decade. Its next report, the fourth in a series, is expected to list detections of more than 200 pollutants found in representative samples of the U.S. population.

EWG's biomonitoring program complements the CDC in three key respects:

1. **More chemicals:** CDC looks for fewer chemicals, but in larger, statistically representative samples of the U.S.population. EWG studies typically look for more chemicals than the CDC, but in smaller sample cohorts. EWG has detected more than 414 chemicals in people, compared to 203 reported by the CDC. EWG relies on specialized laboratories around the world to maximize the scope of its analyses.
2. **Mixtures in each person:** CDC reports its results chemical by chemical, estimating how many Americans are exposed to each chemical under investigation. EWG publishes the full list of chemicals found in each person tested to convey the scope and complexity of each person's body burden.
3. **Early life exposures:** CDC tests adults and children age 6 and up. The agency rarely tests cord blood or infants. EWG studies include cord blood, infants and toddlers to help document exposures during the most vulnerable periods of development.

The contaminants found in these children are from unintended exposures to some of the most problematic consumer product and commercial chemicals ever put on the market. Their presence in fetal cord blood represents a significant failure on the part of the Congress and government agencies charged with protecting human health.

Scientists know far too little about the health threats posed by exposure to toxic chemicals in the womb. There is broad agreement, however, that the dangers are greater when exposure occurs before birth. Just how much more dangerous is not known.

Brominated flame retardants, PCBs, the Teflon chemical PFOA and the Scotchgard chemical PFOS, BPA, lead, mercury, perchlorate, dioxins and furans are all considered either likely human carcinogens, serious neurotoxins or well-established hormone disrupters, according to government health authorities. Many are strongly linked to more than one of these effects.

Recommendations

Government, academic and independent biomonitoring studies, including those by EWG, have detected up to 358 industrial chemicals, pesticides and pollutants in the cord blood of American infants. Exploring the so-called "additive" effects of possible carcinogens, hormone disrupters and neurotoxins is a new and urgent priority for environmental health scientists. EWG supports this very important work.

But as this science moves forward, we need to act now to reduce exposures that present the greatest health threats based on what we know today, even as scientists struggle to understand how the cocktail of chemicals in the womb could harm current and future generations.

Many of the up to 232 compounds detected in this study have been the target of regulatory action and government controls. As a rule, however, these actions came far too late, well after the environment and the human race were polluted to a degree that has raised serious health concerns. Our failure to act quickly has ensured that these chemicals will continue to pollute future generations for decades, even centuries to come.

EPA Administrator Lisa Jackson has identified several of the substances found in this study as priority chemicals of concern. These include BPA, brominated flame retardants and the entire class of perfluorinated (Teflon and Scotchgard) chemicals.

In our view, any chemical found in cord blood should be a top candidate for tough regulatory action to protect public health.

To ensure a full accounting of chemical exposure before birth, we recommend that the CDC initiate a comprehensive cord blood-testing program. This work should be coordinated with ongoing biomonitoring in the National Children's Study but should seek to identify and quantify the full extent of chemical exposures in the womb over time. The complete costs of this work must be borne by industry.

Findings

The Environmental Working Group, in partnership with Rachel's Network, commissioned five laboratories in the U.S., Canada, and Europe to analyze umbilical cord blood collected from 10 minority infants born in 2007 and 2008. Collectively, the laboratories identified up to 232 industrial compounds and pollutants in these babies, finding complex mixtures of compounds in each infant.

This research demonstrates that industrial chemicals cross the placenta in large numbers to contaminate a baby before the moment of birth. Test results are shown below.

Chemicals Detected in Umbilical Cord Blood from 10 Minority Newborns

Chemical or chemical family	Geometric Mean (of the detections)	Range	Number of newborn umbilical blood samples with detections	Number of chemicals detected within chemical family
Metals [µg/dL (wet weight) in whole blood] - 3 of 3 found				
Lead [pollutant from lead-based paint in older homes, household dust, vinyl products; harms brain development and function]	0.348 µg/dL	(0.222 - 0.549)	10 of 10	NA
Mercury [pollutant from coal-fired power plants, mercury-containing products, and certain industrial processes; accumulates in seafood; harms brain development and function]	0.64 µg/dL	(0.09 - 3.91)	10 of 10	NA
Methylmercury [organic form of mercury typically found in contaminated fish and seafood]	0.513 µg/dL	(0.08 - 3.28)	10 of 10	NA

Chemical or chemical family	Geometric Mean (of the detections)	Range	Number of newborn umbilical blood samples with detections	Number of chemicals detected within chemical family
Polybrominated dibenzodioxins and furans (PBDD/F) [pg/g (lipid weight) in blood serum] - contaminants in brominated flame retardants; pollutants and byproducts from plastic production and incineration; accumulate in food chain; toxic to developing endocrine (hormone) system				
Brominated dioxin	34.57 pg/g	(0 - 41.8)	2 of 10	Tested for: 6 Found: 1
Brominated furan	292 pg/g	(0 - 1440)	4 of 10	Tested for: 6 Found: 5
Perfluorinated chemicals (PFCs) [ng/g (wet weight) in whole blood] - active ingredients or breakdown products of Teflon, Scotchgard, fabric and carpet protectors, food wrap coatings; global contaminants; accumulate in the environment and the food chain; linked to cancer, birth defects and more				
Perfluorochemicals (PFCs)	2.38 ng/g	(0.736 - 7.08)	10 of 10	Tested for: 13 Found: 6
Polybrominated diphenyl ethers (PBDEs) [ng/g (lipid weight) in blood serum] - flame retardant in furniture foam, computers and televisions; accumulates in the food chain and human tissues; adversely affects brain development and the thyroid				
Polybrominated diphenyl ethers (PBDEs)	7.28 ng/g	(3.05 - 15.1)	10 of 10	Tested for: 46 Found: 26 to 29[1]
Polychlorinated naphthalenes (PCNs) [ng/g (lipid weight) in blood serum] - wood preservatives, varnishes, machine lubricating oils, waste incineration; common PCB contaminant; contaminate the food chain; cause liver and kidney damage				
Polychlorinated naphthalenes (PCNs)	0.64 ng/g	(0.0743 - 3.43)	10 of 10	Tested for: 70 Found: 17 to 24[2]
Polychlorinated biphenyls (PCBs) [ng/g (lipid weight) in blood serum] - industrial insulators and lubricants; banned in the U.S. in 1976; persist for decades in the environment; accumulate up the food chain to humans; cause cancer and nervous system problems				
Polychlorinated biphenyls (PCBs)	22.1 ng/g	(9.68 - 39.7)	10 of 10	Tested for: 209 Found: 98 to 144[3]

Chemical or chemical family	Geometric Mean (of the detections)	Range	Number of newborn umbilical blood samples with detections	Number of chemicals detected within chemical family
Polychlorinated dibenzodioxins and furans (PCDD/F) [pg/g (lipid weight) in blood serum] - pollutants, by-products of PVC production, industrial bleaching and incineration; cause cancer in humans; persist for decades in the environment; very toxic to developing endocrine (hormone) system				
Chlorinated dioxin	52.6 pg/g	(5 - 383)	10 of 10	Tested for: 7 Found: 6
Chlorinated furan	16.3 pg/g	(0 - 278)	6 of 10	Tested for: 10 Found: 9
Bisphenol A (BPA) [ng/mL (wet weight) in blood serum] - building block of polycarbonate plastics and epoxy resins for thousands of consumer products, including baby bottles, drinking water containers, metal food and beverage can liners and dental sealants; linked to hormone disruption, birth defects and cancer				
Bisphenol A	2.8 ng/mL	(0 – 8.61)	9 of 10	NA
Brominated fire retardant [ng/g (lipid weight) in blood serum] - 1 of 1 found				
Brominated Fire Retardant	2986 ng/g	(0 - 3210)	3 of 10	NA
Perchlorate [µg/L (wet weight) in whole blood] - 1 of 1 found				
Perchlorate	0.231 µg/L	(0 - 0.6)	9 of 10	NA
Polycylic musks [ng/g (wet weight) in whole blood] – heavily used synthetic fragrances that mimic natural musk.				
Polycylic musks	0.835 ng/g	(0 - 2.74)	7 of 10	Tested for: 6 Found: 2

Notes:

1.) Numbers are expressed as a range because several PBDEs are tested for in pairs; a positive result may mean one or both are present. The range reflects the minimum and maximum number of possible positive results.

2.) Numbers are expressed as a range because many PCNs are tested for in groups of two or three chemicals; a positive result may mean that one, some, or all are present. The range reflects the minimum and maximum number of possible positive results.

3.) Numbers are expressed as a range because many PCBs are tested for in groups up to six at a time: a positive result may mean that one, some, or all are present. The range reflects the minimum and maximum number of possible positive results.

BPA – plastics chemical

Key findings:
- First ever detection of BPA in U.S. cord blood. Found in 9 of 10 cord blood samples tested.

What is it? - BPA is a petrochemical derivative used to toughen polycarbonate plastic and epoxy resin.

How does it contaminate cord blood? - BPA is found in food, beverages and infant formula sold in metal cans (lined with BPA-based epoxy resin), drinks in polycarbonate plastic containers (made from BPA). Because epoxy resin and polycarbonates are unstable, BPA in food packaging leaches readily into any food or liquids the packaging touches.

Health risks - BPA acts as a synthetic estrogen that disrupts the endocrine system and causes other harmful effects, even at very low doses. In test animals, BPA induces abnormal reproductive system development, diminishes intellectual capacity, causes behavioral problems and has induced reproductive system cancer, obesity, diabetes, early puberty, resistance to chemotherapy, asthma, cardiovascular system problems and other chronic ailments.

Regulatory status – The FDA is considering whether to regulate BPA in food packaging. Minnesota and Connecticut, Chicago, Suffolk County, N.Y., and Schenectady County, N.Y., have banned BPA in baby bottles and other children's food containers and utensils, and Massachusetts has issued a strong warning against them. In 2009, bills to ban or restrict BPA were introduced in the U.S. Congress and 21 states. Major baby bottle and sports bottle makers have voluntarily switched to non-BPA plastics, but the food canning industry has not developed non-BPA linings for metal cans.

Discussion:
Tests performed by the Division of Biological Sciences at the University of Missouri-Columbia identified BPA in cord blood from 9 of 10 minority newborns. Cord blood studies in Asia and Europe have found traces of BPA in cord blood, but until now, scientists have not reported finding the chemical in cord blood of American infants.

The impact on human health of BPA, a ubiquitous plastic component detected by CDC researchers in 93 percent of Americans over age 6 (Calafat 2008), is a major research priority for federal scientific institutions and major independent research laboratories around the world.

Scientists discovered that BPA was a synthetic estrogen as early as 1936, but exposure to traces of the chemical was thought to be harmless until 1997, when a team led by Missouri biologist Frederick Vom Saal demonstrated that very low doses of BPA caused irreversible damage to the prostates of fetal male mice. Since then, scores of animal studies have produced substantial evidence that BPA disrupts the endocrine system, even at the very small concentrations to which people are typically exposed, and may cause a lengthening list of serious disorders.

Among them are:

- Endocrine system disruption
- Cancer
- Impaired brain function and behavioral abnormalities
- Cardiovascular disease
- Infertility and miscarriage
- Obesity and diabetes
- Asthma
- Resistance to chemotherapy
- Epigenetic and transgenerational effects

A rare human epidemiological study, published in November 2009 in the journal Human Reproduction, offers what its authors called "the first evidence that exposure to BPA in the workplace could have an adverse effect on male sexual dysfunction."

