Safer Chemicals Healthy Families health report

Learning and Developmental Disabilities

According to the U.S. Centers for Disease Control and Prevention (CDC), the number of U.S. children with developmental disabilities has been climbing over the past decade, reaching nearly one in six by 2008. The rising incidences of autism and attention deficit hyperactivity disorder account for most of this increase.[1]

The National Academy of Sciences estimates that environmental factors, including toxic chemicals, cause or contribute to at least a quarter of learning and developmental disabilities in American children. [2]

Intellectual disability (ID, formerly referred to as mental retardation) impacts 2%, or approximately 1.4 million, children. Attention deficit hyperactivity disorder (ADHD) is conservatively estimated to occur in 3-6%, or approximately 2 million, children. Almost 1% of 8-year-old children are diagnosed with autism spectrum disorder, a 10-fold increase over just a 15-year period.[3][4][5] About 30% of this dramatic rise in autism cannot be explained by changes in the age of diagnosis and the inclusion of milder cases.[6]

These conditions impose tremendous psychological and economic costs on the affected children, their families, and communities. Just the cost of providing special education services to students with disabilities amounted to $77.3 billion in 1999-2000, an average of $12,474 per student.[7] According to the U.S. CDC individuals with an autism spectrum disorder have average medical expenditures that exceed those without the disorder by $4,110-$6,200 per year.[8][9] A 2006 study reported that the economic costs associated with autism in the U.S. are approximately $35 billion dollars per year.[10]

The human brain: more susceptible during development

As with cancer, much of what we know about chemicals that can cause neurological problems comes from studies of occupational exposures. Research on occupational exposures and epidemics of industrial chemical poisoning have led to the identification of lead, methyl-mercury, polychlorinated biphenyls (PCBs), arsenic, and toluene as known causes of neurodevelopmental disorders. Industrial chemicals have been identified in the peer reviewed scientific literature as causing neurological effects in adults, mostly through occupational exposures (see Table 2). Many of these chemicals are in common use and are produced in high volumes.

However, in recent decades, many scientists have begun to focus on the effects of chemicals on the brain during fetal development and childhood. In the years since the Toxic Substances Control Act (TSCA) became law, evidence has been accumulating that lead, mercury and other neurotoxic chemicals have a profound effect on the developing brain at levels that were once thought to be safe. Scientists have learned that the developing human brain is much more susceptible to toxic substances than the adult brain. Windows of unique vulnerability occur as the brain begins to develop in utero and continue through adolescence, along a precise and delicate step-by-step sequence involving various neurobiological processes. A chemical exposure at three months gestation may result in a different effect than exposure to the same chemical at six months gestation or at two years of age. If chemicals inhibit, interfere with, or halt a developmental process, the damage may be permanent.

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This new understanding of the developing brain's unique vulnerability suggests that there may be a thousand or more other chemicals that can impact the developing brain, although no authoritative estimate of the true number of neurotoxicants is available.

Chemicals of Concern

In recent years, peer-reviewed scientific studies continue to identify chemicals and categories of chemicals for which there is sufficient evidence to warrant serious concern over the effects of those chemicals on brain development. The toxic chemicals listed below are just three examples of such chemicals.

Certain **Brominated Flame Retardants**: Used in upholstery, electronics, carpet, building materials, bedding, mattresses, and many other products. In laboratory studies, low doses caused deficits in learning, memory and hearing, changes in behavior and delays in sensory-motor development in mice and rats.

A study of 329 mothers who delivered in hospitals in lower Manhattan following the attacks of 9/11/2001 found an association between levels of brominated flame retardants in their babies' cord blood and delays in mental and physical development measured at 1,2,3,4 and 6 years of age.[11]

Perchlorate: Used in rocket fuel and widely found in U.S. drinking water.

In 2010, scientists with the Office of Environmental Health Hazard Assessment examined records of blood samples drawn from the heels of 497,458 newborns in 1998 in California. The researchers found that babies born in areas of California where tap water was contaminated with perchlorate had a 50% chance of having a poorly performing thyroid gland.[12]

The thyroid is a gland in the throat that produces hormones essential for healthy nerve and brain development. Perchlorate, brominated flame retardants and Bisphenol A (see below) are all under investigation for their potential to interfere with thyroid hormones and function.

Bisphenol A (BPA): A plasticizer that mimics estrogen in the body, BPA is found in hard plastics, food and soda can linings, and cash register receipts among other uses.

