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Understanding Toxic Substances
Michigan State University
Cooperative Extension Service
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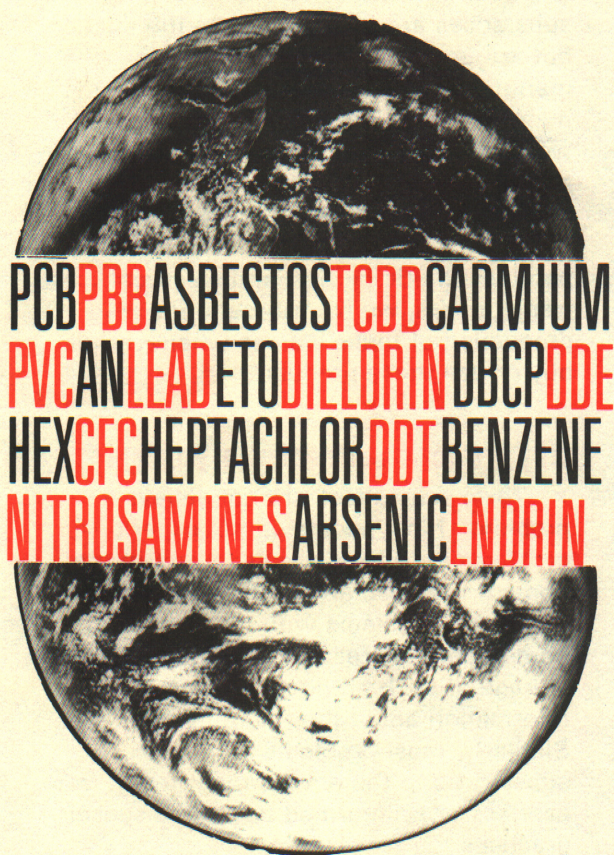
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Understanding Toxic Substances

Extension Bulletin E-1444, Sept. '80

COOPERATIVE EXTENSION SERVICE
MICHIGAN STATE UNIVERSITY



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What are toxic substances?

Toxic substances are chemical substances that may present an unreasonable risk of injury to health or to the environment. Many chemicals are part of our daily lives, and a small percentage of these are toxic. Toxic substances that might be used around the home include paint thinner, garden pesticides, drain-cleaning chemicals, and some medicines. Although such substances may be beneficial when used correctly, they may well be toxic if someone misuses them or is exposed to excessive doses. Other toxic substances are less familiar to the public but are essential ingredients in the manufacture of familiar products. Many manufacturing industries produce toxic waste products that must be disposed of in an environmentally safe way. Although most of us do not see the toxic wastes produced in the manufacture of batteries, paint, synthetic fabrics, and electrical transformers, we contribute to the production of these wastes whenever we buy or use these products.

Why are toxic substances a problem?

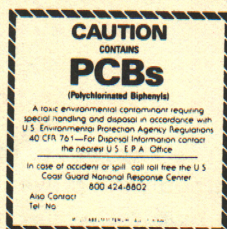
Toxic substances are not always a problem. Most people do not experience problems with toxic products kept in the home if they use and store these products carefully. Problems with toxicants in the home generally result from careless use or storage of such products or from a lack of information about their potential dangers. Similarly, most problems with toxic substances in the environment result from careless or uninformed use and disposal practices.

Chemicals are sometimes not recognized as toxic until after they have been used for many years and released into the environment in significant quantities. Polychlorinated biphenyls (PCBs) are one example of such a chemical group. PCBs were discovered in the late 1800s but were not used industrially in this country until 1929. From 1929 to

1971, PCBs were widely used in industry because of their properties of chemical and thermal stability, fire resistance, and non-conductivity. They were also widely used to change the characteristics of plastics, adhesives, paints, and to make carbonless carbon paper. Today PCBs are used primarily as coolant insulation fluids in electrical transformers and capacitors.

The toxicity of these substances was first recognized as a problem by scientists in Sweden in 1966. Further attention was focused on this problem in March, 1968 after 1,000 people in Japan were accidentally poisoned by eating cooking oil contaminated with PCBs. Victims were afflicted with skin lesions, blindness, hearing loss, jaundice, and abdominal pain.