In 2008, the National Toxicology Program, an authoritative interagency science panel housed at the National Institute for Environmental Health Sciences, concluded that BPA may harm the brain, behavior and prostate gland of fetuses, infants and children, even at the low doses to which people are currently exposed. (NTP 2008). NTP officials called for more intensive research on BPA on the grounds that "the possibility that BPA may affect human development cannot be dismissed."

In response, in October 2009, NIEHS Director Linda Birnbaum targeted $30 million in federal stimulus funds to basic research on BPA and human health.

Children, African Americans and the poor may face heightened health threats from bisphenol A. The CDC has found average BPA levels 80 percent higher in children ages 6-11 than in adults over 20 (Calafat 2008). These surveys have also detected BPA levels 24 percent higher in people from households with annual incomes under $20,000 versus $45,000 or more, and 11 percent higher among non-Hispanic blacks than whites.

In 2008, citing two industry-sponsored studies, the FDA deemed low-dose BPA exposure safe, even for pregnant women and infants. At the urging of its Science Board and 33 university scientists and independent experts, the agency is now reassessing the safety of BPA in food packaging.

Perchlorate (rocket fuel oxidizer)

Key Findings:

- Found in 9 of 10 cord blood samples. This is just the second study to find perchlorate in American babies; the first was published in September 2009 and reported results from children born in New Jersey.

What is it? – Perchlorate is a rocket fuel oxidizer that powers missiles, the space shuttle, fireworks, road flares, automobile airbags and more.

How does it contaminate cord blood? – It seeps into soil and groundwater because of improper storage and disposal at defense and aerospace facilities and chemical plants. Water utilities in 35 states and territories have found perchlorate in drinking water. The FDA detected perchlorate in 74 percent of 285 popular foods and beverages tested, including baby food.

Health risks – Perchlorate can block the formation of thyroid hormones critical to brain development and growth in the fetus, infants, and children. Inadequate iodine intake increases the risk of perchlorate-related compromise of thyroid hormone production.

Regulatory status – EPA is re-evaluating the need for a national drinking water standard. Massachusetts and California have set standards for maximum perchlorate pollution in drinking water. The FDA has taken no action to address perchlorate contamination of food.

Discussion:

Nine of 10 cord blood samples in the current study tested positive for perchlorate. This is the second study to test U.S. cord blood for perchlorate. In the first, published in September 2009, CDC researchers reported the compound in 67 percent of cord blood samples from 126 babies born in New Jersey (Blount et al 2009).

Perchlorate, a component of rocket fuel integral to the firing systems of missiles and some military explosives, has been found to contaminate drinking water in 28 states and territories. The chemical has seeped into groundwater and soil at military and aerospace sites and chemical plants and has entered the food supply through polluted irrigation water, certain naturally contaminated fertilizers, and other routes not yet identified.

In a national biomonitoring study, CDC detected perchlorate in the urine of all 3,000 people tested (Blount et al 2006a), indicating widespread exposure in the U.S. population. FDA testing has found perchlorate contamination in 74 percent of 285 commonly consumed foods and beverages, including baby food (Murray et al 2008). CDC scientists have found widespread perchlorate contamination of powdered infant formula, especially brands derived from cow's milk (Schier et al 2009).

Adequate levels of thyroid hormone are critical to brain development and growth of the fetus. A recent large-scale epidemiological study by the CDC found that among women, current perchlorate exposures are associated with significant effects on thyroid hormone levels, especially in those with lower iodine levels (Blount et al 2006b). This is of special concern in women of childbearing age, who may experience perchlorate-associated fluctuations in thyroid hormone levels during pregnancy (EWG 2006).

Perfluorochemicals (PFCs) - Teflon and Scotchgard chemicals

Key findings:

- First test in the world for PFBA (C4 or perfluorobutanoic acid) in cord blood; found in 1 of 10 infants.
- PFOA (perfluorooctanoic acid) and PFOS (perfluorooctanesulfonate) found in 10 of 10 infants.

What are they? - PFCs are stain- and grease-proofing chemicals

How do they contaminate cord blood? - used in a variety of consumer products, such as carpets and furniture, as stain and grease repellents, in Teflon cookware, food packaging and clothing. PFCs have also been found in drinking water and certain food groups such as fruits and vegetables.

Health risks - PFCs are linked in human studies to a broad range of health risks, including decreased birth weight, reproductive problems, and elevated cholesterol. In animal studies, PFC exposure has been associated with immune suppression and liver, pancreatic and breast cancers.

Regulatory status - In 2002, 3M Corporation, the world's major manufacturer of PFOS, completed its voluntary phase-out of the chemical's production after the EPA raised concerns about its toxicity and widespread detection in human biomonitoring surveys. The EPA is currently developing drinking water standards for both chemicals.

Discussion:

One cord blood sample contained the first-ever finding in cord blood of PFBA, a PFC that appears to be a legacy pollutant. According to the CDC and the EPA, PFBA was last produced in the US in 1998.

This child, the first baby in the world found to be contaminated with this stain- and grease-proofing compound, joins 13 other Americans with PFBA in their blood, according to tests of 75 children and adults sponsored by EWG. Scientists know very little about its possible toxicity.

All 10 cord blood samples in this study tested positive for two members of the PFC family, PFOA and PFOS, confirming CDC studies that found widespread exposure to these chemicals throughout the U.S. population.

PFCs contaminate food, water, wildlife and consumer products and have been detected in every corner of the globe. In the human body, these chemicals are persistent and bioaccumulative and have been found in breast milk.

Researchers at the Johns Hopkins Bloomberg School of Public Health tested PFOA and PFOS levels in nearly 300 mother/infant pairs and found that women with elevated blood levels of these chemicals gave birth to infants with reduced birth weight and head circumference (Apelberg 2007). Low birth weight is a predictor of potentially serious medical problems later in life (Lau and Rogers 2004). Other human studies have linked PFC exposure to difficulty conceiving, lower sperm quality and elevated cholesterol (Fei et al 2009, Joensen et al 2009, Steenland et al 2009).

Concerns about PFOS have prompted an end to U.S. production. Manufacturers have agreed to phase out PFOA. EPA administrator Lisa Jackson recently announced that PFCs are one of six chemicals or chemical classes being considered for priority action (EPA 2009). EPA is developing drinking water standards for both chemicals.

Lead

Key findings:
- Lead was found in cord blood of 10 of 10 newborns tested.

What is it? – Lead is a neurotoxic metal that concentrates in the brain.

How does it contaminate cord blood? – Lead contamination occurs primarily as a result of mothers ingesting or breathing dust from chipped lead paint in older homes or drinking tap water containing lead that leaches from old water pipes, lead solder and brass plumbing fixtures.

Health risks – It is a known human neurotoxin believed unsafe in any amount. More than 30 years of studies have demonstrated lead's dangers to children at lower and lower doses.

Regulatory status – Lead was banned in gasoline and paint decades ago, but many other uses remain. Some states are moving to eliminate lead from consumer goods ranging from wheel weights to cosmetics to children's products.

Discussion:
All 10 newborns in this study had measurable amounts of lead in their cord blood, consistent with previous studies that have found that babies are often contaminated with this neurotoxic metal before birth.

Lead is one of only a handful of substances whose effects in people have been well studied. The EPA lists a litany of health problems linked to lead, including brain and nervous system damage, behavior and learning problems, hyperactivity, slowed growth, hearing problems, reproductive problems and nerve disorders (EPA 2009a).

Three decades of research have shown clearly that lead damages the human brain. Advances in cognitive and behavioral testing have allowed researchers to discern harm at lower and lower exposures. There is no known safe threshold for exposure.

In February, 2009, researchers at Jagiellonian University in Krakow, Poland, published a study in the journal Neuroepidemiology demonstrating damage to cognitive function in newborns exposed to amounts of lead lower than in any previous study – and lower than the amounts found in several newborns in EWG's study. The Polish researchers found a strong correlation between lead levels in cord blood at birth and deficits in cognitive performance in 12-, 24- and 36-month-old children. The median level they detected in cord blood was one-tenth of the current U.S. exposure standard for young children (Jedrychowski 2009). The lead levels EWG measured in minority newborns were about half the typical level in the Polish children.

Despite lead's hazards, a wide range of industries still use it. It is manufactured, imported, processed or used in at least 8,200 facilities in all 50 states, according to company reporting of lead use and emissions in EPA's 2007 Toxics Release Inventory. Lead-acid batteries -- used in cars, trucks and power supplies for computers, telecommunication networks and hospitals -- account for 88 percent of current lead use, but it also shows up in products such as crystal chandeliers and radiation shields.

For most Americans, lead exposure comes from contaminated drinking water (lead leaches from lead pipes, solder and brass plumbing fixtures) or from dust from chipping paint in older homes. Children living near industrial facilities may face higher exposures.

Americans' exposures were far higher until the EPA took steps 30 years ago to restrict lead in gasoline and house paint. Subsequently, the number of children exposed to lead above the government's action level (10 micrograms per deciliter of blood) fell from 87.4 percent to 3.1 percent as of 2001. Public health advocates declared the results a great victory.

Today, some children remain highly exposed, particularly among non-Hispanic blacks and Mexican Americans, children from lower socioeconomic groups and immigrants (CDC 2005). A range of consumer products, including many marketed for children, still contain lead. In recent years, lead has been reported in lunch boxes, lipstick, jewelry, window blinds and imported candy.

Mercury

Key findings:
- Total mercury and methylmercury found in 10 of 10 newborns tested.

What is it? – Mercury is a pollutant from coal-fired power plants and other industrial sources, also used in consumer products such as fluorescent light bulbs and thermometers. Mercury in elemental form pollutes waterways. It is readily converted to the organic compound methylmercury, which accumulates in the food chain, especially seafood.

How does it contaminate cord blood? – Eating methylmercury-tainted seafood is typically the primary source of contamination. Mercury dental fillings are a lesser source of contamination.

Health risks – Mercury is a neurotoxin that interferes with brain and nervous system development and is particularly harmful to the fetus, infants and children.

Regulatory status – EPA has set a reference dose (RfD) of 5.8 ppb for mercury levels in the blood of pregnant women. FDA has issued a health advisory urging pregnant women and young children to limit canned tuna consumption and avoid heavily contaminated fish.

Discussion:
Mercury is a naturally occurring element that can be found in some consumer products, notably thermometers, fluorescent lamps and electrodes, and in dental fillings. Coal-fired power plants pollute the air with mercury emissions that enter oceans and rivers, where they are converted to methylmercury and accumulate in fish and wildlife. Fish consumption is the primary route by which the U.S. population is exposed to mercury.

Mercury is a neurotoxin that interferes with brain and nervous system development and is particularly harmful to developing fetuses, infants and children. A growing body of research links consumption of mercury-contaminated fish during pregnancy to abnormal neuro-development in offspring. A European study of 800 mother/child pairs correlated elevated mercury exposure during pregnancy with lower scores on tests that assessed motor function, attention and verbal acuity in offspring (Debes et al 2006).

The U.S. safety standard for methylmercury is 5.8 ppb in blood during pregnancy. This level was established to protect the fetus from mercury's adverse effects on the brain and nervous system. Although the government has not yet set a safe level to protect non-pregnant adults, the National Academy of Sciences has found that mercury-driven risks for immune disorders and cardiovascular disease may occur at even lower levels than those associated with brain impairment (National Academies Press 2000).

Dioxins and furans (chlorinated and brominated)

Key findings:

- Chlorinated dioxins and furans found in 10 of 10 cord blood samples.
- Brominated dioxins and furans found in 4 of 10 samples.
- First reported detection of hexachlorodibenzodioxin (1,2,3,7,8,9-HxCDD), octabromodibenzofuran (1,2,3,4,6,7,8,9-OBDF) and pentabromodibenzodioxin (1,2,3,7,8-PBDF)

What are they? – Dioxins and furans are contaminants in brominated flame retardants used in foam, pads, furniture, and other products. They also occur as byproducts of incineration of plastics treated with brominated flame retardants.

