Endocrine Disruptors:
playing havoc with our hormones

Version 1.0

Rachel Carson shocked the world in her landmark book *Silent Spring* back in 1962 with a detailed scientific account of the devastating effects of synthetic chemicals on the reproductive systems and behaviour of fish and reptiles.

At the time, the evidence presented was not well accepted, much less recognized by industry, government and academia. Eventually though, government officials and industry leaders were forced to acknowledge the legitimacy of this work. With publication in 1995 of Our Stolen Future, evidence of the profound effect of endocrine disruptors on normal growth and development in wildlife and humans could no longer be ignored.

Today, new results, new modes of action and new perspectives have triggered almost daily reports on how chemicals disrupt the endocrine system. In the past several years, six broad and disconcerting trends have emerged.

- All living birds, mammals and humans alive today have been exposed.
- Laboratory experiments with animals show that exposures to endocrine disruptors have impacts at levels far below those that had been considered possible.
- Many more systems governed by hormones – perhaps all chemically mediated message systems are now considered vulnerable to endocrine disruptors.
- Many more compounds are now known to act as endocrine disruptors.
- Human health effects have recently been expanded to include impacts of adult exposure to endocrine disruptors on fetal development.
- Traditional toxicological methods, emphasizing the dose-response curve, have proven ineffective in studying endocrine disruptors.

What is the endocrine system?

The endocrine system is a complex network of glands that produce and secrete the hormones that regulate all the major body functions in birds, reptiles and mammals, including humans. The most important of these functions are growth, development and reproduction. The main endocrine glands include the pituitary that regulates the other endocrine glands; the thyroid, that controls metabolic rate; the parathyroid that regulates blood calcium; the adrenals, that manage the body's fluid balance; the pancreas, that regulates blood sugar; the pineal gland, that is believed to moderate biorhythms and moods and stimulate the onset of puberty and lastly, the gonads (ovaries in females and testes in males) that control the development of sex characteristics and functioning of sex organs.

How do endocrine disruptors alter hormone function?

An endocrine disruptor is a synthetic chemical that when absorbed into the body can disrupt normal hormone functioning. There are four main mechanisms by which endocrine disruptors can alter normal hormone function.

They can:

- mimic or partially mimic the sex steroid hormones (estrogens and androgens) by binding to hormone receptors or influencing cell signalling pathways;
- block, prevent and alter hormonal binding to hormone receptors or influencing cell signalling pathways;
- alter the production and degradation of natural hormones; and
- modify the creation and function of hormone receptors.

How are we exposed?

Today, synthetic chemicals with known or suspected endocrine disrupting capabilities are pervasive in our air, water and food. Workers manufacturing products containing these chemicals are also exposed in the workplace and citizens purchasing these products are exposed during use. No one – from the unborn to the oldest – has escaped exposure. To date, a large and growing number of chemicals have been implicated as endocrine disruptors. These include:

Phthalates are a group of chemicals identified as having endocrine disrupting capability. Their primary use is in plastics, as a softener, but they also have application in perfumes, cosmetics, hairsprays, lubricants and finishers.

Alkylphenols and their derivatives are yet another group of chemicals known to disrupt endocrine function. Alkylphenols are used as detergents and as plasticisers and stabilizers in plastics.

Bisphenol A, also an alkyl phenol, is a component of epoxy resins and polycarbonate plastics used to package food and drinks. It has also been employed in the resins that commonly coat food cans, bottle caps and water supply pipes.

Polychlorinated biphenols or PCBs have been used since 1929 as heat transfer fluids in transformers and as dielectric fluids in capacitors. PCBs are persistent in the environment, resistant to biodegradation and tend to accumulate in living organisms, with those highest in the food chain most affected.

Dioxins and furans are similar in structure to PCBs. These chemicals are not manufactured but are created during incineration and also display endocrine disrupting capabilities.

Brominated flame retardants or BFRs are a group of chemicals added to consumer goods such as electronics and textiles to reduce the potential for fire. The heating and burning of materials containing these chemicals can produce by-products known to alter endocrine function.

Pesticides' power to disrupt normal hormonal functioning is well documented. This is particularly true of DDT, a pesticide banned in the industrialized world, but still manufactured and sold to developing countries.

Heavy metals such as lead, mercury and cadmium have been known to impact fetal brain development and functioning for hundreds of years. Mothers exposed to these metals through environmental releases from the mining, chemical and power industries or from consumption of contaminated food and water have inadvertently exposed and affected their unborn children.

What are the health effects?

Most of the evidence accumulated to date on the health effects associated with exposure to chemicals that disrupt the endocrine system comes from observations and studies of wildlife. Within this group, the embryo and fetus, whose growth and development are closely regulated by the endocrine system, appear particularly vulnerable to exposure to chemicals with endocrine disrupting capability. Females exposed to these chemicals can pass them to developing offspring, either in eggs (amphibians, reptiles, birds) or the womb (mammals) and after birth through breastfeeding. So while adult animals may not display ill effects, their offspring may suffer lifelong health effects including modified immune systems, altered sexual behaviour, reduced fertility, masculinization of females, feminization of males,

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malformed fallopian tubes, cancers of the uterus, cervix and male and female reproductive tracts.