A few birth abnormalities were also linked to this poisoning episode. Manufacture, transportation, and use of PCBs were drastically reduced and restricted by manufacturers in 1971.



Federally required
label for
certain PCB items.

PCB manufacture, processing, distribution, and use in an open system were prohibited in the U.S., in 1979, except by special permit from EPA. But recent environmental tests have detected PCBs all around the globe—in the fatty tissues of Arctic polar bears, in Great Britain's rainfall, in ocean and freshwater fish, and in the milk of nursing mothers. Especially high PCB concentrations have been detected in the Great Lakes region, in North Atlantic States, and in southeastern coastal States. PCBs are found in soil, air, water, and in many living organisms. Because PCB molecules do not break down easily into other, less toxic molecules, they are expected to remain a significant contaminant in the environment for the undetermined future. Although great care is now being taken to prevent the introduction of PCBs into the natural

ecosystem, they continue to enter the environment when wastes are improperly incinerated or disposed of. PCBs in the atmosphere are carried around the world and reenter land or water in a random pattern.

Another instance of accidental introduction of a toxic substance occurred when PBB, a toxic fire-retardant chemical, was inadvertently mixed with cattle feed in Michigan. Before the mistake was realized, PBB had been introduced into dozens of farms and had found its way into the soil, water, livestock, and crops. Thousands of farm animals were destroyed and numerous farms went bankrupt as a result. Farm families experienced unusual physical symptoms— fatigue, muscle aches, rashes, and irritability. Although this accident was a one-time occurrence, PBB levels are still significant at many of the farms involved, and trace amounts are detectable in many individuals who consumed the products of these farms.

How are people exposed to toxic substances?

People can be exposed to toxic substances through the presence of these substances in food, air, water, soil, or in man-made objects. Toxic substances frequently are released into the environment by the discharge of liquid wastes into waterways, the disposal of wastes in landfills or dumps not properly designed for the containment of toxicants, or the transport of gases and dust through the air. Many toxic materials tend to accumulate in living things and are passed on through the food chain, so that the top predators— flesh-eating fish, birds, and mammals— receive a concentrated dose of such materials. If the substance is one that accumulates in the body, as many do, an organism may take in small amounts of the substance over long periods of time and accumulate a large enough dose to cause health problems.

Some of these toxic contaminants that have occurred in foods include lead, mercury, pesticides, PCBs, and toxic

substances produced by the growth of certain bacteria in foods (for example, ptomaine or botulism). Fish accumulate chemicals from plant and animal life they eat. Fruits or vegetables may contain residues of pesticides that were applied to the crop. Improper handling of perishable foods may cause bacterial growth, which produces toxic by-products. The commercial food industry and the U.S. Food & Drug Administration have established a regulatory network to help prevent contaminated foodstuffs from reaching the commercial market.

Some people are exposed to toxic substances in their workplace. Such occupational exposures are monitored and regulated by the U.S. Occupational Safety and Health Administration. Exposure to toxic substances in the workplace may be connected with industrial jobs that involve the use or manufacture of chemicals or the mining of such materials as asbestos or uranium.

University of Wisconsin photos



Rhesus monkeys are used by University of Wisconsin researchers to study PCB's effects. Infant far left is a control; other infant's mother was fed just 1 ppm PCB in her diet while pregnant and while nursing this baby. The mother showed no ill effects; this infant died at 4 1/2 months.

What can toxic substances do?

Toxic substances can cause a great variety of problems to plants, animals, and humans. These effects can be classified as either short-term (rashes, headache, nausea) or long-term (cancer, birth defects, permanent damage to an organ, or death). Short-term effects result from the acute exposure of the individual to one or more toxicants; these appear quickly and are usually reversible. When the exposure to the toxicant(s) is stopped, the effects generally disappear in a reasonably short time and full health is recovered. Many of

the long-term effects that can result from exposure to toxic substances are permanent. They may involve genetic mutations (permanent changes in hereditary characteristics), irreversible damage to certain organs such as the eyes or the liver, or cancer. Long-term effects may not show up until many years after the exposure, or they may appear in the offspring of the individuals exposed. The list of known toxic substances is large, and much remains to be learned about the long-term effects of exposure to toxic substances.