How do they contaminate cord blood? – Dioxins and furans enter the body from contaminated air, food and water.

Health risks – The state of California considers chlorinated dioxins and furans to be known human carcinogens. Animal studies suggest other health risks, including endocrine disruption and immune suppression.

Regulatory status - Most dioxins and furans enter the environment as byproducts of industrial activities. EPA restricts industrial emissions of dioxins and furans. The agency reports that these restrictions have reduced emissions by 90 percent since the 1980's.

Discussion:
Chlorinated and brominated dioxins and furans pollute the environment as byproducts of incineration and other industrial processes. They have been found in air, soil, food and drinking water. They accumulate in fish and fatty foods such as milk, meats and dairy products. Contaminated food is thought to be the primary route of exposure among Americans.

Animal studies have linked some dioxins and furans to developmental and reproductive toxicity (FDA 2002). German scientists studying 104 mother/child pairs correlated maternal concentrations of chlorinated dioxins and furans with cord blood levels of testosterone and estradiol (Cao 2008) and found that infants born to mothers with elevated blood levels of chlorinated dioxins and furans in breast milk had lower cord blood levels of estradiol and testosterone. Fetuses and infants need adequate levels of testosterone and estradiol for normal reproductive system development.

Polybrominated diphenyl ether (PBDEs) brominated fire retardants

Key findings:
- First detection of PBDE-75 and PBDE 181 in cord blood.

What are they? - PBDEs are flame retardants in electronics, fabric, foam, furniture and plastics.

How do they contaminate cord blood? - PBDEs gradually migrate out of consumer products, contaminating house dust. Meat, poultry, dairy products and fish are sometimes contaminated by processing and packaging.

Health risks - Animal studies have associated PBDEs with disruption of thyroid hormone balance and behavioral changes. PBDEs are considered developmental neurotoxins and can interfere with formation of thyroid hormones critical to fetal and infant brain development.

Regulatory status - Two types of PBDEs, octa and penta, have been phased out of use due to toxicity concerns. Another type, deca, is still widely used, but several states are considering restricting its use.

Discussion:
Although octa and penta-PBDEs have been phased out, all 10 cord blood samples in this study tested positive for penta and six of 10 for octa.

The sources of this contamination may be older foam furniture and plastic components of electronics such as televisions and computers manufactured before the phase-out but still in use in many American homes. Some imported products still contain PBDEs.

These chemicals interfere with the thyroid gland, which controls metabolism and growth. Because thyroid hormones control brain development, PBDEs may affect children's cognitive abilities and behavior. They may also contribute to thyroid disease in adults.

PBDEs accumulate in fatty tissues and can remain in the body for years. They have been found in breast milk. An EWG study tested the blood of 20 mother/child pairs for PBDE and found that on average, each toddler had three times the PBDE levels of his or her mother. Investigators theorize that the children ingested more PBDE-tainted house dust as they played on the floor and placed their hands and toys into their mouths (EWG 2008).

In 2003, European authorities banned two of the most toxic PBDE commercial mixtures because of concerns over their ubiquity in human blood and breast milk: penta (predominantly containing chemicals called PBDE-99 and PBDE-47) and octa (predominantly comprising PBDE-183). In 2005, U.S. manufacturers stopped selling penta and octa, but furniture and other goods permeated with these substances can still be found in many U.S. homes.

Deca-PBDE continues to be in widespread use in the U.S. Deca shares some toxicity characteristics of penta and octa and can break down into those chemicals. Maine and Washington have restricted deca use, and similar bills have been introduced in several other state legislatures.

PCBs (polychlorinated biphenyl ethers)

Key findings:
- PCBs found in all 10 newborns tested
- First reported detection in U.S. newborns of five PCBs - PCB-7, PCB-43, PCB-55, PCB-144, PCB-181. Testing also detected three PCB mixtures: PCB-134/143, PCB-107-124, PCB-139-140.

What are they? - There are more than 200 PCB chemicals. Some are thin, light-colored liquids, others are yellow or black waxy solids. PCBs have been used in many industrial applications, including as transformer insulators and fire retardants, and in pesticides, paints, plastics and caulk. Manufacturers made more than 1 billion pounds between 1929 and 1976, when Congress passed legislation effectively banning PCBs. EPA classifies PCBs as probable human carcinogens, and many studies have shown that they damage the developing brain.

How do PCBs contaminate cord blood? - primarily through food. PCBs enter the food chain in various ways, including migration from packaging, contamination of animal feed and accumulation in fatty tissues of animals.

Health risks - PCBs have been classified as probable carcinogens and are known to be toxic to the immune, nervous and endocrine systems.

Regulatory status - Although Congress voted to ban PCB's in 1976, they are still found in older electrical equipment, in soil, air and water, in toxic waste sites and in some meat.

Discussion:
The United States banned the manufacture of polychlorinated biphenyl ethers (PCBs) in 1979, but these once-widely used, man-made and highly persistent organic chemicals continue to be found in the environment worldwide. EWG's cord blood study found PCBs in all 10 minority newborns tested.

PCBs are synthetic chemicals formerly used in electrical, heat transfer and hydraulic equipment; as plasticizers in paints, plastics, and rubber products; and in many other industrial products (EPA 2009b). In the United States, more than 1 billion pounds of PCBs were produced from 1929 until they were banned under the Toxic Substances Control Act in 1976.

Due to their extensive use and uncontrolled disposal, PCBs still contaminate waterways and soils, the food supply and people's bodies. They are found in older electrical transformers, capacitors and coolers (EPA 2009c). The EPA is struggling to deal with PCB-containing equipment and multiple hazardous waste sites that leach PCBs. The chemicals have been found in at least 500 of the 1,598 hazardous waste sites identified by the EPA (ATSDR 2000).

Since the 1970s, scientists have been aware of PCB toxicity to the immune, nervous, and endocrine systems. Animals exposed to PCBs develop liver cancer. In occupational studies, workers exposed to PCBs had increased mortality from several kinds of cancer, including of the liver and biliary tract. The EPA and the International Agency for Research on Cancer (IARC) have declared that PCBs are probably carcinogenic to humans (ATSDR 2000). In recently published human studies, PCBs have been also associated with an elevated risk of breast (Brody 2007) and prostate cancer (Prins 2008), possibly due to effects on the hormonal system and interference with estrogen signaling (Wolff 2008). Three animal studies published this year indicated that low levels of PCB exposure may have greater health effects than higher exposures. Those studies found that low doses hampered animals' ability to swim a maze (Lein et al 2007) and that exposures increased the "excitability" of neurons (Pessah 2009) and interfered with cell-to-cell signaling in the brain (Yang et al 2009).

Food is the main source of exposure for the general population. PCBs enter the food chain by migrating from packaging materials, by contaminating animal feed, by accumulating in the fatty tissues of animals and by other means. Mothers can transfer PCBs to their infants via breast milk (CDC 2005).

PCB levels in human serum (blood) have been declining since the 1970s, according to studies by the Centers for Disease Control and Prevention (Sjodin 2004), but the majority of Americans are still contaminated (CDC 2005; Herbstman 2007) at levels that can have subtle and insidious long-term effects on health, especially for newborns and developing fetuses.

EWG's tests of umbilical cord blood samples found PCB concentrations of 6.2 ng/g on a lipid basis. Scientists from the Harvard School of Public Health and Harvard Medical School have reported that at these concentrations, PCBs are associated with decreased alertness, responsiveness and other attention-associated behavioral measures in infants, including effects on self-quieting and motor control (Sagiv 2009).

Other major epidemiology studies have consistently found that infants and children with higher PCB exposures score lower on numerous measures of neurological function.

Tetrabromobisphenol A (TBBPA), brominated fire retardant

Key findings:
- Found in 3 of 10 cord blood samples

What is it? – TBBPA is a fire retardant found in electronics, carpet padding and plastic casings for televisions and computers. TBBPA can break down into the plastics chemical bisphenol A (BPA), a synthetic estrogen.

How does it contaminate cord blood? – TBBPA is released from electronics and plastics over time. Consumption of contaminated food and, to a lesser extent, house dust contribute to human exposure.

Health risks – can disrupt thyroid hormone balance. Preliminary studies suggest that it may disrupt the immune system.

Regulatory status – TBBPA use is unrestricted in the U.S.

Discussion:
Three of 10 cord blood samples in the current study had measurable amounts of the fire retardant tetrabromobisphenol A (TBBPA) in cord blood, the first report of the chemical in American newborns.
More than 70 percent of electrical and electronic appliances worldwide contain TBBPA bonded to circuit boards or impregnated in plastic (BSEF 2008).

Because of the chemical's prevalence in consumer products, it is implicated in widespread pollution of people and the environment. Scientists have detected it in sewage sludge in Sweden, human fat in New York City residents, breast milk and cord blood in France, in North Sea sediments and in dolphins and sharks from Florida's coastal waters (Cariou et al 2008, Talsness et al 2009).

Little is known about the dangers of TBBPA. In a 2009 review, scientists noted, "There are only a few published studies regarding the toxicology of TBBPA (Talsness et al 2009).

The most consistent toxicity data links TBBPA exposure to thyroid disruption (NIEHS 2009). Some animal studies link TBBPA to adverse effects on the immune and reproductive systems, but the implications for human health are unclear (Birnbaum 2006, Van der Ven 2008). TBBPA can degrade into BPA, an endocrine-disrupting chemical considered a major priority for U.S. researchers.

Tonalide and Galaxolide Musk Fragrances

Key findings:

- Tonalide and/or Galaxolide found in 7 of 10 cord blood samples tested.

What are they? - Tonalide and Galaxolide are synthetic fragrances that mimic musk odor from endangered Asian musk deer. They are members of a large family of natural and synthetic compounds.

How do musks contaminate blood? - Industry uses 9,000 tons of synthetic musks annually worldwide. People absorb musks through the skin, from soap, cosmetics and clothes washed with scented detergent, and by inhalation from perfumes and cologne sprays. Musks contaminate rivers, pollute fish, concentrate in body fat and persist in tissues long after exposure.

Health risks - unknown. Safety in people has never been studied. A few lab studies, which require confirmation, suggest Tonalide and Galaxolide disrupt hormones and damage organisms' defenses, allowing more toxins to seep into body cells. Musks cling to fat in human blood and breast milk (Washam 2005).

Regulatory status - The industry is in rapid transition, perhaps responding to growing evidence of environmental and health risks from older musks. Tonalide is still in widespread use, but Galaxolide is in decline. At least two new musks, Habanolide and Helvetolide, appeared on the market around 2005. Habanolide is now among at least seven widely used musks never tested in people.

Discussion:

EWG's minority cord blood study produced the first documentation of Tonalide and Galaxolide, synthetic musk fragrances, in American babies. Cord blood from 7 of 10 infants tested positive for at least one synthetic musk. Six of 10 samples contained Galaxolide, 4 of 10 contained Tonalide, and three contained both.

Natural and synthetic musk fragrances have a characteristic animal-like scent originally taken from the glands of the Asian musk deer. Many synthetic musks are used to "fix" scented products, slowing down the release of fragrance molecules and extending product life. Some cling to fabric and are used in laundry detergent.

Galaxolide and Tonalide were invented in the 1950s. They became popular in the 1980s when older musks fell out of use because of questions about their toxicity and persistence in the environment. Galaxolide has been produced or imported in quantities of between 1 million and 10 million pounds annually for the past decade. Tonalide was produced or imported in amounts of up to 10 million pounds in 1997, but industry has not reported manufacturing or importing it since then (EPA 2006).

