Unnecessary Hazards

How Safer Alternatives Can Reduce Our Exposure to Toxic Chemicals

Environment Connecticut
Research & Policy Center

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Cover Photos: Daniel Clarke (Leaf) and Patti Adair (Pesticides)

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Executive Summary

Connecticut citizens are exposed to thousands of harmful toxic chemicals in the course of daily life. Hundreds of substances that didn't exist even 50 years ago can now be found in our blood and body tissues. However, unlike pharmaceutical drugs, most of these chemicals have not been tested for safety.

This report explores 10 types of chemicals that contaminate Connecticut's homes and environment and put our health at risk. For each type of chemical, safer alternatives exist that can be implemented at minimal cost, or even net savings. However, the use of alternatives is not yet widespread.

Connecticut should require the use of safer alternatives for dangerous chemicals found in commerce. Such action can protect Connecticut's environment, workers, and our families – without harming the strength of Connecticut's business and industry community.

Chemical exposure is widespread.

- In a 2003 study, the U.S. Centers for Disease Control and Prevention (CDC) found DEHP, a type of chemical used to add flexibility to plastic medical equipment, plastic wrap, flooring, and other items made from polyvinyl chloride (PVC), in more than three-quarters of Americans tested.
- Pesticides and their breakdown products are commonly found in people. In a recent survey, the CDC found 13 different pesticides in the blood and urine of the average American (out of 23 pesticides under consideration).
- Scientists have found PBDE flame retardant chemicals (commonly added to foams, plastics, and electronics) in rapidly increasing amounts in blood, body tissues and breast milk; levels in Americans are by far the highest in the world.
- Industrial sites and waste dumps, like the Precision Plating superfund site in Vernon, contaminate Connecticut's environment and groundwater with solvents and metals like trichloroethylene, lead and hexavalent chromium.
- Indoor air in homes can be contaminated with formaldehyde from building materials and perchloroethylene emitted from recently dry-cleaned clothing.
- Incineration of wastes containing PVC or related compounds creates dioxin, one of the most toxic substances known.

Toxic chemical exposures put our health at risk.

- DEHP exposures at levels commonly found in Americans have been linked to stunted reproductive development in baby boys and to the development of asthma in children and adults.
- *In utero* exposure to 2,4-D, a pesticide regularly used in lawn care, can lead to birth defects. Organophosphate pesticide exposure has been associated with miscarriage, reduced birth weight and childhood leukemia.
- PBDE flame-retardant chemicals given to newborn mice in small doses permanently impair their learning and behavior.
- The CDC estimates that at least a half million children in the U.S. suffer from irreversible neurological damage from lead poisoning.
- Hexavalent chromium, dioxin, perchloroethylene, formaldehyde and trichloroethylene can all cause cancer.

Safer alternatives can substitute for many uses of toxic chemicals.

- Kaiser Permanente is using safer plastics free of DEHP for IV bags, tubing and catheters.
- By the end of 2007, all of Connecticut's elementary schools and day care providers will stop using cosmetic pesticides for landscaping and lawn care. These institutions can replace pesticides with organic fertilizers and toxic chemical-free pest control techniques.

- Sony and Panasonic have eliminated PBDE flame retardants from television casings while still meeting the highest fire-safety standards, changing to another type of plastic housing that can be treated with safer flame retardants, or to an inherently non-flammable material.
- TEK industries in Vernon and Technical Manufacturing Corporation in Durham offer lead-free electronic component manufacturing services.
- Some cleaners in Connecticut, including Legacy Cleaners in Darien and Colonial Cleaners in Ridgefield, offer "wet cleaning" services, an alternative to dry-cleaning methods that rely on perchloroethylene.
- Building Performance Construction, based in Ridgefield, builds and renovates homes to improve efficiency and health, using building materials that do not emit formaldehyde or other potentially toxic gases.

Reducing exposure can prevent harm.

- The EPA banned household uses of the pesticides chlorpyrifos and diazinon in 2001. The effect of this health-protective action was nearly immediate. After 2001, mothers in New York City had lower levels of these compounds in their bodies and, remarkably, gave birth to heavier and longer babies than before the pesticide ban.
- The phasing out of leaded gasoline and other efforts to reduce lead exposure have reduced the number of children with toxic levels of lead by half over the last decade.

Some manufacturers are ahead of the curve in adopting alternatives to toxic chemicals – especially companies wanting to do business in states and countries with tougher regulations for dangerous chemicals, such as the European Union. However, to make the use of alternatives widespread, Connecticut needs to establish its own reforms.

Connecticut should ensure the safety of all products on the market through comprehensive chemical policy reform, including:

- ***Phase out hazardous chemicals.*** Chemicals that pose serious threats to public health or the environment should be phased out of uses that lead to human exposure, where safer alternatives are available. Connecticut can start by phasing out the use of deca BDE flame retardant in electronic equipment, expanding the elementary school lawn care pesticide ban to include middle and high schools, phasing out DEHP from medical equipment and building materials, and removing any toxic chemical that persists in the environment and accumulates in the food chain from commerce.
- ***Assist businesses in switching to alternatives.*** Connecticut should establish a program similar to the Massachusetts Toxics Use Reduction Act, including requiring information from manufacturers on the volumes of chemicals used in manufacturing and distributed in consumer products. The program should also include a program similar to the Toxics Use Reduction Institute in Massachusetts that can help local businesses identify and implement safer and cost effective alternatives to toxic chemicals and manufacturing processes.
- ***Reform chemicals policy.*** Currently, manufacturers can put chemicals on the market without proving they are safe. Chemical manufacturers should be required to provide all hazard and health-effects information to the government so agencies can begin to assess the thousands of chemicals currently on the market for which little or inadequate data are available. Next, pre-market hazard and health-effects testing should be required for all new chemicals before they are introduced into commerce. Finally, Connecticut agencies must have the authority to ban or restrict the use of a chemical if it poses a risk of environmental contamination or can harm human health, and if safer alternatives are available.

Introduction

Children in Connecticut today grow up surrounded by synthetic chemicals. Their food containers are made with plastic, from reusable bowls to throwaway wrapping. Their homes and yards are treated with pesticides. Their families use cosmetics and personal-care products that contain hundreds of manufactured additives. The furniture and electronics in their homes contain flame retardant chemicals.

And they're not just nearby, contained within our consumer goods. Many of these chemicals escape from products and end up in household dust and in household air.[1] They've become such a part of our lives that these substances are now found with chilling regularity in the blood and bodies of every mother and child.[2]

Since World War II, annual chemical production in the United States has grown more than 15-fold. Today, U.S. companies are the world's largest chemical producers, generating more than 1.2 billion tons of chemicals each year and more than $400 billion in sales.[3] The chemical industry has introduced tens of thousands of new products – substances that did not exist anywhere on Earth before the industrial revolution. While these chemicals have had many undeniable benefits for society, from improved medical care to increases in economic productivity made possible by electronics, the benefits have come with unintended side effects. From plastics to pesticides, the modern world contains potentially hazardous substances in far greater amounts than at any time in human history.

There are now more than 75,000 industrial chemicals on the market in the United States. The health effects of almost half of the major industrial chemicals have not been studied at all.[4] Of those that have been studied, approximately 1,400 chemicals with known or probable links to cancer, birth defects, reproductive impacts, and other health problems are still in use today.[5]

Some common household items are made with developmental toxicants – chemicals that can alter the sequence of events that leads to a healthy life. These substances are with us every day, and they do not stay safely inside the products they helped create: bisphenol-A can be found in plastic food containers and water bottles; phthalates are common in everything from vinyl flooring to food wrappings to beauty products; and flame retardants can be found in electronics and furniture. Developmental toxicants are capable of causing diseases, creating birth defects, reducing the mental or physical abilities of children, and altering normal behavior patterns.[6]

Industrial facilities in Connecticut also use metals like hexavalent chromium and solvents like trichloroethylene – both cancer-causing chemicals. These substances can contaminate waste sites as well as the state's air and water. Some industrial chemicals with links to cancer or other chronic diseases end up in products destined for the home – such as formaldehyde in pressed wood products, or diethylhexyl phthalate in vinyl flooring.

Although it is usually impossible to connect a single chemical to a broad health trend, the evidence continues to mount that toxic chemicals likely have a significant impact on the health of both children and adults.

The risks begin at conception. The National Academy of Sciences estimates that nearly half of all pregnancies in the U.S. end with the loss of the baby, or with a child born with a birth defect or chronic health problem. Moreover, the National Academy estimates that toxic exposures play a role in at least one in four cases of developmental disorders.[7]

Health risks continue through adolescence and adulthood. More than 200,000 adults and 75,000 children in Connecticut have asthma.[8] Cancer is the second-leading cause of death in Connecticut,

accounting for about one-fourth of deaths – with about 17,000 new cases diagnosed each year.[9]

Toxic hazards at places of employment also put workers at risk. Across the U.S., scientists estimate that occupational hazards, such as exposure to toxic chemicals or pollution, lead to more than 800,000 new cases of cancer, cardiovascular disease or lung disease annually – costing the economy more than $25 billion a year.[10]

In many cases, the use of toxic chemicals is unnecessary. This report profiles 10 types of chemicals commonly used in Connecticut, examining the risks they pose and highlighting companies that have chosen safer alternatives. In many cases, businesses have been able to substitute safer materials and processes with minimal cost – and sometimes net savings.

As a society, we have the ability to improve our chances for a healthy life by choosing to incorporate safe materials and practices into our consumer goods and industrial practices.

Many manufacturers that are already doing the right thing are responding to new regulations established in the European Union and some other U.S. states. To make the use of safer materials in Connecticut truly widespread, the state should undertake comprehensive reform of chemical policy, requiring safer alternatives to toxic chemicals where available and practical. By taking action, Connecticut can protect our environment and our families.

The Home as a Toxic Environment

Not all toxic chemicals enter the environment dripping from a factory waste pipe, leaking from a hazardous waste dump at the edge of town, or billowing into the air from an incinerator smokestack. Products containing hazardous materials are made in factories and shipped to our homes and offices, serving as a chemical conduit into our daily lives.

