



“Exposures to certain plastics may have harmful health effects, but the good news is that you have options for protecting yourself and your family. You don’t have to understand all the technical aspects of the make-up and manufacturing of plastics to help minimize the negative impacts in your home. Learn to read the code on plastic containers. Select those known to be safest. When there is a choice, learn what brands or what alternative products have been shown to be safest. When possible, try to use alternatives to plastics. Your awareness and caution in selecting the least harmful plastics and the best alternatives are important for your children’s health and future. In fact, educating yourself about these issues will benefit every member of your family. “

- Larry B. Silver, MD

Should I be concerned about plastics?

Plastics are found everywhere: in food containers, car seats, telephones, computers, toys, cups, floor coverings, windows, and drain pipes – the list is endless. Plastics are such an integral part of our daily lives that it’s almost impossible to conceive how we could function without them. We assume that plastic products are safe, but are they?

The chemicals and processes used to create certain plastics can be highly toxic, affecting not only our groundwater and the air we breathe, but also leaching (slowly dissolving or migrating) into packaged foods, bottled water, and even our skin upon handling them. This column focuses on the health effects of three toxicants in plastic: phthalates (pronounced “THA-lates”), dioxins, and bisphenol-A (pronounced “BIS-fe-noll A”). Strategies for reducing exposures and using alternatives are also provided.

Polyvinyl chloride (PVC) plastic, phthalates and dioxins

Polyvinyl chloride (PVC) is derived from vinyl chloride. More than 60 percent of PVC plastic is used to make construction materials such as vinyl siding, piping, decking, flooring, roofing membranes and electrical cables¹. PVC is also used in medical supplies such as IV bags and tubing; household items such as upholstery, shower curtains, rain coats and plastic food wraps; and children’s products

such as bath toys, waterproof baby books, rattles, balls, and bean bag pellets.

PVC is a hard plastic that is made softer and more flexible when blended with plasticizers called phthalates. Phthalates are toxic chemicals that are known to leach from PVC plastics and cause various health problems.

When PVC plastics are manufactured and again during waste incineration, toxic chemicals called dioxins are released into the air, settle to the ground and enter the food chain and water systems. PVC is a major contributor to dioxin release, with seven billion pounds discarded as household, medical, construction and demolition waste annually in the US. Some hospitals are now beginning to use alternatives to PVC plastics because of the widespread harm it causes to our health and the environment.

Polycarbonate plastic and bisphenol-A

Polycarbonate is a type of hard, clear plastic that is commonly used for medical storage containers, hospital incubators, water bottles, baby bottles, and linings in food cans. Bisphenol-A is a chemical used in the manufacture of polycarbonate plastic and is widely used to make the inside coatings of household water tanks and in plastic dental sealants.

What health problems are associated with these chemicals?

Phthalates

Phthalates are associated with a variety of health problems. In males,

phthalates are associated with undescended testicles and smaller genitalia at birth, lowered sperm counts, benign testicular tumors later

in life, and reduced blood levels of testosterone². In girls, phthalates are associated with premature breast development³. Phthalates are also carcinogenic (cause cancer)⁴ and are linked to both asthma⁵ and allergies⁶. Phthalates may cause damage to the liver, kidneys and heart as well⁷.

Preliminary research of the developmental and cognitive (brain) effects of phthalates has shown that phthalates impair the function of the pituitary and thyroid glands. Because thyroid health is essential for proper brain development⁸, it is likely that research currently underway will show that phthalates contribute to problems in neurological and brain development.

Phthalates interfere with the hormones that determine the physical characteristics of males and females. These hormones also influence cognitive differentiation (spatial learning, perception and memory) and behavior (social play, aggression and hyperactivity)⁹.

Dioxins

Dioxins are associated with cancer, diabetes, endometriosis, birth defects, infertility, and immune-

system depression¹⁰. Dioxins are also associated with impaired thyroid function. The thyroid gland controls synapse development and neuron formation in the brain. Even small disruptions of a mother's thyroid hormone levels at certain points in her pregnancy may cause problems with the child's motor coordination, balance, and other psychomotor skills; spatial relation; perception; memory and language¹¹.

Bisphenol-A

Bisphenol-A disrupts proper hormone functioning, alters genes and disrupts normal physical and behavioral development. In animal studies bisphenol-A has been linked to a variety of reproductive problems in both males and females; birth defects; obesity; behavioral disorders such as hyperactivity, impulsiveness and aggression; abnormal brain structure and chemistry; impaired immune function and a variety of cancers¹². Recent "body burden" studies have shown bisphenol-A to be present in the urine and blood of a wide range of people. Of great concern is the fact that the levels found in humans are much greater than levels that caused problems in animal studies.

Routes of exposure to the chemicals in plastics

People are exposed to phthalates, dioxins, and bisphenol-A in a variety of ways.

Out-gassing of new PVC is one way phthalates enter our bodies. The "new car smell" and the smell of a new shower curtain are examples of PVC out-gassing. When used as a building material, PVC poses risks for its potential to release toxic fumes when exposed to high temperatures¹³.