Little is known about the safety of Tonalide and Galaxolide, particularly for exposures in the womb. Recent research has raised environmental concerns. Both are ubiquitous in wastewater and rivers and are toxic to aquatic life. Scientists from the Technical University of Denmark placed small crustaceans called copepods in water contaminated with tiny amounts of Tonalide, Galaxolide and other musks and reported that, "Since the synthetic musks strongly inhibited larval development… at low nominal concentrations, they should be considered as very toxic" (Wollenberger 2003). Their findings and others have overturned presumptions of safety for synthetic musks.

Because of growing concerns over polycyclic musks like Tonalide and Galaxolide, the market is shifting and macrocyclic musks like helvetolide and habanolide are coming into widespread use. Some are now used in amounts exceeding 1 million pounds annually (EPA 2006). They are poorly tested and have never been monitored in human tissues.

Polychlorinated naphthalenes (PCNs)

Key findings:
- Found in 10 of 10 cord blood samples tested
- First detection of PCNs 9, 13, 63

What are they? - found in wood preservatives, varnishes and industrial lubricants and as a byproduct of waste incineration.

How do they contaminate cord blood? - PCNs pollute the environment and have been found in air, sewage sludge, soil, wildlife and fish.

Health risks - Occupational exposure to PCNs has been associated with liver cirrhosis. Animal studies suggest that PCNs may disrupt hormone systems.

Regulatory status - PCNs were phased out of production starting in the late 1970's due to toxicity concerns but still enter the environment as a byproduct of waste incineration.

Discussion:
Polychlorinated naphthalenes were found in all 10 cord blood samples in this study. Structurally similar to dioxins, they accumulate in fatty tissue. They have been found to contaminate breast milk.
A study of workers subjected to high concentrations of PCNs found higher risk of liver disease, especially cirrhosis, after just two years of exposure (Ward 1994). No studies have been conducted of health effects of long term, low level PCN exposure in humans.

Although PCNs were phased out of major production more than 30 years ago, small amounts are still produced for specific industrial applications. Many PCNs persist in the environment for years. The major source of ongoing environmental contamination is waste incineration.

Chemical Mixtures

Biomonitoring research such as EWG's minority cord blood study show that real world exposures do not occur chemical by chemical. Rather, each of us encounters complex mixtures of chemicals. Many of these compounds are associated with a myriad of toxicities. There are little or no data on how chemical mixtures may affect human health.

For example, EWG found 191 individual chemicals in cord blood from Anonymous Newborn #1. Testing each possible combination of these chemicals at a single dose -- first testing them singly and then in pairs, triplets, quadruplets, all the way up to 191 -- would entail a number of tests equal to 649 times 10 to the 30th power. This is nearly a billion times more than the estimated number of stars in the universe (ESA 2009).

It's no wonder, then, that science has yet to understand how chemical mixtures affect our health. New paradigms for studying mixture toxicity may hold greater promise.

THE MIXING BOWL: Newborns are contaminated with an average of more than 100 chemicals known or suspected to cause cancer, birth defects or other health problems

Health Effect	Average no. of chemicals found in 10 minority newborns (range)	Chemical or chemical class	Hazard classification
Neurotoxicity	103 (71-128)	Lead	Known to be neurotoxic to humans (Grandjean and Landrigan 2006)
		Mercury & methylmercury	Known to be neurotoxic to humans (Grandjean and Landrigan 2006)
		Polychlorinated biphenyls (PCBs)	Known to be neurotoxic to humans (Grandjean and Landrigan 2006)
Developmental toxicity	104 (71-129)	Lead	Known to cause developmental toxicity - California Proposition 65
		Mercury & Methylmercury	Known to cause developmental toxicity - California Proposition 65
		Polychlorinated biphenyls (PCBs)	Known to cause developmental toxicity - California Proposition 65

Health Effect	Average no. of chemicals found in 10 minority newborns (range)	Chemical or chemical class	Hazard classification
Cancer	105 (70-130)	Chlorinated dioxins	Known to cause cancer - California Proposition 65
		Chlorinated furans	Known to cause cancer - California Proposition 65
		Hexadioxin (1,2,3,6,7,8-HxCDD)	Probable human carcinogen class B2 - based on sufficient evidence of carcinogenicity in animals - EPA
		Hexafuran (1,2,3,4,7,8-HxBDF)	Known to cause cancer - California Proposition 65
		Hexafuran (1,2,3,6,7,8-HxCDF)	Probable human carcinogen class B2 - based on sufficient evidence of carcinogenicity in animals - EPA
		Lead	Probable human carcinogen class B2 - based on sufficient evidence of carcinogenicity in animals - EPA
		Methylmercury	Known to cause cancer - California Proposition 65
		Perfluorooctanoic acid (PFOA)	Likely human carcinogen - EPA Science Advisory Board
		Polychlorinated biphenyls (PCBs)	Probably carcinogenic to humans group 2A - IARC; Probable human carcinogenic class B2 - EPA; known to cause cancer - California Proposition 65

Source: EWG compilation of chemical classifications published by U.S. Environmental Protection Agency, California Environmental Protection Agency, the European Union Consumer Products Safety and Quality Unit, the International Agency for Research on Carcinogens (IARC) and neurotoxin listings from academic review published in the journal Lancet (references).

Traditional toxicology testing has involved evaluating one chemical at a time at various concentrations to determine its effects on various biological endpoints. Although toxicologists have been aware for decades of the risks posed by exposure to mixtures of chemicals, a 1992 literature review of 151 toxicology papers calculated that 95 percent focused on single chemicals.

Since then, interest in chemical mixtures has grown. Government agencies such as the Agency for Toxic Substances and Disease Registry (ATSDR), the Centers for Disease Control and Prevention (CDC), and the National Institute of Environmental Health Sciences (NIEHS) have convened programs and conferences on this topic. Federal agencies have also started to develop initiatives to help guide researchers studying health effects of chemical exposures (Monosson 2005).

Linda Birnbaum Ph.D., Director of the NIEHS, has called for more research into the impact on human health of mixtures of environmental chemicals. "Some chemicals may act in an additive fashion," she told a Columbia University audience in March 2009. "When we look one compound at a time, we may miss the boat."

In all, EWG's biomonitoring studies have tested 186 individuals (cord blood from newborns and blood and urine samples from older children and adults) for 552 chemicals and have detected more than 414. (The number ranged from 414 to 493 because laboratories could not distinguish between some congeners.)

EWG's new cord blood study amplifies our understanding that the developing fetus is exposed to complex mixtures of potential neurotoxins, endocrine disruptors and carcinogens. Among the chemicals found by EWG are known neurotoxins such as lead and methylmercury, probable endocrine disruptors such as bisphenol A and perchlorate and suspected carcinogens such as PFOA and deca PBDE.

Recent animal studies support the theory that exposures to mixtures of chemicals often result in more significant adverse effects than single chemical exposures. For example, researchers from the Technical University of Denmark and University of London looked at the effects of four hormone disruptors, individually and in combination, on the reproductive systems of male rats. They found that "the effect of combined exposure to the selected chemicals on malformations of external sex organs was synergistic, and the observed responses were greater than would be predicted from the toxicities of the individual chemicals" (Christiansen et al 2009). Researchers at the University of California found that exposure to combinations of pesticides resulted in higher mortality rates among tadpoles than occurred with individual pesticide exposures (Hayes et al).

Physicians know they should scrutinize potential drug interactions closely before starting patients on new medications. Medications in combination can interact with one another, resulting in toxicities that might not occur if they were administered individually. Similarly, environmentally-acquired chemicals may interact to produce toxicities. In addition, exposure to mixtures of chemicals that have similar biological effects or mechanisms of action may result in cumulative or synergistic toxicity.

Epigenetics

Research teams around the world are exploring the mechanisms by which environmental pollutants may trigger genetic changes that can affect a person's health and that, in some cases, may be passed on to future generations.

EWG intends to share its biomonitoring findings with researchers funded by the National Institutes of Health, including projects under the aegis of the NIH Roadmap Epigenomics Program, which plans to distribute $62 million over the next five years for basic research on "epigenetic changes," meaning "chemical modifications to genes that result from diet, aging, stress, or environmental exposures [that] define and contribute to specific human diseases and biological processes."

In September, NIH awarded 22 grants to researchers exploring epigenetic aspects of glaucoma, Alzheimer's disease, hypertension, autism, mental illness, breast cancer, lupus and other serious conditions. Some research under this initiative is investigating how BPA alters body chemistry at the genetic level.

The National Institute for Environmental Health Sciences, meanwhile, has designated BPA a top research priority and has announced plans to spend $30 million over the next two years to study the chemical's impact on human health and the environment. The BPA program is part of a larger NIEHS-backed effort to broaden and deepen scientific understanding of what scientists call the "developmental basis of disease."

Another promising line of research is focusing on environmental factors behind the epidemic of childhood asthma. An April 2009 study by researchers at the Columbia Center for Children's Environmental Health and University of Cincinnati produced evidence that New York City children exposed in utero to high levels of polycyclic aromatic hydrocarbons (PAHs) from vehicular emissions were more likely to develop asthma than other children. The study involved 700 children born to mothers living in traffic-congested New York neighborhoods. By monitoring prenatal air pollution exposures and collecting cord blood and fetal placental tissue, researchers reported a "positive and significant association" among children with asthma between their mothers' high PAH exposures during pregnancy and structural changes called "methylation" in a particular gene under investigation as an epigenetic marker for asthma.

Ultimately, EWG believes that by directing research toward causes and prevention, instead of focusing solely on treatment, scientists may someday be able to avert incalculable human suffering.

Proving Harm at Low Doses

Confronted with studies documenting that hundreds of industrial chemicals are present in the human body, chemical manufacturers and their leading trade association, the American Chemistry Council, resort to the blanket qualifier: the "mere presence of a chemical" does not prove harm. The U.S. Centers for Disease Control and Prevention uses similar language in reporting its own biomonitoring data.

Mere presence does not prove harm, but studies often do. EWG reviewed the published scientific literature relating to cord blood contaminants detected in the current study. Seven relevant studies published between 1997 and 2009 tested 2,151 newborns for six chemicals or chemical families also detected in the current study: mercury, lead, PBDEs, PCBs, PFOS and PFOA. All these studies found that babies with higher exposures were more likely to experience health problems at birth or later in childhood, including low birth weight, damaged hearing or intelligence deficits.

Three animal studies published in 2009 indicated that low levels of PCB exposure may have greater health effects than larger exposures. The studies produced evidence that low doses hampered animals' ability to swim a maze (Lein 2009), increased the "excitability" of neurons (Pessah 2009) and interfered with cell-to-cell signaling in the brain (Pessah 2009).

In a scientific statement on endocrine disrupting chemicals (EDCs) issued in 2009, The Endocrine Society said: "There are several properties of EDCs that have caused controversy. First, even infinitesimally low levels of exposure — indeed, any level of exposure at all — may cause endocrine or reproductive abnormalities, particularly if exposure occurs during a critical developmental window. Surprisingly, low doses may even exert more potent effects than higher doses. Second, EDCs may exert non-traditional dose-response curves, such as inverted-U or U-shaped curves. Both of these concepts have been known for hormone and neurotransmitter actions, but only in the past decade have they begun to be appreciated for EDCs" (Endocrine Society 2009).

Studies find trace chemical exposure in cord blood associated with mental and physical effects at birth and later in childhood.