Many times more chemicals are shipped from factories to homes, contained within consumer products, than are spilled or dumped into the environment. Massachusetts, one of the few states where companies are required to report the amounts of chemicals they use and ship in products, provides a good illustration. In Massachusetts in 2001, for every pound of chemicals released or disposed of, eight pounds were distributed in manufactured products.[11] Companies shipped thousands of times more of certain toxic chemicals—especially ingredients in plastics and personal care products—than they released into the environment.[12]

Regulations are needed not only to reduce the discharge of toxic chemicals into the environment, but also to prevent toxic chemicals from ending up in our homes.

Teri Olle

10 Toxic Chemicals: Risks and Alternatives

This report focuses on 10 types of chemicals commonly found in Connecticut. These chemicals are widely used in consumer products, in manufacturing, and in commerce. Many can be found in our air, our water, our homes, our bodies and contaminated industrial sites. All 10 of these chemicals have been linked to harmful health effects.

For each chemical, alternative ingredients, materials or processes are readily available. These alternatives pose less risk and are economically feasible. Substituting safer alternatives would limit exposure to these chemicals and improve public health.

DEHP (Diethylhexyl Phthalate)

Diethylhexyl phthalate (DEHP) is part of a family of widely used chemicals called phthalates, with global production volumes of more than 5 million tons per year.[13] Plastic manufacturers use DEHP as an additive to make their products more flexible.

DEHP can be found in hundreds of products in Connecticut, including home siding, flooring, furniture, food packaging, toys, clothing, and car interiors.[14] DEHP is the only phthalate used in polyvinyl chloride (PVC) medical equipment, including blood bags, IV tubing and catheters. PVC (containing 20 to 40 percent DEHP by weight) makes up about a quarter of all the plastics used in hospitals.[15]

Scientists are finding phthalates everywhere they look. This class of chemicals is one of the most widespread contaminants in the environment today. In fact, according to EPA scientist Robert Menzer (as cited by the Worldwatch Institute), phthalates are so common that, "It has become very difficult to analyze any soil or water sample without detecting phthalate esters."[16] Because DEHP is not chemically bound to plastic, it can leach out of products during production, distribution, use and disposal.[17]

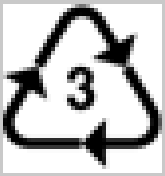
The human body has not escaped contamination. In 2000, Dr. Benjamin Blount at the U.S. Centers for Disease Control and Prevention (CDC) found high levels of phthalates and their transformation products (known as metabolites) in every one of 289 adult Americans tested, including women of childbearing age.[18] The study authors concluded that "phthalate exposure is both higher and more common than previously suspected."[19] The CDC confirmed widespread exposure with a larger study in 2003, finding a variety of phthalate compounds in every person they tested.[20] Measurable levels of the metabolite of DEHP were found in more than three-quarters of samples, and children had higher levels than adolescents or adults.[21]

The most common route of human exposure to DEHP appears to be through inhalation (likely through household dust) and through contaminated food.[22]

Health Effects

At high doses, DEHP can damage the heart, kidneys and ovaries.[23] DEHP can also cause cancer in laboratory animals at high doses, and the U.S. EPA classifies it as a probable human carcinogen.[24]

At lower doses, even at levels to which Connecticut citizens are routinely exposed,



Plastics labeled with the recycling code 3 are made from polyvinyl chloride (PVC), and likely contain phthalates.

DEHP can interfere with normal human development. Effects associated with DEHP include premature birth, defects in the male reproductive system, early puberty, asthma and allergic reactions, and endometriosis (a condition where tissue normally found in the uterine lining in women develops in other parts of the body).

Exposure to DEHP may contribute to premature birth.

- A group of Italian scientists found DEHP and breakdown products in the blood of newborn infants, with higher levels leading to a higher incidence of premature delivery.[25] They report that on average, babies exposed to DEHP enter the world a week earlier than babies with less exposure. Children born prematurely and undersized face more challenges than the average child growing up, including a greater risk for reduced intelligence and behavioral problems, including attention deficit hyperactivity disorder (ADHD).[26]

Exposure to DEHP also poses a risk for disrupting the process of fetal development, causing defects in the reproductive system.

- In 2000, Dr. L. Earl Gray and his colleagues at the U.S. EPA reported that three types of commonly used phthalates (DEHP, BBP and DINP) disrupt sexual development in the male rat.[27] When female rats were fed these phthalates during pregnancy, they gave birth to male pups that weighed less and showed symptoms of malformed urethras (hypospadias), cleft phallus, reduced testes weight, undescended testicles (cryptorchidism) and other reproductive malformations. Apparently, DEHP reduces testosterone production in the developing testes, interfering with the signals that direct normal male reproductive development.[28] A maternal dose of 750 mg/kg/day of DEHP after the second week of pregnancy reduces testosterone levels in male testes to the same level as in female rodents.
- In 2004, Dr. Gray and others at the EPA followed up on this finding, showing that the phthalates DEHP, BBP, and DINP reduce the levels of insulin-like hormone #3. Reduced activity of this hormone is another known cause of undescended testicles in mice.[29]
- In 2005, Dr. Shanna Swan at the University of Rochester and her colleagues revealed a connection between phthalate exposure in human mothers and sexual development problems in their baby boys.[30] Mothers with higher body levels of a mixture of metabolites of phthalates, including DEHP, were 90 times more likely to have boys showing signs of altered genital development than mothers with lower exposure. One quarter of the female population of the U.S. has phthalate levels in her body higher than those causing effects in this study.
- In 2006, Dr. Anderson Andrade at the Charité University Medical School in Berlin found that exposure to DEHP in the womb can alter the function of an enzyme in the brain critical to normal sexual development in the male rat.[31] DEHP showed a measurable effect at levels close to the estimated average daily intake of the German population.
- Phthalate exposure may be part of the explanation for why the number of male children in the U.S. born with reproductive defects has doubled since the 1970s.[32]

Exposure to DEHP can cause defects in the male reproductive system.

Exposure to DEHP may contribute to early puberty.

- Puerto Rican girls well under the normal age for onset of puberty show the highest rates of premature breast development ever recorded. Dr. Ivelisse Colon at the University of Puerto Rico and her colleagues searched for a link between chemical exposures and this phenomenon. They looked for foreign chemicals in blood samples from a set of very young girls with premature breast development, girls with an average age of 31 months. They found high levels of phthalates in these girls compared to normal children.[33] In particular, DEHP levels were seven times higher in girls with premature breast development than normal girls, suggesting exposure to food and drink contaminated by contact with plastic wrappings and containers and chewing or mouthing of plastic toys.

Exposure to DEHP may contribute to asthma prevalence and allergic reactions.

- Exposure to phthalates in household dust could be linked to asthma, rhinitis and eczema in children. Dr. Carl-Gustaf Bornehag at Karlstad University in Sweden and his colleagues identified children with one of these three allergy-related diseases, then tested their homes for phthalate levels. He found that children with the highest exposure to DEHP were more than twice as likely to have asthma than children with the lowest exposure.[34] The authors note that "while there are likely multiple factors responsible for the increases in allergies and asthma that have been documented in developed countries over the past 30 years, it is striking that these increases have occurred during a period when plasticized products have become ubiquitous in the homes, schools and workplaces of the developed world."
- Dr. Jouni Jaakkola at the University of Birmingham surveyed workers in southern Finland who recently contracted adult onset asthma. He found that people who worked in offices with plastic wall materials were more than twice as likely to have contracted asthma.[35] The researchers hypothesize that DEHP from the PVC plastic in wall materials could be responsible for the effect.
- In 2006, Dr. Hirohisa Takano at the National Institute for Environmental Studies in Japan added to these findings, showing that very small doses of DEHP increase the allergic sensitivity of mice to dust mites.[36] Increase allergic sensitivity explains how DEHP exposure and asthma could be related.

Exposure to DEHP could be associated with endometriosis.

- Dr. Roya Rosati at the Center for Infertility Management in Andhra Pradesh, India and her colleagues found that women with endometriosis (a condition where tissue normally found in the lining of the uterus develops in other parts of the body) were significantly more likely to have higher levels of phthalates, including DEHP, in their blood. Moreover, women with more severe endometriosis were more likely to have higher levels of phthalates.[37]

ALTERNATIVES

Scientists have been aware of alternatives to phthalates since the early 1970s, when researchers first discovered significant evidence of environmental and human contamination, including the leaching of phthalates into human blood from PVC bags used in hospitals.[38] As noted by the Worldwatch Institute, NASA scientists were already warning against the use of PVC in the space program in 1971, because of poor physical properties and the presence of phthalates.[39] They noted that "substitute polymers . . .are available and in many cases they have far superior physical properties at a small sacrifice in immediate cost."[40]

Most of the vinyl or PVC plastic products that contain DEHP can easily be replaced with PVC-free (and therefore DEHP-free) alternatives, including medical and office supplies.[41] Specifically, polyethylene and polypropylene, ethylene vinyl acetate, polyurethane and silicone are all available as safer, cost-effective alternatives for most uses. Where flexibility is a primary concern – flexible medical products, packaging film, wire and cable insulation, and flooring – metallocene polyolefins are especially competitive.[42] In addition, plasticizers that can be used as additives to plastic in place of phthalates include citrates, benzoates, and phosphate.

