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Poisonous Plastics; Phthalate Toxicity

Phthalate's are man-made chemicals, developed within the last century that are used to give plastic items their strength, flexibility & durability. They're used in virtually all plastic items and some pesticide formulas, detergents, adhesives and other items. Most readers can recall getting an Email warning of the dangers of microwaving foods and drinking water stored in plastic bottles. These concerns are due to the potential for toxicity and long-life in the environment.

What are they?

Phthalate's are organic chemicals, the term organic simply means that they have carbon, hydrogen, oxygen and other elements that are widely known as the building blocks of life. They can also be toxic. In the case with phthalates, there is a large amount of controversy in terms of the degree that their toxicity is known or suspected.

What are the most common agents?

Di-n-butyl phthalate (DBP); Industrial solvent used in products such as nail polish, cosmetics and insecticides.
Diethyl phthalate (DEP); Industrial solvent used in many consumer products, mostly in those containing fragrances. Products include perfume, cologne, bar soap, shampoo and hand lotion.
Bis-2-ethylhexyl phthalate (DEHP); Primarily used to produce flexible plastics (PVC tubing, Blood bags). Formally used in children's toys and food packaging in the U.S.
Are the most common molecules in these classes.
These chemicals are very beneficial, we wouldn't really be able to enjoy many of the comforts and conveniences we've grown accustomed to without them. Humans are exposed to phthalates by way of Inhalation, Ingestion, Skin and Eye contact and also by direct injection. Below are the exposure routes and common sources.
DBP and DEHP residues have been found in fish, water, and sediment, however, these phthalates do not bioaccumulate. The major sources of phthalates in waterways are from municipal and industrial effluents. Phthalic acid esters (PAE's) can absorb to particulate matter in the stream and be deposited in the streambed. DBP and DEHP can bind with fulvic acid, a chemical found in humic substance in soil and water because of the phthalate-fulvic acid is water soluble it can quickly move the insoluble PAE in aquatic ecosystems. DEP under aerobic conditions will have a half live of 2 days to 2 weeks in aquatic systems but

if absorbed onto suspended particles can exist in the soil sediment for over a century. DBP, DEHP, and DEP have all been found in city drinking water in both surface and groundwater systems in low levels.

Controlling Phthalate Exposures:
Ideally we'd be able to get by without these agents. We probably won't see that in our lifetime. There are some ways to reduce the amount in our plastics however, such as using a 3 layer polypropylene plastic in blood bags to allow needed softening while maintaining the barrier protection. Other substitutes would include silicon, polyurethane, polyethylene and nylon. Disposal of the effluent can also be regulated. Microbes can degrade DEHP in weeks, light degrades DEP.

Why do we care, what's the harm to us?
When DEHP enters the human body, the compound is metabolized into various substances that are more readily excreted. Unfortunately, the most important of these metabolites, mono-ethylhexyl phthalate (MEHP) is thought to be responsible for much of DEHP's toxicity. The enzymes that break down DEHP into MEHP are found mainly in the intestines but also occur in the liver, kidney, lungs, pancreas, and plasma. Because conversion of DEHP to MEHP occurs primarily in the intestinal tract, exposures to DEHP by ingestion may be more hazardous than by intravenous exposure, which largely bypasses the intestinal tract.
MEHP is not the only metabolite of DEHP and many of the known secondary metabolites have not been studied for their toxicity.
Mechanisms of toxicity are likely to be multiple and variable, depending on the health endpoint, the organ, and species studied. One very important point to make is that no human studies have been done. Any time lab animal studies are done, there is ALWAYS a potential that results in a given species of lab animal won't cause the same result in humans. Another caveat is that total dose administered, time course of exposure (prolonged low-level vs. "one time" high dose exposure) can also cause variable results. In mature animals, each phthalate has a different toxicity profile. The liver, kidneys, thyroid, and testes are common targets for general toxicity from oral exposures.
Liver cancer has been found to develop in rats exposed to these agents.
Reproductive system toxic effects are the bigger problem. Although there is a lot of controversy on whether these agents are toxic and how dangerous the toxicities are, one agreed upon finding is that they seem to target the reproductive system, probably by mimicking hormones and thus interfering with the normal numerous functions that hormones are responsible for. DEHP is known to shrink the testes in rats, mice & guinea pigs. Lowered sperm counts have been found in humans exposed to phthalates.
Adverse effects also include death and disfigurement/dysfunction to developing embryo's. Again this is probably due to molecular mimicry that goes on with the hormone systems during development. Adverse effects include deformed cleft palate, vertebrae in the neck and upper back, ribs, and kidney changes.
Some of the phthalates have estrogen-like effects. Women who are pregnant with a male child are at risk for abnormal development of the child after phthalate exposure during pregnancy due to molecular mimicry that enables these compounds to alter male sexual development in the brain and other organs.
In humans we know that these chemicals are lipo-phillic or fat-loving. They tend to accumulate in fat deposits where they are cleared very slowly. Testing to detect long-term exposure is done on fat biopsies for this reason. Studies of human tissue show that levels of 0.3-1.0 ppm (parts per million) have been found in up to 48% of specimens (patients) sampled. Clearly we have proof that these agents are getting into our systems and that they have a role in our metabolism. To date we don't have evidence that phthalates cause cancer in humans. We know that rodents develop cancers, but these studies did not show DNA reactivity, they showed peroxisome proliferation, a different mechanism of action that has not been documented to have occurred in human exposures.

Conclusion:
There is a tremendous amount of dispute and controversy as to whether these compounds are harmful, what the harms may be and what the safe exposure levels, tissue levels and routes of exposure may be. Those at highest risk due to most intense exposure are the folks using medical equipment. It's essential to keep in mind a mental balance sheet on these compounds; on one side, what are the benefits? Convenience, safety from exposure to infected body fluids, ease of storing food, ease of life afforded by the many roles that plastics play in our lives and our very culture.

The other side of the equation would involve the detriments which are more suspected than well-established. The cancers caused in rodent populations are due to a mechanism that doesn't involve humans, but there is still evidence that these chemicals can mimic hormones and play a role during pregnancy and potentially with breast feeding. We also know that these compounds are stored long-term in our body fat which raises the question of what long-term adverse effects occur without being recognized. It may be prudent to recall as well that these compounds are metabolized to many secondary compounds with potential toxicities of their own. Any time man-made compounds are metabolized by God-made organs that weren't designed to handle these compounds, there is a risk for molecular mishaps. For years margarine was touted as being safer than butter, causing less cardiovascular disease risk. Now we know that trans-fats are probably more dangerous than use of butter in moderation. All in all, perhaps we should remember that it's best to not to try to fool (around with) mother nature!

Please remember that I'm always looking for topics of your interest to write about. If you have any topics that you'd like to see discussed, please contact me at my website; www.tequestafamilypractice.com and use the link to DrOenbrink@teqfamprac.com

Thanks and Stay Healthy!

http://enhs.umn.edu/5103/phth/intro.html for more information.