Cord Blood Contamination and Associated Health Effects

Chemical	Newborns in the study	Amount in cord blood found harmful	Health effect at birth or later in childhood
Scotchgard (PFOS, or perfluorooctane sulfonate)	293 babies born in Baltimore, Md. 2004-2005 (Apelberg 2007)	**> 7.8 ppb** [nanograms per gram (wet weight) in serum]	Reduced birth weight and head circumference, factors associated with effects on intelligence and greater susceptibility to chronic diseases later in life
Teflon (PFOA, or perchlorooctanoic acid)	293 babies born in Baltimore, Md. during 2004-2005 (Apelberg 2007)	**> 2.1 ppb** [nanograms per gram (wet weight) in serum]	Reduced birth weight and head circumference, factors associated with effects on intelligence and greater susceptibility to chronic diseases later in life
Lead	444 babies born 2001-2004 in Krakow, Poland (Jedrychowski 2009)	**>1.81 µg/dL** [micrograms per deciliter (wet weight) in whole blood]	2.3-3.3% reduction in cognitive test scores at age 1 compared to children with cord blood levels <0.91 µg/dL (depending on mother's education level). Deficit in cognitive function was also observed at ages 2 and 3 for these groups of children.
Mercury	Birth cohort study of 1022 babies born 1986-1987, Faroe Is., Denmark, tested at age 7 (Grandjean 1997)	**>13.1-40.8** ppb [micrograms per liter (wet weight) in whole blood], interquartile range for the entire cohort	Children with higher cord blood levels of mercury had lower scores on neurobehavioral tests of attention, memory, and language skills at age 7 than children with lower cord blood mercury levels.
Mercury	Birth cohort study of 1022 babies born 1986-1987, Faroe Is., Denmark, followed up at age 14 (Debes 2006 1997)	**>16.7 ppb** [nanograms per gram (lipid weight) in serum), median level for four PCB congeners: PCB 118, 138/158, 153, and 180]	Children with higher cord blood levels of mercury had lower scores on neurobehavioral tests of motor function, attention and verbal acuity at age 14 than children with lower cord blood mercury levels.

Chemical	Newborns in the study	Amount in cord blood found harmful	Health effect at birth or later in childhood
PCBs (Polychlorinated biphenyls)	297 babies born in Baltimore, Md. in 2004-2005 (Herbstman 2008)	**>16.7 ppb** [nanograms per gram (lipid weight) in serum), median level for four PCB congeners: PCB 118, 138/158, 153, and 180]	Decreased levels of thyroid hormone, necessary for normal brain development, found in newborn infants with higher levels of four PCB congeners (PCB 118, 138/158, 153, and 180).
PBDEs (polybrominated biphenyl ethers)	297 babies born in Baltimore, Md. in 2004-2005 (Herbstman 2008)	**>18.7 ppb** [nanograms per gram (lipid weight) in serum], median level for three PBDE congeners (BDE-47, BDE-100, and BDE-153).	Decreased levels of thyroid hormone, necessary for normal brain development, found in newborn infants with higher levels of three PBDE congeners (BDE-47, BDE-100, and BDE-153).
PCBs (polychlorinated biphenyls)	542 babies in New Bedford, Mass., born 1993-1998 (Sagiv 2008)	**>0.3 ppb** [nanograms per gram (lipid weight) in serum]	Decreased alertness, responsiveness, and other attention-associated behavioral measures in infants with overall levels of four PCB congeners (PCBs 118, 138, 153, and 180) above 0.3 ppb

Descriptions of Studies Showing Health Harm Related to Cord Blood Pollutants

Scotchgard (PFOS, or perfluorooctane sulfonate) – Apelberg (2007)
Scientists at Johns Hopkins University studied the relationship between cord blood concentration of Teflon (PFOA) and Scotchgard (PFOS) and birth weight, head circumference and gestational age in 293 infants born in Baltimore, Md. They found that newborns with higher exposures to PFOA and PFOS had statistically significant decreases in head circumference and birth weight compared to those who had lower cord blood concentrations of the chemicals (Apelberg 2007). Compared to newborns with 3.4 ppb of PFOS (the 25th percentile) in their cord blood, infants with 7.9 ppb of PFOS (the 75th percentile) had a 0.27 cm (0.8 percent) decrease from mean head circumference, a 58 g (1.8 %) decrease from mean body weight and 0.062 (2.4%) decrease from mean Ponderal Index (a measure of body size, expressed in g/cm3 x 100). Lower birth weight and smaller head circumference at birth are associated with greater susceptibility to chronic diseases later in life and effects on intelligence (Lau 2004; Schlotz 2009). [Full ref. Lau C, Rogers JM. 2004. Embryonic and fetal programming of physiological disorders in adulthood. Birth Defects Res C Embryo Today 72(4): 300-12. Schlotz W, Phillips DI. 2009. Fetal origins of mental health: evidence and mechanisms. Brain Behav Immun 23(7): 905-16.]

Teflon (PFOA, or Perfluorooctanoic acid) – Apelberg (2007)
This study by scientists at Johns Hopkins University is described above (Abelberg 2007). Compared to infants with up to 1.2 ppb (the 25th percentile) PFOA in their cord blood, newborns with 2.1 ppb of PFOA (the 75th percentile) had a 0.23 cm (0.6%) decrease from mean head circumference, a 58 g (1.8%) decrease from mean body weight and a 0.039 (1.5%) decrease from mean Ponderal Index (a measure of body size, expressed in g/cm3 x 100).

Lead (Jedrychowski 2009)
Lead is an extensively studied neurotoxicant whose adverse effects on cognitive performance are well established. A new study published this year found that extremely low levels of lead in cord blood are associated with impaired cognition in young children (Jedrychowski 2009). Polish researchers found a strong connection between levels of lead in cord blood at birth in 444 children and cognitive performance when they reached 12, 24 and 36 months of age. The researchers used the standard Bayley Scales of Infant Development MDI test, which measures habituation, problem solving, early number concepts, generalization, classification, memory, vocalization, language and social skills. The median level in cord blood was one-tenth the current U.S. standard for young children. The lead levels we measure in minority newborns were about half of the typical level in the Polish children. Researchers found a decline in cognitive function of about 6 points on the Bayley Mental Development Index for every 10-fold increase in cord blood level concentrations.

Methylmercury (Debes 2006)
Researchers at Harvard University and the Faroese Hospital System, Faroe Islands, Denmark, measured mercury concentrations in cord blood, cord tissue and maternal hair in 878 mother-child pairs at birth and correlated prenatal mercury exposure with performance on neurobehavioral tests at ages seven and 14. The researchers found that infants with higher exposure to mercury during the prenatal period had lower scores on the tests, which assessed motor function, attention and verbal acuity compared with newborns who had lower exposures (Debes 2006). Mercury has long been established as a neurotoxin, especially when exposure occurs during pregnancy. In the U.S., exposure to mercury occurs primarily through consumption of contaminated seafood.

Mercury (Grandjean 1997)
Scientists at Odense University, Denmark studied a group of 917 seven-year-old children in the Faroe Islands The study found that mercury concentrations of 46-79 ppb in maternal blood were associated with doubling of the number of children who perform below the 5th percentile for neruropsychological effects (Grandjean 1997).

PCBs (Herbstman 2008)
Scientists at Columbia and Johns Hopkins universities measured levels of cord blood thyroid hormone at birth relative to levels of PCBs and PBDEs in 297 newborns delivered at the Johns Hopkins Hospital (Baltimore). Researchers found that infants with higher cord blood concentrations of PCBs and PBDEs had statistically significant decreases in thyroid hormone levels compared with newborns who had lower levels of these two classes of chemical pollutants (Herbstman 2008). Adequate thyroid hormone levels during pregnancy and infancy are necessary for normal brain development; research has shown that even minor decreases in thyroid hormone levels during these critical periods can have long-term ill effects (Zoeller 2002, Ginsberg 2007).

PBDEs (Herbstman 2008)
This study by scientists at Johns Hopkins University and Columbia University is described above (Herbstman 2008). Researchers found that newborns with higher cord blood concentrations of PBDEs and PCBs had statistically significant decreases in thyroid hormone levels compared with those who had lower levels of these two classes of chemical pollutants. These associations occurred only in infants born by spontaneous vaginal delivery; other birth modes result in stress-induced changes in thyroid hormone levels, thereby potentially masking effects associated with PBDEs. Adequate thyroid hormone levels during pregnancy and infancy are necessary for normal brain development; research has shown that even minor decreases in thyroid hormone levels during these critical periods can have long-term ill effects (Zoeller 2002, Ginsberg 2007). The newborns in EWG's cord blood study had slightly lower PBDE levels than infants in the Baltimore study. PBDEs were widely used as flame retardants in consumer products. The two most commonly used forms, Octa and Penta, are now banned in the U.S., but Deca PBDE is still in widespread use. PCBs were banned in the 1970's due to their toxicity and persistence in organisms and the environment.

PCBs (Sagiv 2008)
A study by scientists at the Harvard School of Public Health has strengthened the link between fetal exposure to PCBs and behavioral effects in childhood, such as inattention. Study participants were 542 infants from a birth cohort whose mothers resided adjacent to a PCB-contaminated harbor in New Bedford, Mass. between 1993 and 1998. Researchers found that serum PCB levels above the median of 0.3 ppb (on a total serum basis) were associated with decreased alertness, responsiveness and other attention-associated behavioral measures, including self-quieting and motor control in infants tested two weeks after birth. The authors stated that this observation was "particularly notable given … the low-level PCB exposure in [the] study population" (Sagiv 2008).

Vulnerability Early in Life

During pregnancy, the placenta transfers nutrients from the mother's circulation to the fetus and returns waste products from the fetus to the mother to be excreted. Numerous studies have shown that the placenta does not, as once thought, shield the fetus from chemicals and pesticides carried in the mother's body (Barr 2007, EWG 2005, Bearer 1995, Guvenius 2003, Tittlemier 2004, Sandau 2002).

In utero exposures are particularly worrisome because of the unique vulnerabilities of the fetus (Grandjean and Landrigan 2006). Studies have shown that exposure to toxic chemicals during critical windows of development can result in permanent and irreversible brain and organ damage (Barr 2007).

There are several reasons for the greater vulnerability of the developing fetus:

- A developing child's chemical exposures are greater pound-for-pound than those of adults.
- The blood-brain barrier, which prevents many harmful substances from entering the brain, is not fully developed until after birth (Rodier 1995).
- The fetus cannot detoxify and excrete many chemicals as completely as an adult (Birnbaum 2003).
- Fetal blood contains lower levels of some proteins that bind to harmful chemicals and neutralize them. As a result, fetal blood can contain higher levels of unbound, biologically active chemicals than the mother's blood (Koren 1990).
- The fetus undergoes rapid cell division, proliferation and differentiation in utero, making its developing cells particularly sensitive to chemical exposures (Birnbaum 2003).

Fetal exposures to industrial chemicals can result in immediate harm to the developing brain and other organ systems, but some adverse effects may not manifest themselves for years or decades. Scientists refer to this phenomenon as the "fetal basis of adult disease," a term coined by British researcher David Barker. He found that newborns malnourished during pregnancy had higher rates of heart disease and diabetes later in life than well-fed infants(NIEHS 2008).

This phenomenon has also been seen as a result of chemical exposures, including to mercury (NIEHS 2008). Scientists now consider it prudent to assume that the environment in which the fetus develops has long-term health repercussions and that harmful exposures during pregnancy can lincrease the later incidence of certain diseases or medical conditions (Basha 2005, Anway 2005).

Minority Children and Chemical Risks

Minority communities often experience high exposures to toxic chemicals

The newborns in the current study are anonymous, and we have no evidence that they were born into homes and neighborhoods with unique amounts of contaminants. But a large body of research has found that certain minority groups are at particular risk from chemical exposures, simply because of where they live or work.