Any harmful effect of a chemical substance is related to its relative toxicity, which is the amount of the substance needed to produce a toxic effect compared to other toxic substances. The smaller the lethal dose of a chemical, the higher its relative toxicity. Other factors — amount and duration of exposure, the sensitivity of the individual to that chemical — can affect the type and degree of an individual's reaction to exposure. For instance, the substances contained in cigarette smoke are known to cause lung cancer in humans, but not all people who smoke will contract lung cancer. This seems puzzling at first, but it illustrates that the toxic activity of a substance is not predictable and is instead subject to interaction with many other factors, some of which are not yet well understood.

The fact that we do not know everything about what toxic substances can do is a source of anxiety and unease in the general public. It may seem that every time one picks up a newspaper something else has been found that causes cancer. In fact, while many unknown health hazards are connected with living in a technological society, the chances of living a long and healthy life, free from severe toxic effects, are great. It is important to cautiously evaluate and control toxic substances by a rational, step-by-step approach. Exaggerated accounts of dangers that imply everything causes cancer or is harmful do little more than stir up people's fears.

What can be done to protect us from toxic substances?

Some important things that are being done by EPA in cooperation with State and local governments, international commissions and responsive industries are:

- comprehensive testing of new chemical substances before they are introduced into commerce.
- evaluation of known toxic substances and their interactive effects.
- development of less-hazardous substitutes for substances that are unacceptable. These substitutes may be biodegradable (quick to break down), less toxic, or not subject to accumulation in living organisms.
- innovations in the use of such toxic substances as pesticides, such as reducing the quantity of the substance recommended to do the job. Integrated Pest Management Programs, for example, develop ways to use smaller amounts of pesticides at specific points in the life cycle of the pest in order to produce similar results to the applications of large amounts of pesticide without relation to the organism's life cycle.
- development of industrial waste exchanges with special emphasis on the re-use of toxic waste as a raw ingredient in the manufacture of a new product.
- establishment of safe, carefully monitored disposal sites for toxic materials.
- expansion of research on the long-term effects of toxic substances on human health.
- increased public education and information-dissemination programs on toxic substances.

Toxic substances are a part of our world. They have been produced in the past, and many will be produced in the future. If toxic substances must be used and disposed of, as it appears they must, it is important that they be handled safely, both for our own and for future generations' sakes.

FEDERAL LAWS THAT REGULATE TOXIC SUBSTANCES INCLUDE:

Toxic Substances Control Act, 1976.

Authorizes the U.S. Environmental Protection Agency (EPA) to inventory industry data on production, use, and health effects of chemicals and to regulate the manufacture, distribution, use, and disposal of chemical substances.

Clean Water Act, 1972; amended 1977.

Requires EPA to set toxic pollutant effluent standards and to grant discharge permits.

Clean Air Act, 1970; amended 1977.

Empowers EPA to regulate hazardous air pollutants and to set emissions standards.

Resource Conservation and Recovery Act, 1976.

Gives EPA the authority to regulate the treatment, storage, transport, and disposal of hazardous wastes.

Occupational Safety and Health Act, 1970.

Enables the Occupational Safety and Health Administration to regulate exposure to hazardous substances in the workplace.

Federal Food, Drug, and Cosmetics Act (plus amendments), 1938...1976.

Provides the Food and Drug Administration with the authority to set tolerances for contaminants in commercial foods, drugs, and cosmetics, and to ban unsafe products.

Federal Insecticide, Fungicide, and Rodenticide Act and the Federal Environmental Pesticide Control Act, 1972.

Authorizes EPA to register all pesticides and uses, issue permits to applicators, and cancel or suspend specific pesticides or uses if they are deemed unduly hazardous.

Is it costly to control toxic substances?

It is indeed expensive for government and industry to perform tests, develop premanufacturing notifications, and compile an inventory of chemicals. Increased costs to the manufacturer who must control toxic substances may be passed on to the consumer in higher prices. People may not understand— or be happy— when a popular product that may also be toxic disappears from the marketplace or increases in price. It also costs more in the short-term to dispose of toxic substances in an environmentally sound manner. Confined disposal areas or high-temperature incinerators are some of the approved methods of disposal, and they are expensive.