Information obtained from investigations of human populations is strikingly similar. Exposure to chemicals displaying endocrine disrupting properties has been related to a wide range of problems including impaired reproductive patterns and reduced endocrine, immune and central nervous system functioning. Also cancers of the reproductive system (prostate, testicles, ovaries, endometrium and female breast) now account for 30 percent of all cancers in total and are on the rise worldwide. Between 1970 and 1987, ectopic pregnancies increased four-fold in the United States. The incidence of undescended testes is also growing in many industrialized countries. Additional scientific research reveals a significant decline in the quality and quantity of male human sperm.

But perhaps the most convincing evidence that synthetic chemicals act like hormones comes from the human experience with the drug diethylstilbestrol or DES. DES is a strong synthetic estrogen provided to pregnant women in the 1950s and 1960s during periods of critical fetal development to prevent miscarriage. Children of women who took this drug display a higher than expected number of reproductive abnormalities, including cancer. Laboratory studies have since confirmed these findings in mice.

More disturbing than this however, is the ability of endocrine disruptors to impair human neurological and physical behaviour. Children of mothers with high blood levels of metals and dioxins have shown impaired cognitive functioning when measured at birth and also in later years. Delayed language development, lower intelligence, and deficiencies in memory and attention are evident in children of mothers exposed prenatally to chemicals with endocrine disrupting ability.

What can be done?

Addressing the concerns associated with endocrine disruptors is one of the greatest challenges the human race faces this decade and beyond. It will take individual and collective action. Informed consumer choices for instance, can help. Limiting, wherever possible, the purchase and use of products that were produced using these chemicals or contain these chemicals is an important step. But rethinking the way these chemicals are made and used in the first place is clearly the most effective approach.

Efforts to move in this direction are gaining hold worldwide. Dr. Michael Braungart, a German chemist and William McDonough, an American architect, leaders in this new approach, have recently proposed guidelines that advocate reducing the number of chemicals used in a given product, only manufacturing products with known chemical components and refraining from producing products that don't quickly and easily degrade in the environment. This approach also proposes intelligent design and manufacture of products, handling material in the same way nature recycles waste.

Some practical examples include work completed by fabric and car manufacturers. DesignTex, a New York based group of textile designers and distributors, recently developed a new process using fewer chemicals and none with known toxicological properties, to create fabric of natural fibers and colours. Car manufacturers are also considering similar tactics including a redesign of some of their most popular models such that parts can be easily disassembled and recycled at the end of their life.

Voluntary measures alone though will not achieve the paradigm shift necessary to effectively deal with this issue. In Europe, phthalate additives in polyvinyl chloride (PVC) toys for children under the age of three have been banned. The European Union has also passed an End-of-Life Vehicle Directive legislating the phase-out of toxic substances in auto production, including endocrine disrupters like lead, mercury and cadmium.

Closer to home, Massachusetts requires all companies using some 250 of the most toxic substances, many of which are endocrine disrupters, to file an annual plan with the state detailing their targets for reduction and how they will achieve them. Here in Canada, municipalities are passing bylaws to eliminate cosmetic use of pesticides. These initiatives and others are prompting many to ask, can we not accomplish this in all jurisdictions? With these laws we can protect both worker and environmental health.

A recent international treaty on Persistent Organic Pollutants (POPs) represents one of a few efforts on this front. A product of United Nations negotiations, it was adopted in May 2001 at a diplomatic conference held in Stockholm, Sweden.

This legal instrument aims to phase out and eventually eliminate the 'dirty dozen' of persistent organic pollutants, including endocrine disrupters like PCBs, dioxins and furans and DDT. To their credit representatives of Canada were the first of 50 countries needed to ratify the Stockholm Convention. To date 24 countries have followed Canada's lead. Meantime, several ratifying countries are not content to wait until the Convention comes into effect, they are moving ahead with implementation now.

The benefits of such actions are great because exposure to these chemicals has not yet altered genetic material, only how genes are expressed, and the damage seen today can be reversed. The next generation need not suffer reduced intellectual, immune or reproductive capacity. If exposure to endocrine disruptors can be eliminated, future generations have the opportunity to grow and develop, once again, in the way nature intended.

EDITOR'S NOTE:

The Workers Health & Safety Centre offers many training programs on issues related to endocrine disruptors. Also be sure to visit the World Wildlife Fund website **www.wwf.ca** for information on their endocrine disruptors campaign, and **www.greenhealthcare.ca** for information about the Canadian Coalition of Green Health Care's efforts to promote PVC- and mercury-free alternative products.

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