A number of body burden studies have identified "hot spots" -- polluted communities -- where residents have elevated levels of industrial chemicals. CDC's massive NHANES (National Health and Nutrition Examination Survey) survey series, which examines pollution exposures in the general population, has identified some general differences in pollution exposures for racial and ethnic groups. Academic studies have also investigated this issue.

Some notable trends:

- African American children ages one to five have 64 percent higher geometric mean levels of lead exposure than white children. They were also 2.8 times more likely to have elevated blood lead levels than white or Mexican American children (3.4 percent vs. 1.2 percent) (Jones 2009).
- Mercury levels in women of childbearing age are highest for Asian American, Native American, Pacific Islander, and Caribbean (Hispanic Black) populations, with many more women of childbearing age exceeding health-based levels (Mahaffey 2009).

Farmers and farm workers, who in the U.S. are often Latino, have higher exposures to a variety of pesticides, including some that can impair brain development. Children born to women in agricultural communities have high levels of pesticide exposures in utero. (Eskenazi 2008).

African Americans and Mexican Americans have higher levels of two phthalates than non-Hispanic whites. Phthalates are widely used in consumer and personal care products.

Mexican Americans have higher levels of PBDE-47, a fire retardant (Sjodin 2008).

There are several important reasons why minority populations, especially those living in poorer communities, experience higher exposures to environmental pollutants. For one thing, hazardous waste sites and other polluting facilities are more likely to be deliberately placed near communities of color and low-income communities than near more affluent neighborhoods (Brulle and Pellow 2006).

The sociologist Robert Bullard noted in his watershed book *Dumping in Dixie* that communities of color are deliberately and consistently sought out for toxic dumping. The proximity of these toxic facilities can result in heavily polluted local environments. Residents of "fenceline" communities, so-called because they border toxic industrial facilities, are often exposed to outsized concentrations of pollutants.

Some minority populations reside in poorer urban neighborhoods that are congested and close to busy roads. Their homes may be older and deteriorating and have pest infestations. Exposure to lead, indoor and outdoor air pollutants and soil pollutants have all been found to be higher in minority populations who live in congested urban neighborhoods (Frumkin 2005).

Some minority groups are also exposed to toxic chemicals through employment in hazardous industries. The National Institute of Occupational Safety and Health (NIOSH) reports that 84 percent of the 2 million U.S. farm workers are of Latino heritage. Many of these workers are Spanish speakers and cannot understand English instructions on the proper use and disposal of chemicals. Others lack protective gear. Many workers fear retribution if they report violations of laws governing occupational hazards.

Some farm workers unintentionally expose their families to toxic chemicals by coming home wearing clothing contaminated with pesticides (NIOSH). In addition, the National Center for Farmworker Health estimates that up to 300,000 children are directly employed in the agricultural sector every year (NCFH).

EPA estimates that there are currently 155,000 nail salon workers in the U.S., the majority of whom are Asian women, especially of Vietnamese origin. The nail polishes and solvents used in these salons often contain known endocrine disruptors and carcinogens. Many salon owners do not provide adequate protective gear and ventilation (EPA 2008). Surveys of nail salon workers have found that they experienced more rashes, headaches and breathing problems after they began working at the salons (Quach 2008).

Residents of urban neighborhoods often lack access to high-quality, affordable fresh fruits and vegetables. Many of these neighborhoods often only have small markets that stock processed foods, alcohol and tobacco products. (Frumkin 2005).

Dr. Jane Hightower of the California Pacific Medical Center and coauthors found that 27 percent of study participants who self-identified as Asian, Pacific Islander, Native American or multiracial had elevated mercury levels, while only 10.8 percent of participants from other ethic groups had unsafe levels.

The primary source of mercury exposure in the U.S. is contaminated seafood. High mercury levels, especially during pregnancy, affect the development of the brain and nervous system. In adults, high mercury levels have been associated with cardiac disease and neurological problems (Hightower 2006).

Researchers at the University of Pittsburgh Center for Environmental Oncology have found that African American women use more personal care products that contain hormone disruptors than other populations. The researchers hypothesized that these products may contribute to decreasing age of puberty and increased rates of pre-menopausal breast cancer among African American girls and women (Donovan 2007).

It is clear that minority populations in the U.S. have higher exposures to many chemical pollutants. In recognition of the growing problem of environmental inequality, in 1994 President Clinton issued Executive Order 12898, requiring federal agencies to incorporate environmental justice considerations into their programs.

But that initiative withered once Clinton left office. A 2004 report by the EPA Office of Inspector General (OIG) concluded that during the Bush administration, the agency had failed to consider environmental justice issues sufficiently when setting policies and regulations (EPA 2004).

In a 2006 report, the OIG recommended that the EPA conduct environmental justice reviews of its existing programs and develop protocols to "make environmental justice policies a priority" (Obama-Biden 2008). In November 2009, EPA Administator Lisa Jackson recruited two seasoned advisors to advance the adgency's environmental justice and civil rights agenda.

Appendix A: Methodology

Cord blood sample acquisition: The Environmental Working Group contracted with Cryobanks International, an organization that specializes in collecting and storing umbilical cord blood, to obtain cord blood from 10 newborns of minority background, born between December 2007 and June 2008. EWG obtained no identifying information other than racial or ethnic identity. Samples consisted of a minimum of 90 milliliters (mL) of cord blood and 35 ml of citrate-phosphate-dextrose (CPD) anticoagulant in a 250 mL Baxter Fenwal Blood-Pack unit (Baxter Healthcare Corporation, Deerfield, IL). The 35 mL of CPD anticoagulant consisted of 921 mg sodium citrate, 893 mg dextrose, 105 mg citric acid, and 78 mg monobasic sodium phosphate. Samples were frozen upon collection at -20 degrees Celsius and shipped from the hospital where they were obtained to Cryobank's international headquarters in Altamonte Springs, Florida.

Cryobanks repacked the samples with gel ice packs and shipped them to AXYS Analytical Services (Sydney, British Columbia). Samples were stored at AXYS at 4 degrees Celsius until the last one was collected in June 2008.

Sample preparation: AXYS took multiple sub-samples of blood for secondary laboratory analyses (musks, perchlorate, bisphenol A and metals) and AXYS analyses of DX/Fs, PCBs, PBDEs, BrDX/F, PCNs, PFCs and TBBPA). Blood collection bags containing just anticoagulant were submitted to each lab for analysis. Sub-samples were stored at -20 degree Celsium prior to secondary labs shipments or prior to extraction and analysis for the PFC/TBBPA portion at AXYS.

Sample extraction: Samples were analyzed in two batches. Each batch had its own QC including a procedural blank and a spiked matrix sample. An empty blood bag proof extract was prepared with a water/ethanol mixture added to the bag and collected. This extract was split into two equal portions to be analyzed with each batch.

Analysis of Chlorinated Dioxins and Furans: AXYS method MLA-017: Samples were spiked with a suite of isotopically labeled PCDD/F surrogate standards prior to analysis, then solvent extracted and cleaned up on a series of chromatographic columns. The extract was concentrated and spiked with an isotopically labeled recovery (internal) standard. Analysis was performed using a high-resolution mass spectrometer coupled to a high-resolution gas chromatograph equipped with a DB-5 capillary chromatography column (60 m, 0.25 mm i.d., 0.1 um film thickness). All procedures were carried out according to protocols as described in EPA Method 1613B, with some additional internal AXYS guidelines applied.

Analysis of Brominated Dioxins and Furans: AXYS method MLA-024: Samples were spiked with a suite of isotopically labeled PBDD/F surrogate standards prior to analysis, then solvent extracted and cleaned up on a series of chromatographic columns. The extract was spiked with isotopically labeled recovery (internal) standards prior to analysis by high-resolution mass spectrometer (HRMS) coupled to a high-resolution gas chromatograph (HRGC) equipped with a DB-5HT capillary chromatography column (20 m, 0.25 mm i.d. x 0.1 um film thickness). To minimize photo-degradation of the PBDD/F's, manipulations and analysis of samples and standards were conducted using low light levels and aluminum foil was used to provide protection from ambient lighting.

Analysis of Polychlorinated Biphenyls (PCBs): AXYS method MLA-010: Samples were spiked with isotopically labeled PCB surrogate standards prior to analysis, then solvent extracted and cleaned up on a series of chromatographic columns. The final extract was spiked with isotopically labeled recovery (internal) standards prior to instrumental analysis. Analysis of the extract was performed on high-resolution mass spectrometer (HRMS) coupled to a high-resolution gas chromatograph (HRGC) equipped with a SPB-Octyl chromatography column (30 m, 0.25 mm i.d., 0.25 µg film thickness). The method was carried out in accordance with the protocols described in EPA Method 1668A with some additional internal AXYS guidelines applied.

Analysis of Brominated Diphenylethers (PBDEs): AXYS method MLA-033: Samples were spiked with isotopically labeled BDE surrogate standards prior to analysis, then solvent extracted and cleaned up on a series of chromatographic columns. The final extracts were spiked with isotopically labeled recovery (internal) standards prior to instrumental analysis. Analysis of extracts was performed on a high-resolution mass spectrometer (HRMS) coupled to a high-resolution gas chromatograph (HRGC) equipped with a DB-5HT chromatography column (30 m, 0.25 mm i.d., 0.10 um film thickness). The method was carried out in accordance with the protocols described in EPA Method 1614 with some additional internal AXYS guidelines applied.

Analysis of Polychlorinated Naphthalenes (PCNs): AXYS method MLA-030: Samples were spiked with isotopically labeled PCN surrogates prior to analysis, then solvent extracted and cleaned up on a series of chromatographic columns, done using a solvent extraction procedure. The final extracts were spiked with isotopically labeled recovery (internal) standards prior to instrumental analysis. Analysis of extracts were performed on a high-resolution mass spectrometer (HRMS) coupled to a high-resolution gas chromatograph (HRGC) equipped with a DB-5 chromatography column (30 m, 0.25 mm i.d., 0.10 um film thickness).

Calculations for Dioxin, Furans, PCBs, PBDEs, and PCNs: Target concentrations for each analysis were determined by isotope dilution or internal standard quantification procedures using Micromass OPUSQUAN and/or MassLynx software. Sample specific detection limits (DL's) were determined from the analysis data by converting three times the height of the average noise signal to a response, using the area/height ratio of the labeled standard, and then to a concentration following the same procedures used to convert target peak responses to concentrations. If the OPUSquan or MassLynx software selected an unrepresentative area for the detection limit calculation, the data interpretation chemist or the QA chemist made corrections.

Analysis of Perfluorinated Chemicals (PFC) and Tetrabromobisphenol-A (TBBPA)- AXYS method MLA-049/042 and AXYS Method 4226: Samples were spiked with isotopically labeled PFC and TBBPA surrogate, extracted in acetonitrile, cleaned up on SPE cartridges, split into two portions (1) PFC and (2) for TBBP-A and submitted for separate instrumental analysis runs. Samples were analyzed by liquid chromatography/mass spectrometry (LC-MS/MS). Analysis of sample extracts for perfluorinated organics was performed on a high performance liquid chromatograph column (Agilent Zorbax XDB Reverse phase C18, 7.5cm, 2.1mm i.d., 3.5 um particle size or equivalent) coupled with a triple quadrupole mass spectrometer, running MassLynx v.4.0 software. Final sample concentrations were determined by isotope dilution/internal standard quantification against matrix calibration standards carried through the analysis procedure alongside the samples.

