



Assuring a System of Care for Iowa's Children and Youth with Special Health Care Needs

Environmental Toxins and Neurodevelopment of Infants and Toddlers

Executive Summary

Final Report

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**IDEA Part C ARRA Report
Phase I Project 2/3
EXECUTIVE SUMMARY**

Environmental Toxins and the Neurodevelopment of Infants and Toddlers

In September of 2009, the Iowa Early ACCESS Council (ICEA) charged the University of Iowa Child Health Specialty Clinics to collect data and conduct an impact study of the effects of environmental toxins on the neurocognitive development of infants and toddlers. “These data are to be used to estimate the increased number of infants and toddlers who would be eligible for Early ACCESS (EA) services if selected environmental toxin exposure(s) were added to the list of EA eligible conditions and will be used for EA state level decision-making.”

The resulting report is based on a review of a database of over 325 articles, interviews with nine individuals, and analysis of reports and data produced by a number of state agencies and the University of Iowa. The focus of the report is on effects of toxins on neurodevelopment of children; other impacts such as cancer, respiratory problems, or obesity were not considered.

The Problem: The numbers of newborns and young children impacted by toxins are growing. Early ACCESS services are much too limited in capacity and funding to address the existing and increasing numbers of children who need developmental monitoring and/or intervention services as a result of exposure to toxins. What is needed is a comprehensive, integrated and multi-systems approach. Some recommendations based on the work of many individuals and organizations in Iowa at the state and local level, and on potential cross-systems collaborations, are included at the end of the report.

“. . . [V]irtually all research in toxicology and all environmental-health policy in the United States had prior to 1993 focused on the ‘average 70-kg man’ and took no cognizance of the unique exposures or the special susceptibilities of fetuses, infants, and children.”¹

Significant differences between children and adults contribute to children’s increased susceptibility to pesticides and other toxic chemicals.

1. Children have greater exposure than adults to toxic chemicals on a body-weight basis
2. Children’s metabolic pathways are immature
3. Children’s incredibly rapid, but exquisitely delicate developmental processes are easily disrupted
4. Children have more time than adults to develop chronic diseases that may be triggered by harmful exposures in the environment²

It is only in the past 10-15 years that research on the impacts of various chemicals on the health of young children has been conducted.

¹ **Children’s Health and the Environment: An Overview**, Philip J. Landrigan, MD, MSc, and Amir Miodovnik, MD, MPH *MOUNT SINAI JOURNAL OF MEDICINE* 78:1–10, 2011

² Ibid

Specific Toxins of Concern: A number of specific toxins exposures known to negatively affect children were researched and are highlighted in the following chart.

TOXIN	IMPACT ON NEURODEVELOPMENT	CHILDREN 0-3 EXPOSED/ AFFECTED	SOURCE OF EXPOSURE
Mercury	Mercury disrupts brain development by inhibiting important enzymes and preventing certain cells from dividing to produce more neurons and support cells. Research shows that mercury also increases the vulnerability of the brain to the adverse effects of other toxins at levels that are otherwise thought to be below dangerous thresholds, thereby producing a so-called “double hit.”	2,300 to 6,400 children potentially exposed; 230 to 640 potentially affected.	<i>Coal fired plants, also cement production facilities affecting rivers streams and lakes.</i> Ingestion of larger fish by pregnant women or children is the source of human exposure; persons fishing for subsistence or food supply at particular risk.
Organophosphates	Higher in-utero organophosphate pesticide exposure was associated with increased odds of maternally reported pervasive developmental disorder at 24 months in one study and at 36 months in another. Additionally, researchers for the second study detected a negative association of exposure on attention problems with and without hyperactivity at 36 months. Findings from two studies focused on the development of older infants and children have suggested that in-utero exposure is associated with deficits in mental development and with maternal report of pervasive developmental disorder in children aged 2–3 years old. Children in the highest quintile of maternal DAP [particular pesticide] concentrations had an average deficit of 7.0 IQ points compared with those in the lowest quintile.	Potentially 20% or more of the over 115,000 children ages 0-3 could be exposed. If 5% of these children were affected, that number would be 2,300. This would be the low end of estimates.	<i>Primarily agricultural pesticides/herbicides.</i> Exposure is higher in farm families for some specific substances, but not all. Iowa farm families using several different pesticides, have roughly four to six times higher concentrations than the geometric means in the U.S. representative subsample of National Health and Nutrition Examination Survey (NHANES), 1999- 2000.
Bisphenol A (BPA)	Behavioral abnormalities; also, birth defects, cancer, chromosomal and reproductive system abnormalities, cardiovascular system damage, early puberty and obesity are associated with BPA.	96% of lowans may have detectable levels of BPA; levels are higher among children, females, and lower income individuals. Number of children exposed and/or affected would at least be in the 100’s if	<i>Industrial sources or from product leaching, disposal, and use.</i> BPA is used to make products such as compact discs, automobile parts, baby bottles, plastic dinnerware, eyeglass lenses, toys, and impact-resistant safety equipment. Epoxy resins containing BPA are used in protective linings of some canned food containers, wine vat linings, epoxy resin-based paints, floorings, and some dental composites. About 5-6 billion pounds of bisphenol were produced annually