Dioxins are **released during waste incineration and settle to the ground**, affecting groundwater, pastures and farms. Dioxins and phthalates are fat-soluble chemicals, which means that they remain in fat cells rather than get processed out of the body through the kidneys or liver. **Fatty meats** such as chicken and beef contain phthalates and dioxins, which then build up in the fat cells of people who eat these meats.

Bisphenol-A **leaches into foods and liquids** stored in polycarbonate plastic and plastic-lined

containers or water tanks. The older the polycarbonate plastic container, the greater the leaching activity. **Temperature affects the amount of leaching** from these containers, with higher temperatures (as from dishwashing or boiling) increasing leaching¹⁴. Phthalates leach into foods from **plastic packaging** as well.

All these chemicals also pass from **mother to child** in the womb across the placenta and are present in breast milk. Nevertheless, breastfeeding is still the best possible food for infants for many other reasons.

Babies are also exposed to these chemicals when they mouth plastic **toys**, drink baby **formula from cans lined with plastic resins**, or drink from **plastic baby bottles**. Since fetuses and babies are particularly susceptible to the health effects of these toxic chemicals, parents should be particularly concerned about exposures both before and after birth.

Take a “Three Steps” approach to reduce and eliminate exposures

Step 1: Avoid PVC and leaching plastics

Plastic products are usually numbered on the bottom, indicating the type of resin used in their manufacture. Avoid PVC (#3).

Besides PVC (#3), polystyrene (#6) and other plastics (#7) are also known to leach harmful chemicals such as phthalates or bisphenol-A into the foods they contain. Avoid them.

Step 2: Substitute Safer Plastics

Choose non-PVC cling wrap such as Glad Wrap. Also, Saran Premium Wrap and Saran Cling-Plus Wrap do not contain PVC or bisphenol-A.

Choose #1 (PETE), #2 (HDPE), #4 (LDPE) and #5 (PP) plastics. The codes on the bottom of plastic containers indicate the type of resin used. Numbers 1, 2, 4 and 5 are safer choices since most research has not shown leaching of carcinogens or hormone-disrupting chemicals from these. However, #4 and #5 are not as widely recyclable. Some bread and frozen-food bags and squeezable bottles are made of #4 plastic. Some ketchup bottles and yogurt and margarine containers are made of #5 plastic. Medela and Evenflo baby bottles are generally made of safer plastics.

Choose biodegradable plastics. The use of a corn-based biodegradable plastic called polylactide

(PLA) is growing. For example, Wild Oats supermarket chain replaced its bulk food containers with PLA. Biodegradable garbage bags and disposable dinnerware are now available for home use (see www.simplybiodegradable.com or www.trellisearth.com). Ask your grocery and other retail store managers to provide biodegradable plastic bags for customers.

Step 3: Use Alternatives to Plastic

Glass, ceramic and stoneware do not leach chemicals into foods. Glass recycling is also more environmentally friendly than plastics recycling. (Note: Some foreign-made ceramics use a lead-based glaze, introducing other potential health risks. When in doubt, check with the manufacturer.)

Instead of disposables, use canvas shopping bags or dinnerware made from bamboo or other environmentally friendly materials.

Stainless steel containers are both inexpensive and 100% recyclable and will not react with foods during cooking.

Wax paper sandwich bags are an alternative to plastic sandwich bags.

Wood cutting boards are preferable to plastic. Clean your cutting board with vinegar to kill bacteria after each use.

ICEH Medical Advisor Dr. Larry B. Silver is a child and adolescent psychiatrist and clinical professor of psychiatry at Georgetown University Medical Center. His popular book *The Misunderstood Child: A Guide for Parents of Children with Learning Disabilities* is now in its fourth edition. His other books include *Attention Deficit Hyperactivity Disorder: A Clinical Guide to Diagnosis and Treatment for Health and Mental Health Professionals* and *Dr. Larry Silver's Advice to Parents on Attention Deficit Hyperactivity Disorder*. Past president of the Learning Disabilities Association of America, he received their Learning Disabilities Association Award. He also received the Berman Lifetime Achievement Award from the American Academy of Child and Adolescent Psychiatry for his contributions to the study and treatment of learning disabilities.

For more information or for other Practice Prevention columns, visit the Institute for Children's Environmental Health (ICEH) online at www.iceh.org/resources.html or call 360-331-7904.



ICEH serves as the national coordinator for the Collaborative on Health and the Environment's Learning and Developmental Disabilities Initiative.