Calculations for PFCs and TBBPA: Target concentrations for each analysis were determined by isotope dilution or internal standard quantification procedures using Micromass MassLynx software. Sample specific detection limits (DL's) were determined from the analysis data by converting three times the height of the average noise signal to an area using the area/height ratio of the labeled standard, and then to a concentration following the same procedures used to convert target peak responses to concentrations. If the MassLynx software selected an unrepresentative area for the detection limit calculation, the data interpretation chemist or the QA chemist made corrections. Reporting limits were equal to the greater of the lowest calibration standard concentration equivalent or the sample specific detection limit (SDL).

Analysis of Lead: Whole blood samples were diluted 50x with a one percent HNO3. Digests are analyzed using Inductively Coupled Plasma: Mass Spectrometry (ICP-MS) for the analysis of Lead (Pb). Results were blank corrected as per Brooks Rand SOPs for EPA 1638 Modified method.

Analysis of Total Mercury: All samples were prepared and analyzed in accordance with the Appendix to EPA Method 1631E. Blood samples were first digested with nitric acid/sulfuric acid (HNO3/H2SO4) and further oxidized with bromine monochloride (BrCl). All samples were analyzed with stannous chloride (SnCl2) reduction, gold amalgamation and cold vapor atomic fluorescence spectroscopy (CVAFS) using a BRL Model III CVAFS Mercury Analyzer. Summarized sample results were blank corrected as described in EPA Method 1631 E.

Analysis of Monomethyl Mercury: Blood samples were prepared by potassium hydroxide/ methanol (KOH/MeOH) digestion followed by distillation. All samples were analyzed by aqueous phase ethylation, Tenax trap collection, gas chromatography separation, isothermal decomposition, and cold vapor atomic fluorescence spectrometry (CVAFS). The samples were analyzed by a modification of EPA Draft Method 1630, as detailed in the BRL SOP BR-0011. All results were blank corrected as described in the method.

Analysis of Bisphenol A: Blood samples were analyzed for bisphenol A (BPA) by HPLC with CoulArray detection. The standard curve in our assay ranges from 0.05 – 4 nanograms per HPLC run. Values below and above the range of the standard curve are outside the limit of quantitation (LOQ) of the assay, and these values are indicated by asterisks. These estimated values are different from samples labeled as "non detectable (ND)", where there was no evidence for the presence of BPA in the sample. For concentrations below this limit of quantitation (LOQ), a value equal to the LOQ divided by the square root of 2 was substituted for the estimated value (Hornung and Reed 1990; Calafat, 2008.)

In more detail, two separate measurements were made for each sample. The samples were first extracted with methyl tert-butyl ether to remove free (unconjugated) BPA. The sample remaining after extraction was then treated with glucuronidase and sulfatase to deconjugate glucuronides and sulfates, and then re-extracted. Bisphenol A was quantified using HPLC with CoulArray detection. Aliquots of human serum (from Fisher Scientific), either untreated or spiked with BPA, were run as recovery controls for serum extractions. Additional recovery estimates were made for blood samples using spiked aliquots of the samples provided. An aliquot of the travel blank was extracted in the same way as the serum and blood samples. The blood bag was filled with HPLC-grade water, and a sample of the water was extracted in the same way as the serum and blood samples.

Analysis of Musks: Each sample is weighed into a clean glass 60 ml vial. Methanol, 0.1 M HCI and a set of internal standards (one or more for each group of chemicals) is added to the sample. The sample is extracted three times with a hexane-diethyl ether mixture and centrifuged after each extraction to separate the organic phase. The combined extracts are washed with a 1 percent KCI-solution and dried with anhydrous sodium sulphate. The serum extract is concentrated to a small volume and purified using a florisil clean-up procedure. The purified extracts are concentrated to a small volume and an injection standard is added. The final extracts are analyzed with gas chromatography coupled with mass spectrometry (GC/MS) in the selected ion monitoring mode (SIM). The identification of analytes is based on correct retention times and/or qualifier ion ratios, compared to an external standard. The quantification was based on an external standard analyzed together with the samples. The recovery of added internal standards (musk xylene-d 15 and Tonalide-d3) were used to determine the performance of the analysis, but not to correct the results of the target compounds. The results are expressed in ng/g matrix. The matrix is blood.

Analysis of Perchlorate: Blood samples were spiked to a final concentration of 1 ppb with an isotopically labeled perchlorate internal standard. 2.5 ml of blood sample was diluted with 2.5 ml DI water and each sample was placed in the top portion of an Amicon Ultra 15 centrifugal filter device and centrifuged at 5000 rpm at 20C for 90 min. The resulting liquid that passed through the filter was added to 0.5 g of Amberlyst 15 cation exchange resin that was pre-washed with methanol and water. Sample was vortexed for 60 seconds. Liquid sample was passed through a 0.45 um syringe filter and placed into an autosampler vial for analysis. Samples were analyzed using IC-MS/MS using Dionex AS-16 (2mm x 250 mm) column with AG-16 guard column. A Quantum Discovery Max ESI-MS with HESI probe was used in the MS/MS mode for quantification.

QA/QC: All organic analyses were conducted in accordance with AXYS' accredited QA/QC program including regular analysis of QC samples and participation in international inter-laboratory comparison programs. Each analysis batch included a procedural blank to demonstrate cleanliness and a spiked laboratory control sample to monitor precision and recovery. The sample results were reviewed and evaluated in relation to the QA/QC samples worked up at the same time. The sample surrogate standard recoveries and detection limits, procedural blank data and the laboratory control sample data were evaluated against method criteria to ensure acceptable data quality.

We analyzed two background samples for each of the contaminants studied. One was an in-laboratory blank, and the other an empty blood bag with added anticoagulant.

We applied the following criteria to account for background contamination:

1. If the two background tests were non-detects, we simply used the reported result for that sample.
2. If either of the background samples had detected contamination we counted the detection as a hit if it were at least 20 percent over the larger background value and at least three times the detection limit for the particular test.

The laboratory flagged some values for not meeting certain analytical criteria. These related to ion abundance ratios and the method calibration limit. We used these values but note the data quality flags in the data section of our Human Toxome website.

The number of chemicals detected is reported as a range due to the co-eluting chemicals in the PCB, PBDE and PCN families. The minimum value counts each co-eluting value as only one chemical, and the maximum value in the range counts each of the co-eluting chemicals.

Chemicals in cord blood -- literature review
We searched the published literature for chemicals detected in umbilical cord blood samples. We used two publicly available search engines: NIH-sponsored PubMed and Google Scholar. We queried a variety of search terms including “cord blood,” “umbilical cord,” “contaminants,” “xenobiotic” and “toxic.” We also did a targeted search for individual chemicals, chemical families and categories like “pesticides.” In addition to scientific publications we included a several conference abstracts and NGO reports (white papers) that reported unique chemicals in cord blood.

We did not include essential trace elements (such as zinc, manganese, magnesium), but included natural elements that can be toxic. We also excluded pharmaceutical drugs. We also excluded chemicals detected in other biological media: maternal blood or urine during pregnancy, follicular or amniotic fluid, meconium, infant urine or DNA adducts from our analysis.

For each study we cataloged information about the study location, population, time of sample collection and the full reference for the study.

Chemicals were not included in our review unless the specific chemical names were mentioned in the text or supplemental materials, and it was clear that the chemical was detected in at least one sample. This may under-represent some trace chemicals, especially in the PCB, Dioxin, Furan and PBDE families, since scientists many times do not name and quantify the detections for trace congeners. Instead researchers may report the total measurements by chemical family or use a TEQ (toxicity equivalent factor) to sum up overall toxicity of detected chemicals.

Appendix B A Review of All U.S. Cord Blood Contaminant Studies

The Centers for Disease Control and Prevention (CDC) calls biomonitoring measurements "the most health-relevant assessments of exposure" for their ability to define precisely "the amount of chemicals that actually enter people's bodies" (CDC 2009). The agency devoted $13.8 billion to its biomonitoring programs in 2009 alone and has launched a significant new national children's study that initially will test 525 pregnant women and their babies for a broad range of pollutants.

CDC rarely tests cord blood, even though it has acknowledged that "for children age 5 years and younger, minimal information exists on exposure to priority environmental chemicals, and this lack of information is a major gap in protecting children from harmful exposures."

EWG set out to address this gap, focusing on exposures for newborns. EWG researchers conducted a comprehensive survey of the published scientific literature, identifying every study in which scientists tested umbilical cord blood for industrial chemicals. They then compiled a database of all published cord blood studies and the chemicals detected and cross-referenced it against EWG's database of cord blood contaminants found in its own studies.

EWG's findings agree with CDC's – the peer-reviewed literature contains surprisingly little biomonitoring information for newborns. The vast majority of chemicals found in cord blood have been identified in EWG-led research.

Altogether, biomonitoring studies report finding between 288 and 358 chemicals in cord blood from U.S. newborns. (The range occurs because analytical instruments cannot distinguish between some chemicals, and so laboratories report them together as "co-eluting" chemicals. One or both could be present in the sample.)

Large, population-scale biomonitoring studies could fill this critical gap in biomonitoring data. Such studies could help scientists and policymakers to determine how infant exposure to chemicals in the womb varies across populations; what other industrial compounds may be present in umbilical cord blood; and what health risks those pollutants may pose, alone or in combination, to developing fetuses.

CORD BLOOD BIOMONITORING STUDIES

Nationally, cord blood biomonitoring studies have detected up to 358 chemicals

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
Dioxin & Furan	Brominated dioxin	EWG tested cord blood from 10 newborns for 12 brominated dioxins and furans and found at least one of these chemicals in 7. In the 7 newborns, 6 to 7 different congeners were found. Mean total level was 12 pg/g lipids in blood serum. (EWG 2005)	10	U.S. hospitals	6-7
Dioxin & Furan	Brominated dioxin	EWG tested cord blood from 10 newborns of minority background for 12 brominated dioxins and furans and found at least one in 4 of the subjects. Six different congeners were found. Mean total level was 10.7 pg/g lipids in blood serum. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	6
Dioxin & Furan	Chlorinated dioxin	Researchers at the SUNY Health Science Center tested cord blood from 5 babies delivered via C-section from late 1995 to early 1996 for dioxins, dibenzofurans, and coplanar PCBs. Mean measured levels of total PCDDs, PCDFs, and coplanar PCBs were 165 pg/g for cord blood. (EWG 2005)	5	N.Y.	1
Dioxin & Furan	Chlorinated furan	EWG tested cord blood from 10 newborns for 17 chlorinated dioxins and furans and found at least one in all 10 subjects. Eleven different congeners were found. Mean total level was 56.3 pg/g lipids in blood serum. (EWG 2005)	10	U.S. hospitals	11

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
Dioxin & Furan	Chlorinated furan	EWG tested cord blood from 10 newborns of minority background for 17 chlorinated dioxins and furans and found at least one in all 10 subjects. Fifteen (15) different congeners were found. Mean total level was 59.7 pg/g lipids in blood serum. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	15
Fire Retardant	Brominated Fire Retardant	EWG measured TBBPA levels in cord blood from 10 newborns of minority background. TBBPA was found in 3 samples with a mean level of 11 ng/g lipids in blood serum. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	1
Metal	Cadmium	Researchers at Harvard measured cord blood concentrations of cadmium in 94 healthy babies, finding concentrations ranging from 0.003 to 0.210 µg/dl, with mean of 0.045 µg/dl. (Rabinowith 1984)	94	Boston, Mass.	1
Metal	Lead	Researchers at SUNY Oswego, the New York State Department of Health, the University of Albany and Penn State University measured cord blood lead levels in 154 children and correlated lead levels with adrenocortical responses to acute stress in children. They divided cord blood levels into the following 4 quartiles: < 1.0 (1st quartile; n = 37), 1.1–1.4 µg/dL (2nd quartile; n = 39), 1.5–1.9 µg/dL (3rd quartile; n = 36), and 2.0–6.3 µg/dL (4th quartile; n = 42). (Gump 2008)	154	N.Y.	1