But the costs that are harder to determine are those of not regulating toxic substances and instead suffering the long-term consequences, both in health and in damage to the environment. One example of a short-term economy that led to enormous financial burdens to society and industry was the disposal of hazardous chemicals in the Love Canal area by a major chemical company in the 1940s. Although care was taken to prevent the escape of the toxic materials stored there, the safeguards did not go far enough. The containment system was breeched, and 30 years later toxic chemicals were found to have escaped and contaminated local soil and water. People have been evacuated from their homes because of the effects of toxic pollutants, and large areas of developed land are now unusable. The costs in human health problems and birth defects that may be linked to this one situation are high, and they are impossible to define in hard figures. The human tragedy is real. In short, the costs of preventive measures seem small compared to the damage.

Other instances of toxic substance pollution that involve human injury include the 1977 contamination of dozens of city water systems in and around Philadelphia by carbon tetrachloride accidentally mixed with process chlorine; mercury poisoning

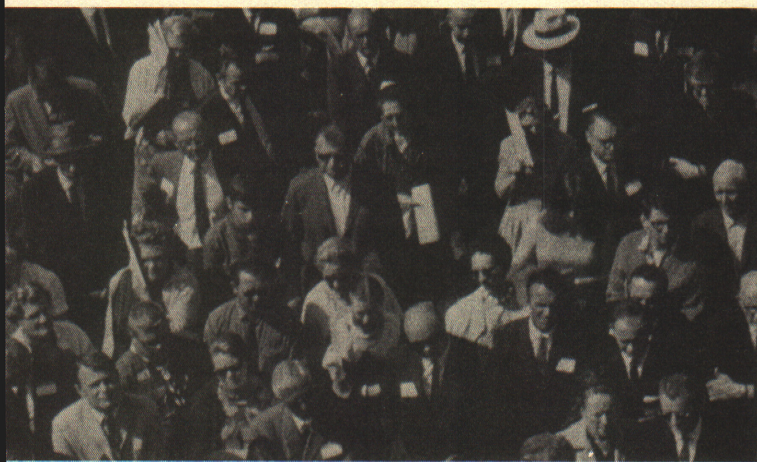
in Rockford, Illinois in 1974, which occurred when mercury from an open dump leached into a farm well and affected humans and livestock; and the pollution of rivers and water systems near Little Sandy River, Kentucky in 1977, when railroad cars carrying acrylonitrile derailed and ruptured, spilling their contents and contaminating the Ohio River.

It is important to learn from such experiences. More stringent requirements for the disposal of toxic wastes— properly engineered and constructed disposal areas, high-temperature incineration or more stringent regulation of transportation and distribution of toxic substances— could have prevented many of these problems. If we spend a moderate amount of money to prevent such disasters, we will not be faced with the incalculable costs of toxic pollution in the future.

What can I do?

Private citizens and environmental organizations have been very important in the past in identifying toxic substance problem areas and prompting regulatory action. You can become involved in the protection of the environment from toxic pollutants. Your ideas are important — the problems involved are complex and require difficult decisions. It is important that citizens become part of the decision-making process.

So.....GET INVOLVED!



Become informed. Keep up-to-date on toxic substance problems through newspapers and other media. Become aware of potential sources of toxic pollution in your community or in your workplace. As a concerned individual, you have an important role in the control of toxic substances. These are important things you can do:

- participate in public meetings and forums.
- avoid the unnecessary use of dyes and other toxic substances in paper products.
- promote public education about toxic substances, help to schedule educational events, and encourage schools to include environmental problems and solutions as part of their courses of study.
- work for legislation that ensures better control of toxic substances.
- reduce household use of toxic products, such as pesticides. Ask yourself: Do I really need to use this potentially toxic product? Use such products cautiously and dispose of them properly.
- get answers to your questions. If you think that an incident of toxic pollution may be occurring, ask questions — of your local or State pollution control agency or U.S. EPA. Find out the facts, see what's being done, and follow through.

For more information from EPA, call (312) 353-2072.



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