Polycarbonate Plastic Water Bottles: Are They a Health Risk?

I. Background

Plastic is a commonly used material to hold beverages because it is lightweight, durable, inexpensive, and convenient. Items made from plastics are often labeled with a number (usually 1 through 7) to indicate a particular type of plastic. Polycarbonate, a type of plastic that can be used to create plastic water bottles is frequently labeled #7 on containers. A recent concern is that water bottles made from polycarbonate material that are often reused may leach chemicals such as bisphenol A (BPA) into the water and cause adverse health effects. This document will examine what BPA is; where it is found; whether or not it leaches into liquids; and whether or not it has an adverse effect on human health. Given that current research on BPA has indicated mixed evidence regarding its impact on human health, this guidance provides ways to minimize possible exposure to BPA if polycarbonate bottles are the preferred choice for storing liquids.

II. Guidance

What is Bisphenol A?

Bisphenol A is a chemical produced for use in the production of polycarbonate plastics and epoxy resins (NIEHS, 2008). Polycarbonate is often used in the manufacturing of water bottles and infant feeding bottles, and resins can often be found in the lining of food cans, in bottle tops, and in water supply pipes (NIEHS, 2008; Kamrin, 2004; Kang, 2006). Bisphenol A can also be found in dental sealants, tooth coatings, and children’s toys (CERHR, 2007; Vom Saal and Hughes, 2005).

What are current levels in the population and what is deemed safe?

A recent study by CDC measuring exposure to bisphenol A in the US population found that BPA was detected in 92.6% of the study population when urine samples of 2,517 participants 6 years of age and older were analyzed (Calafat et al., 2008). Differences in concentration levels were found amongst children, adolescents, and adults. Children had higher concentrations of BPA than adolescents and adolescents in turn had higher concentrations of BPA than adults (Calafat et al, 2008). Current EPA standards state that the accepted lowest observed adverse effect level (LOAEL) for BPA is 50 micrograms (or .00005 grams) of BPA per kilogram of body weight per day (EPA, 1988).

Based on metabolic studies on BPA, more than 99% of free BPA and its metabolites are excreted in feces and urine (Kang, 2006). Until recently, many of the studies have looked at rat metabolism, but studies on humans have shown that orally administered BPA is metabolized more quickly and completely in humans than in rats (Kamrin, 2004).
What is the health concern?

Two main causes of concern about BPA use in plastic containers are that it can leach into water and may cause adverse reproductive and developmental toxicity in humans.

Does BPA leach into liquids?

Research examining whether BPA is released from polycarbonate drinking bottles and baby bottles used for the consumption of water and other liquids have ranged from non detectable to detectable levels under varying test conditions (Tan and Mustafa, 2003; Howe and Borodinsky, 1998; Kang et al., 2006; Le et al., 2007). Although the literature has shown mixed results of BPA levels detected in liquids at various temperatures and time duration, studies have found that exposing polycarbonate drinking bottles to hot water (e.g., boiling water at 100 degree Celsius) and leaving the water over time at room temperature increased the rate of BPA migration (Kang et al., 2006; Le et al., 2007). A European study, looking at the migration of bisphenol A in both new and used bottles, found that baby bottles subjected to dishwashing, boiling, and brushing had higher levels of bisphenol A released when filled with 100 degree Celsius water as compared to new bottles (Brede et al., 2003). BPA migration from used polycarbonate containers as opposed to new containers can be due to the degradation of the polymers; although the carbonate linkages are said to be stable, they can breakdown in hot water or when exposed to acidic and alkaline solutions (Kang et al., 2006; Vom Saal and Hughes, 2005).

Does BPA have an effect on human health?

The primary concern of BPA on human health is that it exhibits similar biological activities as estrogen and may affect reproductive and developmental health. At high doses, laboratory animal testing has shown that BPA has an effect on the uterus and prostate glands of experimental animals (CDC, 2008). Studies on laboratory rodents who were exposed to high levels of BPA during their pregnancy and/or lactation, which exceed estimated exposure levels in children, adults, or workers, have found reduced survival, birth weight, growth, and delayed onset of puberty in rodent offspring (NIEHS, 2008).