In August 2007, a group of 38 leading scientists expressed unanimous concern that recent trends in human disease may be related to BPA exposures, based on their assessment of hundreds of peer-reviewed research studies. Experiments with animals have established links between BPA and prostate and breast cancers, genital abnormalities in male babies and decline in sperm quality, early onset of puberty in girls and neurobehavioral problems such as attention deficit hyperactivity disorder.[13]

A 2009 study of 249 women and their babies found that the daughters of the women who had higher exposure levels to BPA while pregnant were more likely to show aggressive and hyperactive behavior as two-year olds. [14]

The chemicals highlighted above are widespread in products, the environment and people. The CDC finds that more than 90 percent of Americans have detectable levels of the brominated flame retardants, perchlorate and Bisphenol A in their bodies. As described, all of these chemicals are linked to problems with brain development.

Chemicals, learning and developmental disabilities, and TSCA

There is an emerging scientific understanding that disparate chemicals used for different purposes in multiple products can result in similar effects on a particular system in the body. The National Academy of Sciences – the nation's most esteemed body of scientists – recommends that review of chemicals for safety should include an assessment of cumulative chemical exposures – meaning exposures from multiple chemicals that relate to the same or similar adverse effects. This approach to assessing chemicals is critical to protecting the developing brain from harm. Under a revised TSCA, EPA is directed to assess cumulative exposures of toxic chemicals wherever possible.

There is very solid and mounting scientific evidence on a limited number of chemicals, including those described above, to show that these chemicals are harmful to brain development. Where the weight of the evidence warrants concern, TSCA should require swift action to replace known toxins with safer alternatives.

However, for most of the thousands of chemicals on the market, we have very little data on their effects on the developing nervous system. Of the 3,000 chemicals produced in highest volume (over one million pounds per year), only 12 have been adequately tested for neurotoxicity. To ensure healthy brain development for future generations, TSCA must be updated to require that all existing and new chemicals are shown to be safe for pregnant women, children, workers, and other vulnerable populations.[15]

Table 2 - Chemicals Known to be Neurotoxic to Humans

Metals and inorganic compounds	*Organic solvents*	*Other organic substances*
Aluminum compounds	Acetone	Acetone cyanohydrin
Arsenic and arsenic compounds	Benzene	Acrylamide
Azide compounds	Benzyl alcohol	Acrylonitrile
Barium compounds	Carbon disulphide	Allyl chloride
Bismuth compounds	Chloroform	Aniline
Carbon monoxide	Chloroprene	1,2-Benzenedicarbonitrile
Cyanide compounds	Cumene	Benzonitrile
Decaborane	Cyclohexane	Butylated triphenyl phosphate
Diborane	Cyclohexanol	Caprolactam
Ethylmercury	Cyclohexanone	Cyclonite
Fluoride compounds	Dibromochloropropane	Dibutyl phthalate
Hydrogen sulphide	Dichloroacetic acid	3-(Dimethylamino)-propanenitrile
Lead and lead compounds	1,3-Dichloropropene	Diethylene glycol diacrylate
Lithium compounds	Diethylene glycol	Dimethyl sulphate
Manganese and manganese compounds	N,N-Dimethylformamide	Dimethylhydrazine
Mercury and mercuric compounds	2-Ethoxyethyl acetate	Dinitrobenzene
Methylmercury	Ethyl acetate	Dinitrotoluene
Nickel carbonyl	Ethylene dibromide	Ethylbis(2-chloroethyl)amine
Pentaborane	Ethylene glycol	Ethylene
Phosphine	n-Hexane	Ethylene oxide
Phosphorus	Isobutyronitrile	Fluoroacetamide
Selenium compounds	Isophorone	Fluoroacetic acid
Tellurium compounds	Isopropyl alcohol	Hexachlorophene
Thallium compounds	Isopropylacetone	Hydrazine
Tin compounds	Methanol	Hydroquinone
	Methyl butyl ketone	Methyl chloride
	Methyl cellosolve	Methyl formate
	Methyl ethyl ketone	Methyl iodide
	Methylcyclopentane	Methyl methacrylate
	Methylene chloride	p-Nitroaniline
	Nitrobenzene	Phenol
	2-Nitropropane	p-Phenylenediamine
	1-Pentanol	Phenylhydrazine
	Propyl bromide	Polybrominated biphenyls
	Pyridine	Polybrominated diphenyl ethers
	Styrene	Polychlorinated biphenyls
	Tetrachloroethane	Propylene oxide
	Tetrachloroethylene	TCDD
	Toluene	
	1,1,1-Trichloroethane	
	Trichloroethylene	
	Vinyl chloride	
	Xylene	

		Tributyl phosphate 2,2',2''-Trichlorotriethylamine Trimethyl phosphate Tri-o-tolyl phosphate Triphenyl phosphate

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