Numerous hospitals across the world are working to reduce or eliminate the use of DEHP-containing PVC products. For example, the Neonatal Intensive Care Unit at Stanford University's Lucile Packard Children's hospital switched to custom-made DEHP-free IV products. This substitution was expected to save the hospital $200,000 every year.[43] Additionally, the Glanzing Clinic in Vienna is now completely PVC-free making it the first pediatric facility in the world to eliminate PVC.[44] Kaiser Permanente, the nation's largest non-profit health plan, is using PVC- and DEHP-free alternatives for IV bags, tubing, catheters and feeding tubes.[45] Kaiser has an environmental purchasing policy that directs staff to avoid all products containing DEHP, and instruct suppliers accordingly.[46]

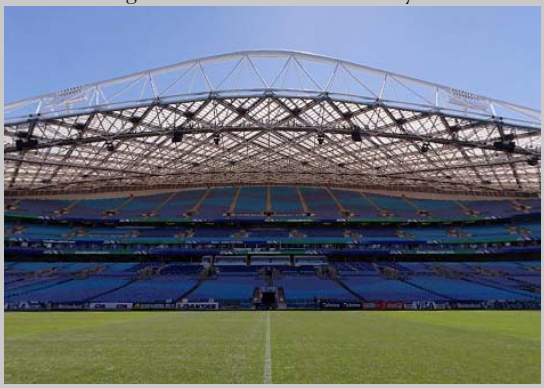
Alternative materials can also help eliminate DEHP from products commonly found in Connecticut homes. Among many alternative materials, floorings can be made from wood, cork, linoleum, and polyolefin plastics. These materials are likely to last longer and cost less.[47] Wall coverings may also be made from polyolefin plastics or textiles.[48]

Manufacturers are also producing DEHP-free products. American Insulated Wire in Attleboro, MA eliminated DEHP in its products by substituting a lower-impact plasticizer.[49]

European governments are also taking initiative in reducing public exposure to DEHP. For example, the European Union banned DEHP in all childcare items and toys and the EU Cosmetics Directive bans the use of DEHP in cosmetic products.[50] Meanwhile, the US has no enforceable standard for phthalates in children's toys – only a 1986 voluntary agreement between the Toy Industry Association and the U.S. Consumer Product Safety Commission not to use DEHP in pacifiers, rattles and teething rings.[51]

The 2000 Sydney Olympic Stadium: PVC-Free

The Australian Stadium 2000 Consortium, the group which won the competition to design, construct and build the Olympic Stadium in Sydney, Australia, used alternatives to PVC in plumbing, drainage and flooring materials. The seating, flooring, wall finishes and plumbing in the Olympic Stadium are all PVC-free. The Olympic Hotel eliminated PVC in all electrical services, light and power cabling, computer cabling, wet area flooring and cold and hot water systems.



Telstra Stadium

Organophosphate Pesticides

Pesticides, which include insecticides, herbicides, fungicides, and rodenticides, are commonly used in agriculture, landscaping, and in and around the home. These chemicals are created and used with the specific intent to kill something, be it weeds, insects, fungus or rodents.

Americans use approximately 77 million pounds of organophosphate pesticides every year: 17 million pounds on lawns and gardens and in homes, and the rest in agriculture.[52]

Residential pesticide use brings adults and children who work and play in their gardens or yards in direct contact with these toxic chemicals. Pesticides applied outdoors can be tracked inside on shoes or clothing. Studies of residentially applied pesticides in Jacksonville, Florida found contaminants in the carpets of 82 percent of all houses surveyed.[53]

Agricultural use of organophosphate pesticides can contaminate surface and groundwater through runoff. These pesticides even remain on fresh fruits and vegetables that Connecticut citizens buy in the neighborhood grocery store.[54]

Dozens of pesticides and their breakdown products can readily be found in people. In a recent study, the U.S. Centers for Disease Control and Prevention (CDC) found at least

three different pesticides in 100 percent of the people tested for pesticides in both blood and urine. Of the 23 different pesticides tested for by CDC, the average person had 13 in their body.[55]

Health Effects

Every year there are 20,000 reported cases of accidental poisoning with organophosphate pesticides.[56] Acute exposure to organophosphates can cause tightness in the chest, wheezing, excessive tearing, nausea, vomiting and involuntary defecation or urination.[57] It can also lead to neurological problems including confusion, insomnia, slurred speech, muscle weakness, cramping, seizures and ultimately death.[58]

However, long-term exposure to low levels of pesticide contamination is much more common. Chronic exposure is associated with a variety of health effects, including cancer, miscarriage, birth defects, and impaired brain development.

Pesticide exposure is associated with childhood cancer.

- Studies have found that children with parents who are exposed to pesticides at work are more likely to contract cancers like leukemia.[59] One study found that children who are exposed to pesticides in their homes and yards are 4-7 times more likely to be diagnosed with leukemia.[60] A National Cancer Institute review of numerous studies conducted on the links between pesticides and cancers concluded that most studies found an increased likelihood of leukemia and brain cancer from pesticide exposure.[61]

Pesticide exposure could be linked to miscarriage.

- Dr. Erin Bell of the University of North Carolina and her colleagues showed that mothers who live within a 9-square mile area in which commercial pesticide spraying takes place during pregnancy are 40 to 120 percent more likely to suffer miscarriages due to congenital birth defects.[62] Risk is greater during gestation weeks 3-8, the critical period when many organ systems first begin to take shape. Associations were apparent for five major classes of pesticides: organophosphates, carbamates, pyrethroids, and endocrine disrupting pesticides.

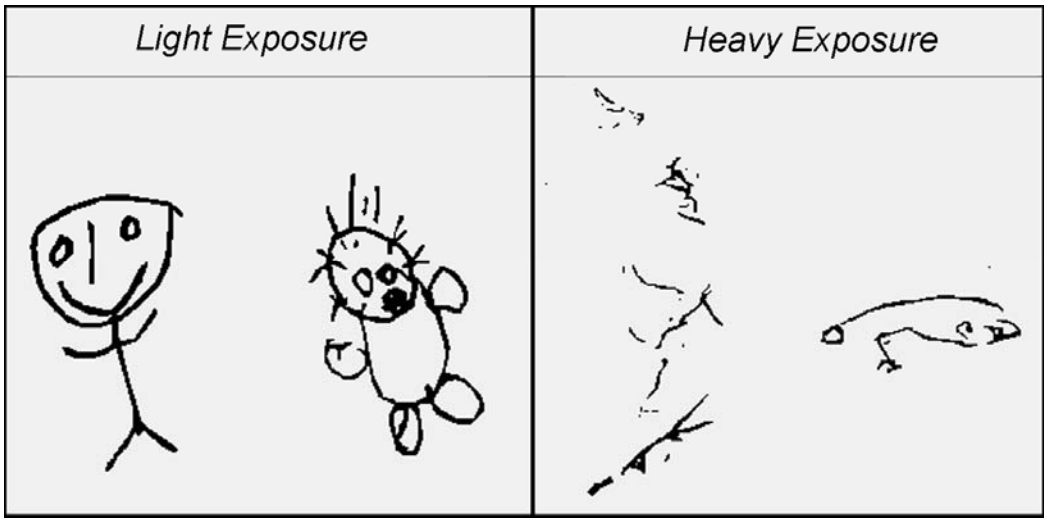
Pesticide exposure could be harming infant brain development.

- Infant mice exposed to neurotoxic pesticides early in life develop irreversible defects in learning and hyperactivity.[63]
- Dr. Elizabeth Guillette at the University of Arizona and her colleagues in Sonora, Mexico looked at the effect of pesticides on preschool-age children in the Yaqui Valley, Mexico. Farmers in the community had used pesticides in the valley since the 1940s, while farmers in the foothills avoided pesticide use. Dr. Guillette compared children from both areas, and discovered dramatic functional differences. While the children did not differ in physical growth patterns, children exposed to high levels of pesticides were less mentally able to perform basic tasks and showed behavioral problems. For example, Dr. Guillette asked 4-year olds to draw a picture of a person. Less-exposed children were able to produce recognizable drawings, while children exposed to high levels of pesticides were not. (See Figure 1.) Heavily exposed children were also deficient in stamina, balance, hand-eye coordination, and in short-term memory compared to their less-exposed counterparts.

Alternatives

By using pest control techniques that don't require the use of toxic chemicals, or by substituting less toxic compounds, Connecticut

Figure 1: Drawings of People by 4-Year Old Children Exposed to Pesticides in Mexico's Yaqui Valley[64]



can reduce its citizens' exposure to organophosphate pesticides.

Landscaping can be carried out without toxic chemicals using either organic lawn care or integrated pest management (IPM).[65] The principle of organic lawn care is to eliminate the use of toxic chemical pesticides entirely. Homeowners can create beautiful, healthy lawns by replacing toxic chemicals with organic fertilizers and pest control. Numerous websites provide information on how to create environmentally safe lawns without toxic chemicals.[66]

Similarly, integrated pest management is a system that allows for the use of pesticides only in emergencies. Instead of spraying pesticides as part of regular lawn maintenance, IPM uses chemical solutions only when absolutely necessary.[67] IPM programs focus on prevention, monitoring and control and seek to reduce or completely eliminate the use of pesticides. IPM programs apply knowledge about specific relevant pests to prevent them from damaging crops and homes. For example, pests are controlled by reducing or eliminating their food, water or shelter, and by maintaining healthy soil and plants. Through this approach, pesticides are used as a last line of defense and as part of a multi-tool effort to manage pests. When deemed necessary, pesticides with the lowest toxicity have priority.

The University of Connecticut Cooperative Extension System and Department of Plant Science operate an IPM clearinghouse, providing information for farmers, landscapers and homeowners on how to use IPM to manage landscapes in safer ways. The IPM program, started in 1980, holds training programs and distributes information about IPM through presentations, publications, pest information hotlines and a website.[68] From 1984 to 2004, the program has prevented the application of more than 91 tons of pesticide chemicals in Connecticut, while saving growers more than $2.6 million.[69]

In 2004, the IPM program:

- Helped 13 vegetable growers, including the Logue Farm in Woodbury, CT, cut their use of pesticides in half, while increasing yields more than 12 percent;
- Assisted four fruit orchards, including Woodstock Orchards in Woodstock, CT, to reduce pesticide applications by 356 pounds over 103 acres.
- Educated more than 730 Connecticut residents on how to maintain lawn and turfgrass with methods that both protect the environment and improve lawn quality; and
- Worked with greenhouse and nursery growers to promote the use of safer pest management techniques.