Recently, there has been concern that low doses of BPA could affect human development and reproduction because of research showing that BPA, even at low levels, exhibits estrogen-like activity (Le, Carlson, Chua, Belcher, 2008) and could possibly be an endocrine disruptor (Kamrin, 2004; Vom Saal and Hughes, 2005; Kang 2006). Reviews of published studies have shown evidence both for and against the adverse effects of low doses of BPA in animals. Some researchers assert that attempts to demonstrate or replicate adverse effects of low doses of BPA in laboratory settings and other investigations unsuccessful (Kamrin, 2004; Harvard Center for Risk Assessment, 2004), and others have found that BPA has had a negative developmental and reproductive effect on human health.

An extensive review of 115 published experimental animal studies with low doses at or below 50 µg/kg/day reported estrogenic activity in 94 studies. Among the 94 low dose studies, 31 published studies reported effects such as changes in brain chemistry and structure, behavior, the immune
system, enzyme activity, and male and female reproductive systems in various animal studies including snails, fish, frogs, mice, and rats. However, whether there was a positive or negative finding was dependent on the funding source of the study. Of the 104 government studies, 94 (90%) report significant effects whereas 0 out of the 11 (0%) report negative findings when the same dose levels were used (Vom Saal and Hughes, 2005). The review concluded that additional research was required at doses even below the current reference dose.

In the past year, the National Institute of Environmental Health Sciences’ Center for the Evaluation of Risks to Human Reproduction (CERHR) convened a 12 member panel of government and non-government scientists to examine and understand the inconsistent findings in low-dose studies (CERHR, 2007). In their report, the panel mentioned several large, robust, well-designed studies with multiple dose groups using several strains of rats and mice in which no adverse reproductive effects at low-to-moderate dosage levels of BPA were detected. Furthermore, none of these studies detected changes in prostate weight, age at puberty, pathology or tumors in any tissue, or reproductive tract malformations (CERHR, 2007). The panel concluded that negligible concern for adverse reproductive effects exists in the non-occupationally exposed general adult population. However, within certain sub-populations, such as pregnant women and fetuses, there is:

- Some concern that BPA exposure in utero causes neural and behavioral effects (CERHR, 2007)
- Minimal concern that BPA exposure in utero causes effects on the prostate as well as accelerations in puberty (CERHR, 2007)
- Negligible concern that BPA exposure in utero results in birth defects or malformations (CERHR, 2007)

Among infants and children, there was some concern among panel members that BPA exposure causes neural behavioral effects and minimal concern that can potentially accelerate puberty (CERHR, 2007). A recent draft conclusion of the National Toxicology brief based on conclusions from the CERHR panel has elevated the concern for possible effects of BPA on prostate gland, mammary gland, and acceleration of puberty among exposed fetuses, infants, and children (NIEHS, 2008)

- CDC and CERHR’s panel of scientists both state that the evidence that BPA effects human health is inconclusive as scientists continue to have differences of opinion on this topic (CDC, 2008; CERHR, 2007). The mixed evidence in literature supports this conclusion.
- FDA is currently NOT recommending to consumers to discontinue use of products containing BPA while they convene an agency-wide task force to conduct a risk assessment of all BPA products that its agency regulates (FDA, 2008).
What are other alternatives to polycarbonate water bottles?

Although literature on the adverse effects of polycarbonate bottles on human health is inconclusive, consumers have choices beyond polycarbonate bottles. Other material options used for containing drinking water include plastics without bisphenol A, metal, and glass. Water bottles from #1 (Polyethylene terephthalate ethylene) or #2 (high density polyethylene) plastics, unlike those made from polycarbonate, are for single use only.

Because of recent media attention, several manufacturers have announced plans to produce and market BPA products including plastic water bottles that will NOT contain BPA.

Helpful hints when using polycarbonate bottles

If a polycarbonate bottle is the preferred choice, some helpful hints in reducing the possibility of leaching include the following:

- Discarding any old or scratched bottles
- Avoiding the use of warm or hot liquids
- Avoiding microwaving the bottle
- Avoiding use of the bottle for storing acidic or alkaline solutions
- Replenishing water frequently

Bacterial contamination is another health concern of water bottle use and can be reduced by thorough daily cleaning but avoid harsh detergents that may increase chemical leaching.
III. Additional Information


Center for Disease Control. (2007). National report on human exposure to environmental chemicals spotlight on bisphenol A and 4-tertiary-Octylphenol. Atlanta, GA.


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