Additional Resources

- Adverse Health Effects of Plastics, www.ecologycenter.org/fact_sheets/plastichealtheffects.html
- PVC — Bad News Come in Threes, www.besafenet.com/PVC04/majorfindings.pdf
- Researcher Dispels Myth of Dioxins and Plastic Water Bottles, www.jhsph.edu/publichealthnews/articles/halden_dioxins.html
- Toy Safety, <http://toysafety.net/toysafety.asp?id2=20594>.
- General information on healthier consumer choices, www.thegreenguide.com/

Footnoted resources

1. Michael Belliveau and Stephen Lester. PVC: The Bad News Comes in 3's: The Poison Plastic, Health Hazards and the Looming Waste Crisis. December 2004, http://www.besafenet.com/PVCDisposalReport_2-Column_R6.pdf, viewed 4/6/2006.
2. Waldman P. From an Ingredient in Cosmetics, Toys, A Safety Concern. *Wall Street Journal*, October 4, 2005, page A1.
3. Colon I, Caro D, Bourdony CJ, Rosario O. Identification of phthalate esters in the serum of young Puerto Rican girls with premature breast development. *Environmental Health Perspectives*, 2000 Sep;108(9):895-900. Comment in: *Environmental Health Perspectives* 2004 Jul;112(10):A541-3.
4. Tsuda H, Naito A, Kim CK, Fukamachi K, Nomoto H, Moore MA. Carcinogenesis and its modification by environmental endocrine disruptors: in vivo experimental and epidemiological findings. *Japanese Journal of Clinical Oncology*. 2003 Jun;33(6):259-70.
5. Bornehag CG, Sundell J, Weschler CJ, Sigsgaard T, Lundgren B, Hasselgren M, Hagerhed-Engman L. The association between asthma and allergic symptoms in children and phthalates in house dust: a nested case-control study. *Environmental Health Perspectives*, 2004 Oct;112(14):1393-7. Comment in: *Environmental Health Perspectives*, 2005 Mar;113(3):A152-3.
6. Glue C, Platzer MH, Larsen ST, Nielsen GD, Skov PS, Poulsen LK. Phthalates potentiate the response of allergic effector cells. *Basic & Clinical Pharmacology & Toxicology*, 2005 Feb;96(2):140-2.
7. Ganning AE, Brunk U, Dallner G. Phthalate esters and their effect on the liver. *Hepatology*. 1984 May-Jun;4(3):541-7; and Rhind SM, Kyle CE, Telfer G, Duff EI, Smith A. Alkyl phenols and diethylhexyl phthalate in tissues of sheep grazing pastures fertilized with sewage sludge or inorganic fertilizer. *Environmental Health Perspectives* 2005 Apr;113(4):447-53.
8. Institute for Children's Environmental Health. Thyroid Hormone Fact Sheet. <http://www.iceh.org/pdfs/LDDI/PracPrevention/ThyroidFactSheet.pdf>, viewed 4/3/2006.
9. Schantz SL, Widholm JJ. Cognitive effects of endocrine-disrupting chemicals in animals. *Environmental Health Perspectives*, 2001 Dec; 109(12): 1197-1206.
10. Mandal PK. Dioxin: a review of its environmental effects and its aryl hydrocarbon receptor biology. *Journal of Comparative Physiology. B, Biochemical, Systemic, and Environmental Physiology*. 2005 May;175(4):221-30; Kakeyama M, Tohyama C. Developmental neurotoxicity of dioxin and its related compounds. *Industrial Health*. 2003 Jul;41(3):215-30; Wang SL, Su PH, Jong SB, Guo YL, Chou WL, Papke O. In utero exposure to dioxins and polychlorinated biphenyls and its relations to thyroid function and growth hormone in newborns. *Environmental Health Perspectives* 2005 Nov;113(11):1645-50.; ten Tusscher GW, Koppe JG. Perinatal dioxin exposure and later effects — a review. *Chemosphere*. 2004 Mar;54(9):1329-36.
11. Ten Tusscher GW, Koppe JG. Perinatal dioxin exposure and later effects--a review. *Chemosphere*, 2004 Mar;54(9):1329-36.
12. vom Saal FS. Low-dose BPA: confirmed by extensive literature. *Chemistry & Industry*, 4 April 2005:14-15; vom Saal FS. Plastic Promises: Better Living or Bodily Harm. Slide presentation, Seattle, 15 Feb. 2006; and <http://endocrinedisruptors.missouri.edu/vomsaal/vomsaal.html>, viewed 4/11/2006.
13. Al-Malack MH. Effect of UV-radiation on the migration of vinyl chloride monomer from unplasticized PVC pipes. *Journal of Environmental Science and Health. Part A, Toxic/Hazardous Substances & Environmental Engineering*. 2004;39(1):145-57; Froneberg B, Johnson PL, Landrigan PJ. Respiratory illness caused by overheating of polyvinyl chloride. *British Journal of Industrial Medicine*. 1982 Aug;39(3):239-43; Genovesi MG, Tashkin DP, Chopra S, Morgan M, McElroy C. Transient hypoxemia in firemen following inhalation of smoke. *Chest* 1977 Apr;71(4):441-4.
14. vom Saal FS. Plastic Promises: Better Living or Bodily Harm. Slide presentation, Seattle, 15 Feb. 2006; and <http://endocrinedisruptors.missouri.edu/vomsaal/vomsaal.html>, viewed 4/11/2006.