The U.S. Environmental Protection Agency (EPA) is also helping agricultural users to reduce pesticide use. The EPA's Pesticide Environment Stewardship Program (PESP) has partnered with members of the tree fruit and nut sector to advance IPM strategies and examine alternatives to control current and emerging pest problems.[70] Additionally, an organization of cranberry growers, the Cranberry Institute, is working to implement IPM strategies and replace organophosphate insecticides.[71]

Local governments are also working to reduce pesticide use. For example, in nearby Massachusetts, the Toxics Use Reduction Institute (TURI) at the University of Massachusetts, Lowell, has funded organic lawn and garden demonstration sites, and communities like Marblehead have responded with organic pest management policies.[72]

Patti Adair

2,4-D (2,4-Dichlorophenoxyacetic Acid)

2,4-D is the most used herbicide worldwide.[73] Common lawn care products, including *Scotts* and *Weed-B-Gon* weed killers and *Miracle-Gro Weed and Feed* contain 2,4-D.[74]

Similar to organophosphate pesticides, 2,4-D does not remain fixed after application on lawns or fields. One study found that one week after applying 2,4-D on a lawn or garden outside the home, the chemical shows up on a variety of surfaces within the home.[75] An EPA assessment indicated that home lawn care products account for 96 percent of the risk associated with using this chemical for women of childbearing age – the most sensitive group.[76]

Health Effects

2,4-D is highly toxic if ingested or inhaled. Short-term, intense exposure can result in arm and leg stiffness, lack of coordination, lethargy, vomiting and nausea, diarrhea, and coma. Prolonged long-term exposure affects kidney and liver functions in animals.[77]

In addition to damaging the brain and nervous system, researchers suspect this poisonous herbicide to be a cardiovascular, developmental, endocrine, reproductive and respiratory toxicant.[78]

2,4-D is a possible carcinogen.

- Herbicides containing 2,4-D have been linked to cancer in humans, especially among those who work with the chemical every day. Agricultural workers and those who apply pesticides are at elevated risk of developing non-Hodgkin's lymphoma, a cancer affecting tissues that produce immune system cells.[79]
- Dogs living in homes that regularly use 2,4-D on their lawns face a higher risk of developing canine lymphoma.[80] Additionally, rats develop brain tumors when exposed to 2,4-D.[81]
- Both the World Health Organization and the International Agency for Research on Cancer (IARC) have classified 2,4-D as a possible human carcinogen.[82]

2,4-D is associated with increased risk of birth defects.

- Dr. Warren Porter at the University of Wisconsin discovered that rodents exposed to low doses (commonly found in the environment) of a commercial herbicide mixture including 2,4-D have reduced litter sizes.[83] This experiment is striking in that very low doses—as low as one seventh of the drinking water standard set by the EPA—produced the greatest effect. Testing by the EPA doesn't always take into account the possibility that very low doses can have different effects than high doses, which can be the case with chemicals that interfere with the body's communication systems (for example, chemicals that interfere with hormone signaling).

- Dr. Dina Schreinemachers at the U.S. EPA found that human babies born in wheat-growing areas of the western U.S. (where chlorophenoxy herbicides like 2,4-D are used in large amounts) are more likely to have birth defects than babies in non-wheat-growing areas of the West.[84] She found that:
  - Children born in high-wheat areas were 60 to 90 percent more likely to have birth defects in the respiratory system, circulatory system, and in the muscles and skeleton (fused digits, clubfoot, extra digits, etc.).
  - The frequency of birth defects was highest for babies conceived in the spring, when herbicide spraying is most intense. Boys conceived in high-wheat counties in April and May were almost five times more likely to have a birth defect than boys conceived in low-wheat counties at other times of the year.
  - Infant death due to congenital abnormalities was more frequent for boys in wheat-growing counties compared to low-wheat counties.
- An EPA risk assessment found that rats exposed to 2,4-D *in utero* showed an increased incidence of skeletal abnormalities such as extra ribs and malformed ribcages. In rabbits, 2,4-D has been shown to cause miscarriages as well as skeletal abnormalities.[85]
- In November 2005, California's Office of Environmental Health Hazard Assessment (OEHHA) announced its intention to list the herbicide 2,4-D and related compounds as developmental toxicants under California's Safe Drinking Water and Toxic Enforcement Act of 1986, more commonly known as Proposition 65.

ALTERNATIVES

Integrated pest management (IPM), which uses pesticides as a last line of defense and as part of a multi-tool effort to manage pests, and organic lawn care, which uses physical and biological strategies exclusively, remain the best solutions for consumers who wish to avoid exposure to harmful pesticides.

The University of Connecticut's IPM Program offers information and advice to homeowners, landscapers and growers for pest management around homes, businesses and in commercial agriculture. (See "Organophosphate Pesticides, Alternatives" on page 12.)

PBDEs (Polybrominated Diphenyl Ethers)

Household products made from flammable materials, such as polyurethane foam in furniture and plastics in computers and electronics, contain chemicals designed to reduce the spread of fire in the event of an accident. Polybrominated diphenyl ethers, or PBDEs, have been among the most common of these additives for the past several decades.

There are three primary types of PBDEs – penta, octa, and deca BDE – differing in the number and configuration of bromine atoms. While penta and octa BDE have been phased out by U.S. manufacturers, pressure from industry has kept deca BDE largely on the market.

In 2001, North American industry used 49 million pounds of deca BDE. Deca BDE is found in the casings of electronics (especially televisions), wire and cable coatings, paint, hair dryers, fax machines and small electronic parts – to name only a few. In addition, manufacturers sometimes add deca BDE to furniture, mattresses, or carpet padding.

PBDEs can alter thyroid hormone levels, which are critical for normal brain development, especially *in utero* and up to 2 years after birth.

PBDEs are not chemically bound to products, and they can escape into the home, contaminating dust and even forming films on the insides of windows.[86] Scientists suspect that ingestion of PBDEs through dust is the most common route of exposure.[87]

PBDEs build up in fatty tissue and do not readily leave the body. As a result, these chemicals are building up rapidly in the tissues of people across the U.S. Contamination levels in the breast tissue of California women and in the breast milk of women throughout America are up to 75 times higher than those found in European countries, where most uses of PBDEs have been banned.[88] Americans have the highest levels of PBDE contamination in the world.[89]

Health Effects

PBDEs are toxic to development, and the levels found in some mothers and fetuses are rapidly approaching the levels shown to impair learning and behavior in laboratory experiments.[90]

PBDE exposure affects the thyroid hormone system, which is critical for normal brain development.

- Flame retardants have been shown to alter thyroid hormone levels, an effect similar to that caused by the notorious environmental contaminants polychlorinated biphenyls, or PCBs. When rodents are exposed to PBDEs, they show depressed thyroid hormone levels and physical changes in the thyroid gland.[91] These effects occur in mice when exposed to a common PBDE at single doses as low as 0.8 milligrams per kilogram of body weight.[92] These effects appear to be additive with the effects of PCBs and dioxins on thyroid hormone levels.[93]

PBDE flame retardants cause irreversible neurological damage to infant mice.

- Mice exposed to PBDEs in small doses as newborns develop learning and movement problems that worsen as the animals grow older, an effect similar to that seen with PCBs.[94]
- Evidence in animals suggests that exposure will have the same effect in humans. In the case of PCBs, humans were actually more sensitive than rodents used in experiments by at least 1,000 times.[95]

Deca BDE, the last remaining PBDE flame retardant in production in the U.S., poses unacceptable health risks and should be phased out.

- Although industry has argued that deca BDE is stable and that the large size of the deca molecule makes it difficult for the human body to absorb, numerous tests have found otherwise. When exposed to sunlight, deca BDE breaks down into more toxic chemical forms including those that make up penta and octa, the two banned PBDEs.[96] Humans can also metabolize deca BDE into related compounds, including some that have been implicated as developmental toxicants, and

that are likely more toxic than deca BDE itself.[97] Hence the use of deca could be responsible—at least in part—for the rapidly increasing levels of flame retardant chemicals found in the fatty tissues and breast milk of North American women.[98]

- Deca BDE can concentrate in the food chain. Deca BDE has been found in peregrine falcons in Europe.[99] Evidence indicates that accumulation is most pronounced for the land-based food chain.[100]
- Indoor air is a major source of exposure for people to PBDEs, and deca BDE is the major type of flame retardant found in indoor air.[101] Deca BDE can be directly absorbed through the air, as shown by samples of blood from workers at a recycling plant.[102]
- Animal studies have shown that deca also has toxic effects—disruption of brain development in infant mice, and impairment of learning and memory.[103]

Alternatives

PBDEs can be replaced either by using an inherently flame-retardant design, a flame-retardant type of base material instead of plastic, or by using alternative flame-retardant additives with less-toxic properties. Many companies are already deploying alternatives to comply with recent regulations banning or restricting the use of PBDEs. (See "Regulatory Action on PBDEs, page 18.)

Products can be designed to be less prone to catching fire. For example, electronics manufacturers can move a power supply from inside the product to a safer, external location.[104]

Alternative base materials with better flame-resistant properties can be used. For example, furniture-maker IKEA switched from PBDE-containing plastics to textiles and materials that are naturally fire-resistant without additive chemicals.[105] Restonic Mattress Corporation uses a non-halogen, inherently flame-retardant resin called ULTEM, a polyetherimide resin made by GE, in its Comfort Care Mattress.[106] In 1998, Toshiba announced a transistor casing that was PBDE-free, instead using a type of plastic designed to withstand high temperatures (polyphenylene sulfide).