		not 1,000's.	worldwide.
Arsenic	Evidence that exposure to arsenic can cause cognitive delays.	Unknown	<i>Water sources such as private wells.</i> A 2006-08 statewide survey of 475 wells conducted by the University of Iowa and the State Hygienic Laboratory, showed that almost half of the water samples contained arsenic; about 8% of those had arsenic concentrations at or above 10 parts per billion, EPA's drinking water standard for public water supplies.
Illicit Drug Use	. . [P]renatal exposure to Cocaine, methamphetamine ("speed"), and methylphenidate (Ritalin) are psycho-stimulant substances that have been shown to cause functional impairments in animals and humans who experience prenatal exposure. . . . Most prospective studies of prenatal cocaine exposure in humans report relatively modest developmental changes in infants and toddlers but measurable problems with attention, hyperactivity, and mood control as the children are followed into their early teen years.	If hospital screening were done using a standardized format, 1,200 infants would be identified and referred.	<i>Maternal use of illicit drugs.</i> In one study, as a result of inadequate screening and testing, only 537 newborns were confirmed as having been exposed to drugs <i>in utero</i> . Number should have been much higher. Very few, even of the ones identified, receive EA services even though children exposed are automatically eligible
Prescription Drug Use during Pregnancy	FDA Category D drugs: "There is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience or studies in humans, BUT the potential benefits from the use of the drug in pregnant women may be acceptable despite its potential risks." FDA Category X drugs: "Studies in animals or humans have demonstrated fetal abnormalities OR there is positive evidence of fetal risk based on adverse reaction reports from investigational or marketing experience, or both, AND the risk of the use of the drug in a pregnant woman clearly outweighs any possible benefit (for example, safer drugs or other forms of therapy are available)."	Between 4 and 9% of pregnant women use Category D or X prescription drugs. Thus approximately 1,500 to 3,000 infants are exposed each year (4,500 to 9,000 children 0-3 exposed in utero).	<i>In Utero exposure to FDA category D or X drugs.</i>
Lead	The primary functional deficits resulting from lead exposure, which have been demonstrated through repeated studies in both humans and animals, include a range of problems in learning, behavior, and the ability to focus and sustain attention.	Over 1,000 children should be receiving EA services, while only between 30-60 are.	<i>Lead paint and other household sources being ingested by young children.</i> Approximately 7% of Iowa children are known to have lead levels above 10mcg/dl. Children with blood lead levels 20 mcg/dl are eligible

			for Early ACCESS services.
Tobacco Smoke	Effects on the child of prenatal tobacco exposure attributable to maternal tobacco use: 1. Poor growth.2. Behavioral and neurocognitive effects, including abnormal neonatal neurobehavior, developmental delay, attention deficit hyperactivity disorder, conduct disorder, and other aggressive behaviors, and psychiatric disorders. 3. Speech processing ability. 4. Significant reductions in cortical gray matter and total parenchymal volumes and head circumference.	Over 5,000 newborns each year are exposed to tobacco smoke in utero. Between 500 and 775 each year are low birthweight and/or preterm.	<i>In utero exposure and second hand exposure to tobacco smoke.</i> 25.2% of pregnant women on Medicaid smoke; 48% of children in low income families are exposed to second hand smoke; 35% of children under 1 year of age live in households with adults who smoke.

Vulnerable Children Face Higher Risk: Most of the studies and articles regarding various environmental toxic exposures reviewed for this report reference the higher incidence of exposures and impacts on children who are lower income.

The impact of environmental toxicant exposure is exacerbated by other factors that contribute to susceptibility to disease such as race, ethnicity, and socioeconomic status. . . . Additional research on the cumulative impact of multiple risk factors that contribute to unequal negative health outcomes for vulnerable children is underway. In sum, there is substantial evidence that “environmental exposure is a contributor to higher incidence of disease and mortality experienced by certain racial/ethnic groups.” Thus, program and policy work to make early childhood environments as healthy as possible is an important component of broader efforts to reduce disparities and help all children thrive.³

Interventions Can Positively Affect Outcomes: Interventions can make a difference in interrupting or ameliorating the negative impacts of environmental toxin assaults on children. While preventing negative environmental exposures is of paramount importance, early childhood interventions to improve developmental outcomes are really secondary prevention measures. “Although exposure to toxins can result in serious injury, the brain is also resilient as biology protects it over other organ systems and helps it resist the potentially negative impacts of outside threats. Moreover, when given the chance, the brain often demonstrates the capacity to recover from damage. This balance between vulnerability and resilience determines how different environmental conditions affect brain development over time.”⁴