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
Metal	Lead	Researchers at Harvard University, Emory University and University of Massachusetts at Amherst tested lead levels in cord blood from 527 babies born between 1993 and 1998 and found mean levels of 1.45 µg/dL. (Sagiv 2008)	527	New Bedford, Mass.	1
Metal	Mercury	Researchers at Columbia University and the CDC tested for cord blood levels of mercury in women who live and or work close to the World Trade Center site between Dec. 2001 and June 2002. The researchers found a mean cord mercury level of 7.82 µg/L. (Lederman 2008)	289	New York City, N.Y.	1
Musk	Musk	EWG measured nitro and polycyclic musk levels in cord blood from 10 newborns of minority background. Galoxolide was found in 6 samples at a mean level of 0.483 ng/g, and Tonalide was found in 4 samples at a mean level of 0.147 ng/g. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	2
PAH	Polyaromatic hydrocarbons (PAHs)	Researchers at Columbia University measured levels of benzoApyrene DNA adduct levels in 203 babies from New York City mothers who were pregnant during 9/11. (Perera 2005)	203	New York City, N.Y.	1
PAH	Polyaromatic hydrocarbons (PAHs)	EWG tested cord blood from 5 newborns for 18 polyaromatic hydrocarbons and found at least one in all 5 subjects. Nine (9) different chemicals were found with total mean concentration of 279 ng/g lipids in blood serum. (EWG 2005)	5	U.S. hospitals	9

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
PBDE	Polybrominated diphenyl ether (PBDE)	Researchers at Columbia University and Johns Hopkins tested 297 cord blood samples from babies born at Johns Hopkins Hospital from Nov. 26, 2004 to March 16, 2005 for 8 PBDE congeners. They report that 94% of the samples contained at least one of the tested congeners. (Herbstman 2007)	297	Baltimore, MD	7
PBDE	Polybrominated diphenyl ether (PBDE)	Researchers at Indiana University measured levels of 6 PBDEs in 12 paired samples of maternal and cord blood from live births that occurred from Aug. to Dec., 2001. They found that concentrations of PBDEs in both sets of samples were 20-to-106 fold higher than levels reported in a similar study from Sweden, leading them to conclude "human fetuses in the United States may be exposed to relatively high levels of PBDEs." (Mazdai 2003)	12	Indianapolis, Ind.	6
PBDE	Polybrominated diphenyl ether (PBDE)	EWG tested cord blood from 10 newborns for 46 polybrominated diphenol ethers (PBDEs) and found at least one of these chemicals in 10 out of 10 participants. Among all 10 participants who tested positive for the chemicals, 27 to 32 different congeners were found. Mean total level was 4.53 ng/g lipids in blood serum. (EWG 2005)	10	U.S. hospitals	27-32

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
PBDE	Polybrominated diphenyl ether (PBDE)	EWG tested cord blood from 10 newborns of minority background for 46 polybrominated diphenyl ethers (PBDEs) and found at least one in all 10 samples. Among all 10 participants who tested positive for the chemicals, 26 to 29 different congeners were found. Mean total level was 72.9 ng/g lipids in blood serum. (EWG 2009)	10	U.S. hospitals	26-29
PBDE	Polybrominated diphenyl ether (PBDE)	Researchers at Columbia University and Johns Hopkins tested 288 cord blood samples from babies born at Johns Hopkins Hospital from Nov. 26, 2004 to March 16, 2005 for 3 PBDE congeners. In all the 288 subjects, all three congeners were found. (Herbstman 2008)	288	Baltimore, MD	3
PBDE	Polybrominated diphenyl ether (PBDE) Metabolite	Researchers at the School of Public and Environmental Affairs at Indiana University tested PBDE and PBDE metabolities in 20 pregnant women and their newborn babies who had not been intentionally or occupationally exposed. They noted that metabolites in humans seem to be accumulating. (Qiu 2009)	20	Indianapolis, Ind.	10

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
PCB	Polychlorinated biphenyl (PCB)	Researchers at Columbia University and Johns Hopkins tested 297 cord blood samples from babies born at Johns Hopkins Hospital from Nov. 26, 2004 to March 16, 2005 for 35 PCB congeners. They report levels for 4 of the 35 but note that ">99% (of samples) had at least one detectable PCB congener." (Herbstman 2007)	297	Baltimore, Md.	18
PCB	Polychlorinated biphenyl (PCB)	Researchers at SUNY Oswego investigated cord blood levels of PCBs in children born between 1991 and 1994 and correlated levels with response inhibition when the children were 4.5 years of age. The researchers found that "results indicated a dose-dependent association between cord blood PCBs and errors of commission." (Stewart 2003)	10	U.S. hospitals	98-147
PCB	Polychlorinated biphenyl (PCB)	EWG tested cord blood from 10 newborns for 209 polybrominated diphenol ethers (PBDEs) and found at least one of these chemicals in 10 out of 10 participants. Among all 10 participants who tested positive for the chemicals, 98 to 147 different congeners were found. Mean total level was 6.2 ng/g lipids in blood serum. (EWG 2005)	10	Mich. Fla. Wis. Mass. Calif.	98-144

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
PCB	Polychlorinated biphenyl (PCB)	Researchers at Harvard, Emory, and the University of Massachusetts at Amherst tested levels of 51 PCB congeners in cord blood from 542 babies born between 1993 and 1998. No information on levels of individual congeners is given; however, the mean sum of PCB congeners 118,138,153, and 180 is 0.25 ng/g and the TEF-weighted sum of mono-ortho PCB congeners 105, 118, 156, 167, and 189 is 6.75 pg/g lipid. (Sagiv 2008)	542	New Bedford, Mass.	>4
PCN	Polychlorinated naphthalene (PCN)	EWG tested cord blood from10 newborns for 70 polychlorinated naphthalenes and found at least one in all 10 subjects. In all, 31 to 50 different congeners were found with total mean concentration of 0.574 ng/g lipids in blood serum. (EWG 2005)	10	U.S. hospitals	31-50
PCN	Polychlorinated naphthalene (PCN)	EWG tested cord blood from10 newborns of minority background for 70 polychlorinated naphthalenes and found at least one in all 10 subjects. In all, 17 to 24 different congeners were found, with total mean concentration of 0.637 ng/g lipids in blood serum. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	17-24

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
Pesticide	Carbamate	Researchers at Columbia University, the CDC and the Southwest Research Institute measured the levels of 29 pesticides in cord plasma from 211 babies born into an urban community in New York City between Sept.1998 and May 2001. 48% of the babies had exposure to 2-Isopropoxyphenol, 45% to carbofuran, and 36% to bendiocarb. All of the babies were exposed to at least one carbamate. (Whyatt 2003)	211	New York City, N.Y.	5
Pesticide	Fungicide	Researchers at Columbia University, the CDC and the Southwest Research Institute measured the levels of 29 pesticides in cord plasma from 211 babies born into an urban community in New York City between Sept. 1998 and May 2001. 83% of the babies had exposure to dicloran, 70% to phthalimide. All of the babies had exposure to at least one fungicide. (Whyatt 2003)	211	New York City, N.Y.	4
Pesticide	Herbacide	Researchers at Columbia University, the CDC and the Southwest Research Institute measured the levels of 29 pesticides in cord plasma from 211 babies born into an urban community in New York City between Sept. 1998 and May 2001. 38% had exposure to chlorthal-dimethyl and 20% had exposure to Alachor. All had exposure to at least one herbicide. (Whyatt 2003)	211	New York City, N.Y.	5

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
Pesticide	Imide	Researchers at Columbia University, the CDC and the Southwest Research Institute measured the levels of 29 pesticides in cord plasma from 211 babies born into an urban community in New York City between Sept. 1998 and May 2001. 83% had exposure to dicloran and 70% had exposure to phthalimide. All had exposure to at least one fungicide. (Whyatt 2003)	211	New York City, N.Y.	1
Pesticide	Mosquito Repellent	Researchers at Columbia University, the CDC and the Southwest Research Institute measured the levels of 29 pesticides in cord plasma from 211 babies born into an urban community in New York City between September 1998 and May 2001. 33% of the babies had exposure to diethyltoluamide. (Whyatt 2003)	211	New York City, N.Y.	1
Pesticide	Organochlorine Pesticide (OC)	Researchers at Harvard, Emory and the University of Massachusetts at Amherst tested levels of 2 organochlorine pesticides in cord blood from 542 babies born between 1993 and 1998. Mean DDE levels were 0.48 ng/g serum. Levels of HCB were not given. (Sagiv 2008)	542	U.S. hospitals	1
Pesticide	Organochlorine Pesticide (OC)	EWG tested cord blood from10 newborns for 28 organochlorine pesticides and found at least one in all 10 subjects. In all, 21 different pesticides were found. (EWG 2005)	10	U.S. hospitals	21

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
Pesticide	Organophosphate Pesticides and Metabolites	Researchers at Columbia University, the CDC and the Southwest Research Institute measured the levels of 29 pesticides in cord plasma from 211 babies born into an urban community in New York City between Sept. 1998 and May 2001. 71% had exposure to chlorpyrifos (mean 4.7 pg/g) and 49% had exposure to diazinon (mean 1.2 pg/g), the two most commonly detected pesticides. All other pesticides were found in 4% or less of the samples and all babies had exposure to at least one of the organophosphates. (Whyatt 2003)	211	New York City, N.Y.	8
Pesticide	Pyrethroid	Researchers at Columbia University, the CDC and the Southwest Research Institute measured the levels of 29 pesticides in cord plasma from 211 babies born into an urban community in New York City between Sept 1998 and May 2001. 7% had exposure to trans-permethrin and 13% had exposure to cis-permethrin. (Whyatt 2003)	211	New York City, N.Y.	2
PFC	Perfluorochemical (PFC)	Researchers at CDC, Columbia University and Johns Hopkins tested cord blood from 299 babies born at Johns Hopkins Hospital between Nov. 26, 2004 and March 16, 2005 for 10 PFCs. They detected PFOS in 99% and PFOA in 100% of samples. Eight other PFCs were detected at lesser frequency. (Apelberg 2007)	299	Baltimore, Md.	9

Chemical class	Chemical subclass	Summary of representative study	No. of newborns tested	Place of birth	No. of Chemicals found
PFC	Perfluorochemical (PFC)	EWG tested cord blood from 10 newborns for 12 perfluorochemicals and found at least one of these chemicals in 10 out of 10 participants. Among all 10 participants who tested positive for the chemicals, 9 of 12 different chemicals were found with total mean concentration of 5.86 ng/g in whole blood. (EWG 2005)	10	U.S. hospitals	9
PFC	Perfluorochemical (PFC)	EWG tested cord blood from10 newborns of minority background for 13 perfluorochemicals and found at least one of these chemicals in 10 out of 10 participants. Among all 10 participants who tested positive for the chemicals, 6 of 13 different chemicals were found with total mean concentration of 2.38 ng/g in whole blood. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	6
Plastic	Bisphenol A & BADGE	Researchers at the Environmental Working Group measured BPA levels in cord blood from 10 newborns of minority background. BPA was found in 9 of 10 samples with a mean level of 2.18 ng/L. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	1
Rocket fuel	Perchlorate	Researchers at the Environmental Working Group measured perchlorate levels in cord blood from 10 newborns of minority background. Perchlorate was found in 9 of 10 samples with a mean level of 0.209 ug/L. (EWG 2009)	10	Mich. Fla. Wis. Mass. Calif.	1

Appendix C: References

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