Manufacturers can also use alternative flame-retardant additives with less toxic properties. For example, in countries with the most stringent requirements, IKEA uses flame retardants composed of organic phosphate and nitrogen.[107]

Alternatives also exist for deca in electronics. Companies that have phased out the use of deca, include Dell, Ericsson, Hewlett Packard, Eizo Nanao and Sony, with Daikin, Matsushita, Mitsubishi Electric, NEC, Phillips, Samsung, View Sonic and Xerox following close behind.[108] Others leading the way include RTP Company and GE Polymers – both offer high impact polystyrene and polyphenylene oxide plastics for electronic enclosures that contain non-brominated, non-chlorinated flame retardants.[109] According to RTP Company in Minnesota, the company currently produces eight different flame retardants free of chlorine or bromine (often part of toxic chemicals) to be used in computers, business equipment, appliances, and telecommunications and building components.[110]

Intel does not use any PBDEs in its products and ensures that none of its suppliers use PBDEs in their products. Ericsson has also banned all PBDEs from its products. In fact, in August of 2003, Ericsson announced a line of chlorine- and bromine-free, PBDE-free converters that cost about 25 percent less than other environmentally-friendly converters and are comparably priced to standard converters.[111]

Alternatives for deca BDE are also readily available. Sony and Panasonic, for example, have eliminated deca BDE from television casings, while still meeting the highest fire-safety standards.[112] The companies switched to another type of plastic housing that can be treated with safer flame retardants, like resorcinol bis-diphenyl phosphate.[113] The Maine Department of Environmental Protection sees no technical or cost barriers for widespread adoption of this alternative, and recommended that the state ban the sale of electronic products containing deca BDE.[114]

Regulatory Action on PBDEs

European countries began proposing PBDE bans in the mid-1980s and early 1990s.[115] In 1986, industrial users in Germany agreed to a voluntary phase-out with manufacturers and users in Sweden and the Netherlands following suit. In February 2003, the European Union announced a ban on penta and octa BDE in all products.[116]

In 2003, the State of California enacted a ban for two types of flame retardants, penta and octa BDE.[117] Subsequently, the only U.S. manufacturer of these two chemicals announced a voluntary phase-out of these chemicals. Shortly thereafter, EPA issued a regulation prohibiting the manufacture or import of these chemicals without EPA evaluation.[118]

Maine passed a bill to ban penta and octa BDE by January 1, 2006 with a longer term review of phasing out other brominated flame retardants.[119] Hawaii passed legislation to ban penta and octa BDEs.[120] Michigan and New York both passed legislation to ban penta and octa BDE and are currently studying deca.[121]

In 2005, the Washington Department of Ecology and the Department of Public Health recommended that the state legislature ban the manufacture, distribution or sale of new products containing penta or octa BDE by July 2006. They also recommended that the state legislature ban the manufacture, distribution or sale of new products containing deca BDE if safer alternatives are identified or with additional evidence of deca BDE's harmful effects.[122] On February 16, 2007, the Washington House followed up on this recommendation, passing a bill to phase out deca BDE.[123] The bill now heads to the Senate. If the bill passes, it will be the first U.S. state action to restrict the use of deca BDE.

Dioxins and Furans

Dioxins and furans are not chemicals directly used for commerce in Connecticut. Rather, they are byproducts of chemical manufacturing or of waste combustion, primarily the burning of plastics containing chlorine.

Dioxin can form when chlorine is present during a combustion process. Many health care products, such as polyvinyl chloride (PVC) IV bags and tubing, contain chlorine, enabling the creation of dioxin when these items are burned.[124] Nationally, the U.S. EPA estimates that medical waste incineration is the third-largest source of dioxin air emissions.[125]

In 2004, industries in Connecticut reported emitting a total of 5.5 grams of dioxin-related compounds into the environment.[126] While this might not sound like a lot, dioxin is one of the most toxic substances known. Any exposure to dioxin, even a dose as low as one thousandth of one millionth of a gram, can be hazardous.[127]

According to Environmental Defense, major emitters in Connecticut include Cytec Industries in Wallingford, PSEG's Bridgeport Harbor Station, New Haven Harbor Station, and AES Thames LLC in Uncasville.[128]

Dioxins and furans are persistent and bioaccumulative toxicants, meaning that they last a long time and grow more concentrated as they travel up the food chain. Connecticut citizens are exposed to dioxin primarily by eating contaminated food, especially meat and dairy products. Airborne dioxin settles onto soil and plants. Animals that eat those plants accumulate dioxin in their bodies; people are exposed to dioxin when they eat meat, eggs, and dairy products.

Health Effects

Current average levels of dioxin in humans are at or near the levels that have been demonstrated to cause problems in animals. Because of how dioxin accumulates through the food chain, breast-feeding infants may receive a dose 35 to 65 times higher than "safe" levels.[129] (However, breast milk

is still the best nutrition for infants – the solution is not switching to infant formula, which can also contain contaminants and does not match the beneficial effect of breast milk, but eliminating the use of chemicals that lead to dioxin formation.)

Dioxin exposure can cause cancer, harm development, and suppress the immune system. Dioxin exposure also may be associated with diabetes.

Dioxin is a potent carcinogen.

- The EPA estimates that the cancer risk from dioxin in levels already present in the general public is approximately one case per 1,000 people, far higher than EPA's acceptable risk level of one in one million.[130]
- The International Agency for Research on Cancer, an arm of the World Health Organization, has determined that one type of dioxin (the type present in the pesticide Agent Orange sprayed on foliage in Vietnam) is a known human carcinogen.[131]
- Scientists studying the impacts of an industrial accident in Seveso, Italy in 1976, where dioxin was released into the community, found measurable health impacts from exposure appearing decades later. One study found that higher dioxin exposures lead to greater risk of breast cancer.[132]
- Dioxin does not have a threshold below which it is known to be safe.[133]

Dioxin is a reproductive and developmental toxicant.

- Dioxin has been linked to numerous other problems in addition to cancer, including reproductive and developmental problems, increased heart disease, and a weakened immune system.[134]
- Animal studies have shown that dioxin can lower sperm counts and delay testicular descent in males and increase the risk of endometriosis and failed pregnancies in females.[135]
- Children exposed to dioxin may suffer from delayed development, learning disabilities, and IQ deficits.[136] The impacts of dioxin exposure are particularly severe when exposure occurs *in utero* or during childhood.[137]

Persistent organic pollutants like dioxin could be linked to diabetes.

- Since 1980, the number of Americans with diabetes has more than doubled, now reaching about 7 percent of the population.[138]
- The conventional wisdom surrounding diabetes is that lifestyle and diet are important factors in developing the disease. However, contaminants that interfere with the body's metabolism could also play a role. In fact, studies of exposure to dioxin and other persistent organic pollutants support this hypothesis.
- People with higher levels of persistent organic pollutants (POPs), including dioxin, in their bodies are more likely to have diabetes. In a study of more than 2,000 Americans, the association between body levels of POPs and diabetes was significant for individual dioxins, but even more significant when looking at a mixture of six compounds together. People with the highest levels were almost 38 times more likely to have diabetes.[139]
- People in New York State who live near a hazardous waste site containing persistent organic pollutants, including dioxin and PCBs, are more likely to be hospitalized for diabetes.[140]

ALTERNATIVES

Dioxin contamination can be prevented by choosing materials and manufacturing processes that do not form dioxin.

Process substitution can decrease the amount of dioxin compounds entering our air through waste incineration. For example, many products need not contain dioxin-producing PVC plastic. Many hospitals have switched to PVC-free medical equipment. Currently, there are PVC-free alternatives available for most uses of this polymer in the health care arena, including tubing, IV and blood bags and disposable gloves as well as most types of office supplies.[141] The Olympic stadium for the 2000 Olympics in Sydney, Australia was built completely avoiding PVC products.[142]

SPOTLIGHT ON: GLANZING CLINIC, VIENNA, AUSTRIA:

Realizing the harmful effects of PVC, the Glanzing Clinic in Vienna began phasing out PVC products in 1989. Today, they are almost completely PVC-free. The Neonatology Unit of the Pediatric Clinic Glanzing was the first pediatric unit worldwide to eliminate almost entirely the use of PVC and DEHP in medical practice.

Increased recycling can reduce trash burning and waste incineration, and thus dioxin formation. And on the manufacturing front, companies like Seventh Generation have implemented chlorine-free bleaching of paper products, eliminating the possibility of dioxin formation as a by-product.[143]

Formaldehyde

Formaldehyde is a toxic chemical often included in building materials like plywood, particle board, and other pressed wood products. When used in the home, these products can release formaldehyde into indoor air.

According to the EPA, common building products can create three times what EPA calls a safe exposure level of formaldehyde in our homes.[144]

Medium Density Fiberboard (MDF), a particle board widely used in buildings and furniture, is a notorious source of formaldehyde vapor in the home.[145] Additionally, many forms of insulation use formaldehyde to bind an outside cover to the inner material, contributing to indoor air contamination.[146] Some textiles (including durable press drapes) and glues can also emit formaldehyde into indoor air.[147]

In 2002, Connecticut industries reported the emission of 25,000 pounds of formaldehyde to the air.[148] Connecticut businesses are not required to report how much formaldehyde they use, but such information is required in Massachussets – where industry used 4.8 million pounds of formaldehyde in 2002.[149] This figure represents only in-state manufacturing use above reporting limits and therefore does not include formaldehyde found in imported consumer products.

HEALTH EFFECTS

Acute exposure to formaldehyde can irritate skin and respiratory tissue, while long-term exposure could lead to cancer.

Formaldehyde can irritate skin and respiratory tissues.

- Acute exposure to formaldehyde can lead to asthma attacks, and skin and respiratory inflammation. Evidence shows that people repeatedly exposed to formaldehyde may develop a sensitivity to this chemical, increasing the severity of effects over time.[150]

Formaldehyde is a recognized carcinogen.

- Formaldehyde is known to cause cancer in both humans and animals. The International Agency for Research on Cancer and the Office of Environmental Health Hazard Assessment (OEHHA) in California list formaldehyde as a known human carcinogen.[151]

ALTERNATIVES

Everyday building materials – such as stone, brick, metal, glass, and solid wood – are generally formaldehyde-free. Furniture and buildings made of these materials do not emit formaldehyde, or volatile toxic compounds in general.