Key findings of a Rand Corporation study were:

³ **Environmental Health in Early Childhood Systems Building Opportunities for States**, Andrea Bachrach, Louisa B. Higgins, Shannon Stagman, The National Center for Children in Poverty (NCCP), Columbia University, December 2010. http://www.nccp.org/publications/pdf/text_981.pdf

⁴ **EARLY EXPOSURE TO TOXIC SUBSTANCES DAMAGES BRAIN ARCHITECTURE**, National Scientific Council on the Developing Child, Center on the Developing Child. *Working Paper No. 4*, 2006. <http://www.developingchild.net/reports.shtml>

- Early childhood intervention programs have been shown to yield benefits in academic achievement, behavior, educational progression and attainment, delinquency and crime, and labor market success.
- Interventions with better-trained caregivers and smaller child-to-staff ratios appear to offer more favorable results.
- Well-designed early childhood interventions have been found to generate a return to society ranging from \$1.80 to \$17.07 for each dollar spent on the program.

Developing a Durable System of Care to Address Issues Facing Toxin Exposed Children: The research about interventions shows that there is sufficient knowledge available now to address the challenges facing the realization of healthy child development. However, many barriers exist in the execution of what we know works. “Disjointed medical care in the crucial periods of preconception, pregnancy, and early childhood demands better coordination, as do a broad range of policies that affect families with young children who are facing significant adversities that threaten their physical and mental well-being. These policies include early care and education, child welfare, early intervention, workforce development, housing, urban planning, economic development, and environmental protection, among many others.”⁵

A “system of care” that ties together the many individuals, agencies and systems that touch the lives of children exposed to harmful toxins is key to realizing positive impacts for these children on a durable, ongoing basis.

Interventions for children exposed to harmful chemicals need to include: (1) preconception and prenatal education about and identification of exposures, (2) identification of exposed children and their referral by hospitals, (3) continuous developmental screening and monitoring of exposed children by public health, Early ACCESS, primary care providers, and/or social service providers, and (4) referral to more intensive interventions when delays are identified.

A methodology to move towards a systems of care is outlined in the report.

Recommendations

- 1. The ICEA would advocate for the establishment of a high level, cross-systems Children’s Environmental Health Panel that would (a) educate on policies that limit toxin exposures for children, (b) plan and support the creation of bio-monitoring statewide for pregnant women and children, (c) coordinate efforts of all entities working in any way on prevention or intervention with young children and environmental toxin exposures, (d) identify funding sources to support systems of care for infants and young children and (e) maintain surveillance to identify the most harmful substances.**
- 2. ICEA would implement the recommendations of the “Improving the System of Care for Iowa’s Late Preterm Infants” and “The Health Practitioner’s Role in Healthy Young Child Development” as they relate to developing systems of care and to addressing the social determinants of health. In addition, ICEA would work to ensure that children exposed to**

⁵ **The Foundations of Lifelong Health Are Built in Early Childhood**, co-authored by the National Scientific Council of the Developing Child and the National Forum on Early Childhood Programs and Policy, Harvard University’s Center for the Developing Child, (http://developingchild.harvard.edu/resources/reports_and_working_papers/foundations-of-lifelong-health/)

harmful substances are referred for monitoring, assessment and/or intervention and that health care providers begin to do “environmental assessments,” including screening for in utero drug exposure and early screening for lead and other toxins, and would limit prescribing C,D, or X medications for pregnant women.

3. That the ICEA and the Bureau of Lead Poisoning Prevention work together to (a) ensure that all BLL of 20 or higher are referred to Early ACCESS, (b) that a new focus on “selling” the Early ACCESS services (monitoring and/or interventions) to families with young children with high blood lead levels, and (c) develop strategies to increase the numbers of children at ages 1 and 2 who are tested.
4. *That* Early ACCESS establish an advisory committee that would (1) identify the levels at which a child with mercury poisoning would be eligible for services, (2) promote at least pilot testing for mercury on blood samples for lead level testing (3) utilize this committee to determine whether BPA and/or organophosphates should be included in Early ACCESS eligibility guidelines. (At this point in time, this would add very few children to Early ACCESS rolls because of limited testing.)
5. That the ICEA will work with the Iowa Statewide Perinatal Care Program, Department of Human Services, the Child Protection Program at the University of Iowa, Iowa’s birthing hospitals and providers of prenatal care to advocate for adoption of screening protocols by birthing centers and prenatal care providers and to develop an effective system of referrals of infants who are assessed as drug (and alcohol) exposed at birth.
6. That the ICEA will consider inclusion of children prenatally exposed to cigarette smoke as eligible for Early ACCESS services, or alternatively, that those children born low birthweight or late preterm AND exposed to tobacco smoke in utero be so included