Building Performance Construction, based in Ridgefield, CT, builds and renovates homes to improve efficiency and health, using building materials that do not emit formaldehyde or other potentially toxic gases. In 2000, the company built the first home in Connecticut to meet American Lung Association health standards.[152]

The company chose cabinets that meet European standards for off-gassing of toxic chemicals like formaldehyde. The company also consciously chose flooring and insulation materials that do not use formaldehyde as an adhesive component.[153]

Many other companies across the U.S. are using healthier building materials and developing safer

alternatives to replace toxic products. For example, Green Building Supply insulates homes in the Midwest with a two-part vegetable-based polyurethane insulation that can be sprayed in place.[154] This product contains no formaldehyde and insulates homes as well as formaldehyde-emitting versions. Green Building Supply also sells a variety of oil and water-based paints and finishes, without formaldehyde.[155]

In 2005, Columbia Forest Products, North America's largest manufacturer of hardwood plywood and hardwood veneer, announced its transition to a soy-based adhesive called PureBond.[156] Using this adhesive, Columbia will eliminate formaldehyde from its products.[157]

Neil Kelly Cabinets and Charles R. Bailey Cabinetmakers both sell a wide variety of formaldehyde-free furniture.[158] Charles Bailey himself suffered from years of health problems developed while working with toxic chemicals such as formaldehyde, motivating him to introduce a line of furniture developed exclusively for the chemically-sensitive consumer.[159] Ecobusinesslinks.com has created a directory to other companies around the country that specialize in providing safer building alternatives, many of which replace formaldehyde-containing products.

Alternatives are also possible where formaldehyde is used in manufacturing processes, such as assembling printed wiring boards.[160]

Hexavalent Chromium

Chromium is a metallic element found in rocks, soil and in volcanic dust. Manufacturers use chromium compounds to give products shine, color, and durability. Chromium is primarily used to manufacture stainless steel and other metal alloys.[161] It also is used as a pigment in chrome plating and paints and as a wood preservative.[162]

Chromium occurs naturally in its trivalent form. Hexavalent chromium compounds, which pose greater health risks, are primarily produced as a result of industrial activity.

Workers engaged in chrome plating, stainless steel welding, painting and coating processes are exposed to hexavalent chromium used while performing their jobs. Atmospheric releases also pose a serious problem. In 2002, industries released 2,764 pounds of chromium and chromium compounds in Connecticut.[163]

Johns Manville, with facilities across North America, manufactures a line of formaldehyde-free building insulation materials. See www.jm.com.

Hexavalent chromium can also be found in the groundwater at old industrial waste dumps, like the Precision Plating superfund site in Vernon – where workers poured rinse waters to a storm drain outside its building without a permit until 1983.[164]

Health Effects

Chromium use poses direct hazards to workers. Acute exposure can cause permanent sight loss, brain and neurological damage as well as damage to the immune system and to the liver and kidneys.[165] Chromium released to the environment also poses a hazard for everyone living in Connecticut.

Exposure to hexavalent chromium can cause lung cancer.

- The EPA classifies chromium (VI) as a known human carcinogen by inhalation.[166]
- One study found that people living in Texas counties with higher reported releases of toxic metals, including chromium, were more likely to get lung cancer.[167]
- According to Environmental Defense, the average Connecticut resident faces a cancer risk of 40 in one million because of airborne chromium compounds.[168]

ALTERNATIVES

Safer alternatives to hexavalent chromium are well-established and in use across the country.

In 1999, General Extrusion, Inc. in Ohio removed hexavalent chromium from its paint line by substituting an iron phosphate coating. The substitution reduced hazardous waste generation, saved money and benefited worker health, all while equaling the quality of the previous product.[169]

Alternatives to hexavalent chromium for anti-corrosive electroplating include iron-cobalt, zinc-nickel and zinc-cobalt alloys. These less toxic options are already being embraced by automakers and electronics companies that previously used hexavalent chromium. In the 1990s, Berg Electronics, Inc. in Pennsylvania substituted nickel plating for hexavalent chromium in its electronic products. This step, plus a few other process changes, save Berg an estimated $1.26 million per year, at a one-time cost of $500,000.[170]

Ford, GM, and Chrysler have made major efforts to reduce their use of hexavalent chromium – citing increasing disposal costs and health threats to their workers and the environment.[171] Depor Industries, Inc. has developed a line of organic coatings to meet automotive needs, including coatings without hexavalent chromium. These hexavalent-chromium-free paint systems have been approved for use at GM, Ford and Daimler Chrysler.[172] Hexavalent-chromium-free alternatives to chrome plating are also available for non-automotive markets and are in use by motorcycle, recreational vehicle, construction and agricultural manufacturers.[173]

Sanchem has developed SafeGard CC, chromate-free conversion coatings that pass tests for corrosion and electrical conductivity. A major European telecommunications company is now using this technology to meet the EU directive for the elimination of hexavalent chromium in electrical and electronic equipment by July 2006. The product is already in use in California as well.[174]

Metal Finishing Technologies. (in Forestville) and Whyco Finishing Technologies (in Thomaston) offer alternative metal coating services free of hexavalent-chromium.

Lead

While lead has been banned in house paint since the 1970s and in gasoline since 1986, lead continues to pose a health hazard in Connecticut homes.[175]

Lead can still be found in paint and pipes in older homes as well as in many types of common consumer products still on the market. When lead-containing paint cracks or plastic breaks down in heat or light, lead enters the air and dust, contaminating the house. In older homes, water can be contaminated as it runs through old leaded pipes. Lead can also be found in soil contaminated by gas or paint chips.

Ten thousand housing units (more than 3 percent of homes) in New Haven are at high risk of containing lead contamination.[176]

Old lead paint is the major source of human exposure. However, many common consumer products – including cosmetics, ceramics and jewelry – contain lead and add to the exposure. Some progressive hair dyes, such as Grecian Formula and EBL GreyBan Restores Natural Hair Color, contain lead acetate.[177] Lead is also contained in plastic and vinyl products like mini-blinds and coatings on wiring for cable, telephone, and other electronics. The average

Chromium Industry Efforts to Weaken Regulation

Although scientists have associated exposure to hexavalent chromium with increased lung cancer risk for over 50 years, the chemical was not regulated by the U.S. Occupational Safety and Health Administration (OSHA) based on its cancer-causing properties until 2006. A federal court ordered OSHA to lower its workplace exposure limit after the agency was sued by Public Citizen and a workers union in 1997 and 2002. In response to the threat of stronger regulation, the chromium industry challenged the scientific evidence supporting a better standard, hiring several "product defense" companies.[178]

David Michaels at the George Washington University School of Public Health and his colleagues investigated the industry effort to weaken chromium regulation. Dr. Michaels obtained records documenting the industry campaign through a bankruptcy hearing for the Industrial Health Foundation, an industry-affiliated non-profit organization.

Dr. Michaels discovered that the industry had commissioned a study of the health effects of low levels of chromium exposure, finding that workers with exposure far below the health standard had a five-fold higher risk of lung cancer. The results of the study were strong enough to support a new health standard much lower than OSHA had actually proposed. However, the industry intentionally withheld the results from regulators. Instead, the industry split the study into two halves that masked the strength of its conclusions, selectively offering data to the panel.[179]

On February 26, 2006, OSHA issued a new permissible exposure limit of 5.0 micrograms per cubic meter ($\mu g/m^3$), five times weaker than OSHA had proposed in 2004 and 20 times weaker than the original petition submitted by Public Citizen and the workers union.[180] This level is well above levels shown to increase the risk of lung cancer in exposed workers in the industry's own study.[181]

There are many other examples of industries with a stake in a regulatory decision acting against the interests of public health: tobacco, PCBs, PVC plastics, and more. Research funded by companies with a financial interest in vindicating their products tends to be less reliable than research conducted in an atmosphere free of such conflicts of interest.[182]

computer contains three pounds of lead, including the lead in plastic used for assembly and lead-containing wires and cables.[183]

While Connecticut does not require manufacturers to report lead usage, in nearby Massachussets, manufacturers used 11 million pounds of lead in 2000.[184]

Lead is also a common contaminant at Connecticut Superfund toxic waste sites. Lead has been found in the groundwater at the Barkhamsted-New Hartford Landfill, at the New London Submarine Base and at Nutmeg Valley Road in New Haven County.[185]

Health Effects

Lead is toxic to the nervous system and to development.

- Very low levels of lead poisoning have been linked to kidney damage, learning difficulties, mental and physical developmental problems and behavioral changes.[186]
- The U.S. Centers for Disease Control and Prevention (CDC) estimates that at least a half million children in the U.S. suffer from irreversible neurological damage from lead poisoning.[187]
- Environmental Defense and the Alliance for Healthy Homes estimate that 2,000 children in Connecticut have blood lead levels higher than 10 micrograms per deciliter – levels

clearly associated with harmful effects on children's learning and behavior.[188]
- Lead poisoning costs the country an estimated $43.4 billion in treatment and lost productivity each year.[189]

Alternatives

Safe and inexpensive alternatives to lead exist for many applications. Many alternatives have been developed in response to a 2003 European Union directive requiring that manufacturers produce and sell only lead-free electrical and electronic equipment after July 1, 2006.[190] In addition, both Canada and the European Union have banned the use of lead acetate in progressive hair dyes and other cosmetic products.

In response to the European Union regulations, several local Connecticut electronic component manufacturers have developed lead-free production systems. TEK industries, based in Vernon, offers the ability to design, engineer, manufacture and assemble printed circuit boards and other electronic components without the use of lead.[191] Similarly, Technical Manufacturing Corporation, based in Durham, recently installed a lead-free soldering system and lead-free assembly line for printed circuit boards and related products.[192]

Alternatives are available for non-electronic products as well.[193] Lead-free consumer products such as mini-blinds, batteries, novelty items, jewelry, ceramics and cosmetics are widely available and many manufacturers recognize the increasing consumer demand for safer plastic products. Mixed metal stabilizers of calcium and zinc (Ca-Zn) have replaced lead in many plastic products. These stabilizers perform nearly as well as their lead counterparts without dangerous health effects.[194]

Lead alternatives are becoming more cost-effective and available as demand increases. Baerlocher GmbH, a leading manufacturer of plastics stabilizers, has made the commitment to the development and sales of lead-free plastic additives a cornerstone of its corporate vision.[195] Recognizing the changing corporate landscape, Baerlocher has introduced lead-free plastic additives suitable for use in everyday products, such as wallpaper and floor coverings.[196]

Perchloroethylene

Perchloroethylene is an industrial solvent used in dry cleaning, degreasing, and chemical manufacturing. Dry cleaners that do not specifically advertise alternative methods more than likely use this toxic chemical to clean clothes.

People are exposed to perchloroethylene through air, water and food. Perchloroethylene evaporates and enters the air during use. Once in the air, it can contaminate ground and drinking water. The average level of perchloroethylene in drinking water sources in the U.S. is 1.5 times higher than the maximum set by the EPA.[197]

Exposure to perchloroethylene can occur when people hang recently dry-cleaned clothing in an enclosed space, such as an automobile.

Health Effects

Perchloroethylene has been linked to cancer.

- The International Agency for Research on Cancer lists perchloroethylene as a probable human carcinogen.[198] Some studies show a slightly increased risk of cancers of the esophagus, bladder and non-Hodgkin's lymphoma and reproductive effects.[199]
- Perchloroethylene has been linked to increased risk of leukemia, breast and colorectoral cancer in residents of Cape Cod when it leaked into water pipes through vinyl pipe lining.[200]

Perchloroethylene-exposed expectant mothers may run a greater risk of miscarriage.

- While laboratory and animal tests have not demonstrated significant reproductive toxicity, higher rates of menstrual disorders and spontaneous miscarriages have been documented in workers exposed to PERC.[201]

Alternatives

Numerous dry cleaning alternatives have been developed, including water-based wet cleaning alternatives, non-chlorinated solvents and liquid carbon dioxide.

Wet cleaning involves customized washing for each garment using soap and water. Clothing can be machine-washed in water with specialized machines, steam-cleaned or hand-washed. These technologies use water as the primary solvent to clean clothes. "Dry clean only clothes" can be "wet" cleaned because computerized machines and professional techniques are able to control factors, like temperature, which can otherwise damage clothing.[202]

Some cleaners in Connecticut, including Legacy Cleaners in Darien and Colonial Cleaners in Ridgefield, offer wet cleaning services.

Carbon dioxide cleaning uses liquefied carbon dioxide gas in a high pressure machine. After the washing stops, the carbon dioxide returns to a gaseous state, leaving only the dirt.[203] Because carbon dioxide cleaning uses no heat to clean, the process is said to be gentler on clothing.

Alternative solvents can also substitute for perchloroethylene. For example, Zoots, a cleaning chain with 51 locations in 10 states, including nine in Connecticut, uses a perchloroethylene - free, chlorine-free hydrocarbon cleaning process.[204]

These alternatives are sure to become more common in the future. In January 2007, California became the first state to order the phase-out of perchloroethylene. California banned the purchase of new perchloroethylene machines as of 2008, and ordered the phase-out of all uses of perchloroethylene by 2023.[205]

Zoots, a cleaner in Avon (pictured here) and at 8 other Connecticut locations, offers a dry-cleaning service that uses a perchloroethylene-free dry cleaning process.

Trichloroethylene

Trichloroethylene (TCE) is an industrial solvent commonly used for degreasing and cleaning. It is also an ingredient in adhesives, paint removers and spot removers.[206]

While data for Connecticut are not available, in neighboring Massachusetts, industry used about 1 million pounds of TCE in 2003.[207]

TCE is a notorious groundwater contaminant.[208] TCE evaporates into the air during normal use, where it falls back to the ground through rain and snow, contaminating Connecticut's drinking water supplies.[209]

TCE has been detected in private and public water systems in Connecticut in Cheshire.[210] TCE is also one of the most common contaminants found at Connecticut Superfund sites, including the groundwater at Durham Meadows (Durham), Gallup's Quarry (Plainfield), Kellogg-Deering Well Field (Norwalk), Linemaster Switch Company (Woodstock), and Solvents Recovery Service New England (Southington).[211]

Health Effects

Acute exposure to TCE, most common in the workplace, can cause organ damage.

- Exposure to high levels of TCE can lead to central nervous system, brain, kidney and liver damage, coma and death.[212]

TCE can cause cancer.

- Epidemiological and animal studies reveal that exposure to high levels of TCE increases risks of liver, lung, kidney and cervical cancers. The International Agency for Research on Cancer (IARC) considers TCE a probable human carcinogen.[213]
- TCE in drinking water is suspected of causing childhood leukemia cases in Woburn, MA in the early 1980s. The lawsuit that followed is the subject of the book and movie, *A Civil Action*.[214]

ALTERNATIVES

For many applications, TCE can be replaced by safer water-based solvents or other safer organic solvents.

In Massachusetts, the Toxics Use Reduction Institute (TURI) works with companies who want to replace toxic chemicals like TCE. To date, TURI has worked with more than 20 companies to find alternatives to TCE in a variety of uses, including cleaners, degreasers, ink and paint cleaners and oil removers. Due in large part to TURI's work with small businesses, usage of TCE in Massachusetts decreased by more than 70 percent between 1990 and 2003.[215]

Acushnet Rubber Company, in New Bedford, MA, convinced a supplier to switch to a water-based lubricant, allowing the company to eliminate 80 percent of its TCE use. For the other 20 percent, Acushnet switched to a two-step aqueous cleaner to completely replace harmful TCE. These actions reduced the company's hazardous waste disposal costs, saving about $100,000 annually, while reducing health risks to employees and the community.[216] Several other Massachusetts companies have achieved similar success.[217]

Reducing Exposure Can Prevent Harm

In the last four decades, regulatory agencies have occasionally taken action to reduce or eliminate exposure to a toxic substance after evidence of harm was discovered. Many of these efforts have successfully reduced human contamination and produced real improvements in human health.

In 2001, the U.S. EPA banned household uses of two pesticides, chlorpyrifos and diazinon. As these products were phased out of residential use in Manhattan, exposures declined and mothers gave birth to larger and healthier babies. In the 1970s, the EPA phased out leaded gasoline. As a result, the number of children in the U.S. with lead levels higher than the EPA health target of 10 micrograms per deciliter of blood has fallen by half since the early 1990s. Finally, efforts to reduce the use of toxic flame retardants in Sweden resulted in a reversal of rapidly increasing levels in breast milk.

Unfortunately, in two, if not three, of these cases, human exposures were allowed to reach the point where harm to human health was already occurring before action was taken.

Increased Birth Weight After Ban of Two Pesticides

After the U.S. EPA banned household uses of two pesticides, chlorpyrifos and diazinon, in 2001, women in New York City gave birth to larger babies.

Until 2001, the pesticides chlorpyrifos and diazinon were commonly used to kill insects in homes, schools, gardens and agricultural crops. The EPA banned chlorpyrifos at the end of 2001 and diazinon at the end of 2002, due to significant evidence of harm to children. Products containing these ingredients began to dwindle on shelves while commercial applicators switched to new pesticides. (The products are still used in agriculture and can still be found on some produce, except for certain crops that kids often eat, such as tomatoes and apples).

In March of 2004, Dr. Frederica Perera, Dr. Robin Whyatt, and their colleagues at Columbia University studied the connection between exposure to these two pesticides and birth weight.

The researchers reported that pregnant women in upper Manhattan who had higher exposure to two common pesticides had smaller babies than women with less exposure.[218] Women with the highest pesticide exposures had babies that were more than 0.4 lb lighter and 0.33 inch shorter than babies from women with the least exposure. These findings suggested harm to the health of exposed children not just in the womb, but later in life as well. Interviewed in the *New York Times*, Dr. Perera noted that "Birth weight is a very good predictor of later health and development of children, including physical development, mental development, and school performance."[219]

But the most striking finding of the work was the immediate benefit of the phase-out of chlorpyrifos and diazinon from household uses. The scientists noted that after the ban, women had much less chlorpyrifos in their blood. Before the ban, one third of children fell into the high exposure group. From 2001 on, just one in 77 fell into that group. Remarkably, as pesticide levels fell, birth weight and body length rose.

The scientists were astounded that such an effect was visible so soon, since the phase-out of the pesticide products was not immediate. Surveyors still found remaining stocks of products containing chlorpyrifos and diazinon on the shelves of some stores in Manhattan as late as mid-2003.[220] Accordingly, exposure levels should continue to decline as the products become scarcer. In the *New York Times*, Dr. Whyatt noted that "the exposure levels are still going down... We may continue to see added benefits of this ban over time."[221]

Declining Lead Levels in Children After the Phase-Out of Leaded Gasoline

The story of lead in the United States is one of success, but also one of profound failure.

In the 1920s, oil companies decided to put tetraethyl lead into gasoline to keep car engines from "knocking." Emitted from the tailpipes of millions of cars, lead contaminated the blood of millions of mothers and children, causing extensive developmental damage. Industry continued to promote the use of lead for decades, opposing efforts by the public health community and regulatory agency staff to ban lead in gasoline. Finally in the 1970s, advocates were successful in overriding industry concerns and winning a phase-out. The U.S. EPA began with mandated reductions of lead in gasoline and enforced a total ban in 1986. Other EPA actions eliminated lead from house paint. As a result, average blood lead levels for both children and adults have dropped more than 80 percent since the late 1970s.[222]

Pam Roth

Since EPA began phasing out the use of lead in gasoline in the 1970s, the average blood level of lead in American children has dropped by more than 80 percent.

In 1997, then EPA administrator Carol Browner said, "The ongoing reduction in blood lead levels is a great American success story of environmental and public health protection. Years of aggressive action against lead exposure, particularly EPA's banning of lead in gasoline two decades ago, is yielding a brighter future for our children."[223]

However, the efforts of the EPA and countless public health agencies to reduce lead exposure would not have been necessary had the oil companies chosen ethanol, a relatively safer compound, to add to their fuel. Oil companies forced lead on the American public partially because of fears over competition with ethanol as an alternative fuel. They vigorously defended their product for decades against mounting evidence of harm to children's health. Lead was a known poison before it was introduced: lead manufacturers were aware of health risks and the U.S. public health community was clearly communicating such risks over 80 years ago. The introduction and widespread use of lead, plus delay in eliminating it, unnecessarily exposed roughly 68 million children to toxic levels of lead from gasoline from 1927 to 1987.[224]

Although exposure is much lower today than in 1970, toxic lead levels still persist in close to half a million children—far too many to claim victory over this pervasive health threat. Efforts must be aimed at eliminating the threat to children in low-income housing developments and older housing, where lead exposure is still high. Hopefully, individuals making decisions about the use of potentially hazardous chemicals in the future can learn from the story of lead in the U.S.

Declining Breast Milk Contamination in Swedish Mothers Following Flame Retardant Ban

Sweden and Germany were the first countries in the world to scale back the use of the toxic flame retardants known as polybrominated diphenyl ethers, or PBDEs.

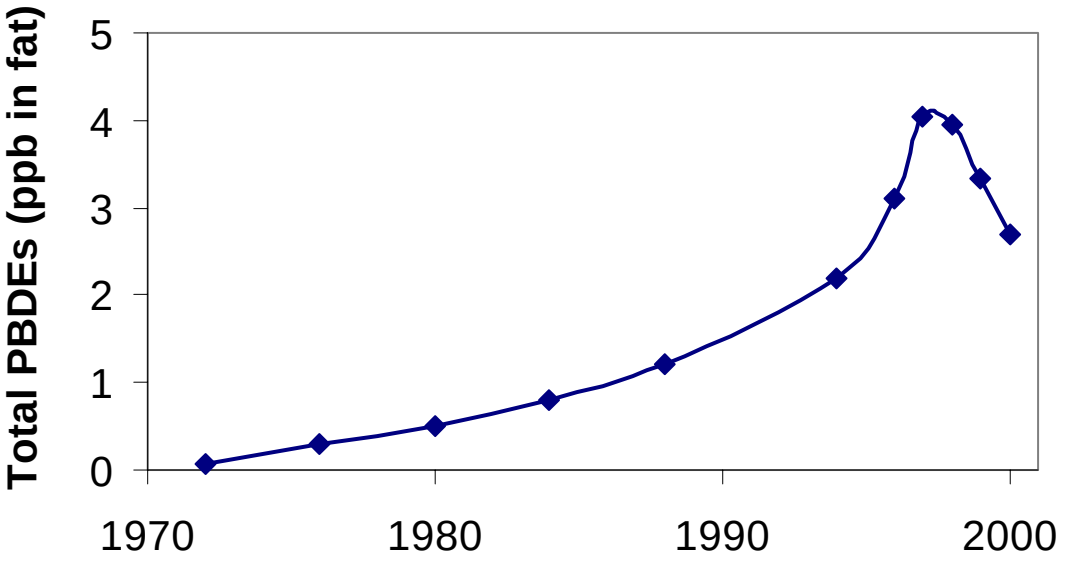
Swedish scientists were also the first to detect the exponential increase in contamination soon found to be sweeping the world. Dr. Ake Bergman and his colleagues at the University of

Stockholm took advantage of Sweden's breast milk monitoring program, which enabled them to look back in time and document rising levels of toxic flame retardants in the breast milk of Swedish mothers [225] The group discovered that samples of milk from Swedish mothers in 1972 had PBDE levels of about 0.072 parts per billion in fat. In 1997, levels had increased about 60-fold to 4 ppb in fat, doubling every 5 years.

This finding caused a stir in the scientific community, especially since the flame retardants were not readily leaving the body and showed similar structural features to polychlorinated biphenyls (PCBs), a well-known public health tragedy. Public concern about the potential health consequences of this trend led to sharply decreased usage of products treated with PBDEs in European countries. Germany had banned PBDEs in 1989 because of concern that they could form dioxins when burned. Sweden had scaled back the use of one type of flame retardant in the mid 1990s. In addition, from 1997 to 1998, the EU cut down on PBDE use by two thirds, or 180,000 pounds. Afterward, levels of contamination in the breast milk of Swedish mothers began a consistent decline (Figure 2).

In 2003, California passed a ban of two types of PBDEs mainly used in furniture foam. One manufacturer of these chemicals made an agreement with the EPA shortly thereafter to phase out national production of the two chemicals. As these actions take effect, the U.S. should see a similar decline in human contamination levels. Lingering questions over a third type of flame retardant (known as "Deca"), used in high volumes and shown to degrade in the environment to form the banned substances, could delay or reduce the response.[226] Full phase-out of all three chemicals would likely result in the swiftest reduction in exposure.

Figure 2: Declining Toxic Flame Retardant Levels in Breast Milk from Swedish Mothers. [227]



Policy Recommendations

The 10 chemicals explored in this report just begin to scratch the surface of the potential impact of toxic chemicals on public health. While there are countless unanswered questions remaining about how chemical exposures are tied to public health impact, the evidence that does exist justifies a greater effort to consciously choose safer alternatives to the most toxic chemicals used in commerce.

Over the past several decades, university and government scientists have accumulated significant knowledge of the potential for toxic chemicals to harm human health, yielding several general lessons: [228]

1) Once a toxicant is identified, further study commonly identifies more subtle health effects at lower levels of exposure;
2) The idea that the "dose makes the poison," or that certain chemicals dangerous in large amounts are safe in small amounts, is overly simplistic. Sometimes, small doses are more potent than large ones, and exposures can cause profound effects during some developmental periods, but no effect at other times;
3) Mixtures of chemicals, which people are most likely to encounter in the real world, can have cumulative effects or effects that individual chemicals don't have on their own; and
4) Ending or preventing exposure is the quickest way to reduce harm.

Unfortunately, current chemical regulatory policy in Connecticut and the U.S. as a whole does not reflect these lessons. When the federal government created the Toxic Substances Control Act in response to the PCB crisis 30 years ago, the chemical industry succeeded in making sure there were no new testing requirements placed on the tens of thousands of chemicals already in use. For new chemicals, the law required only a rapid pre-market screening based on existing information, and did not require toxicity testing for health effects. This approach runs directly counter to other regulatory frameworks, such as the way pharmaceuticals are evaluated by the Food and Drug Administration.

As a result, U.S. chemical regulation stumbles blindly, using an "innocent until proven guilty" model, allowing widespread exposure to toxic chemicals before they have been tested for safety, and often before methods have even been developed to test for the chemical's presence in our bodies, air and water. The burden of proving harm remains on those who suffer the harm—the public. Moreover, where significant evidence of harm to public health already exists, inadequate resources and legal authority often prevent regulatory agencies from taking protective action.

Some manufacturers in Connecticut are ahead of the curve in adopting alternatives to toxic chemicals – especially companies wanting to do business in states and countries with tougher regulations for dangerous chemicals, such as the European Union. However, to make the use of alternatives widespread, Connecticut needs to take action itself.

Comprehensive regulatory reform is necessary to improve our knowledge of chemicals used in commerce, to encourage the use of materials and processes most likely to be safe and to enable government to take action to protect public health from the greatest threats, when warranted.

In order to protect people – especially children – from toxic exposures, we must take firm steps to remedy the ignorance about health effects of widely-used chemicals and empower regulatory agencies to ensure that consumer products do not have dangerous chemicals in them. These steps include:

- **Phase out hazardous chemicals from uses leading to human exposure.** Although complete toxicity information is not available for most chemicals, evidence of potential harm exists for thousands of substances. These chemicals should not be allowed for uses that lead to human exposure. For example, the recent U.S. EPA action phasing out household uses of the pesticides chlorpyrifos and diazinon has been successful at reducing human exposure and improving infant health. When strong potential for harm exists, chemicals should be completely removed from the market and manufacturers should seek and switch to alternatives. Chemicals known to persist in the environment, accumulate in the food chain, or harm human health and development fall into this category.

  Connecticut can start by phasing out the use of deca BDE flame retardant in electronic equipment, expanding the elementary school lawn care pesticide ban to include middle and high schools, phasing out DEHP from medical equipment and building materials, and removing any chemical that persists in the environment and accumulates in the food chain from commerce.

- **Assist businesses in switching to alternatives.** In 1989, the Massachusetts Legislature unanimously passed the Toxics Use Reduction Act (TURA) to help protect its citizens from toxic chemicals. This measure was supported by both industrial and environmental groups and was promptly signed into law by then Massachusetts Governor Michael Dukakis. TURA encourages industry to seek alternatives to toxic chemical use. These include using toxics less frequently, more efficiently, and finding less toxic solutions for the same applications. A number of toxic chemical reporting requirements that keep cities and towns informed about the types of toxic hazards being used in their communities were key to this legislation. Further, TURA established the Toxic Use Reduction Institute (TURI) based at the University of Massachusetts Lowell. TURI conducts research to find new and cost effective ways to reduce toxic chemical use in Massachusetts and educates and trains professionals and citizens about how to reduce toxic chemical use.[229]

  Connecticut should set up a similar program, including requiring information from manufacturers on the volumes of chemicals used in manufacturing and distributed in consumer products. The program should also include a program at the University of Connecticut similar to the Toxics Use Reduction Institute that can help local businesses identify and implement safer and cost effective alternatives to toxic chemicals and manufacturing processes.

- **Reform chemicals policy.** Currently, manufacturers can put chemicals on the market without proving they are safe. Chemical manufacturers should be required to provide all hazard and health-effects information to the government so agencies can begin to assess the thousands of chemicals currently on the market for which little or inadequate data are available. Next, pre-market hazard and health-effects testing should be required for all new chemicals before they are introduced into commerce. Finally, the Connecticut Department of Environmental Protection must have the authority to ban or restrict the use of a chemical if it can harm human health. To that end, Connecticut and the federal government must establish a regulatory framework for regulating chemicals in commerce without the legal barriers that make the federal Toxic Substances Control Act ineffective.

  The European Union recently established a policy called REACH, or Registration, Evaluation and Authorization of Chemicals. This policy is more effective than the regulatory framework used in the U.S., and can serve as a guide for reform.

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