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The Harmful Effects of Toxic Chemicals in the Environment and Human Resources

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ABSTRACT: A chemical exposure can produce a health effect directly at the site of contact (local) or elsewhere in the body (systemic), and that effect can be either immediate or delayed.

Area of the Body Affected: Chemicals can affect any system in the body, including respiratory (nose, air passages and lungs), digestive (mouth, throat, stomach, etc.), circulatory (heart, blood), nervous (brain, nerve cells) and reproductive (sperm, egg, etc.). Some chemicals, like acids, are nonspecific and cause damage on direct contact. Other chemicals, like gasoline, can be absorbed into the blood, and carried throughout the body. Some chemicals affect only certain target systems or target organs.

Every organ system has different functions and physical characteristics. So the effect of chemicals on each system has to be evaluated slightly differently. As an example, consider three ways that chemicals can affect one system: the reproductive system.

First, chemical exposure can affect a man's or woman's reproductive system by making the production of normal sperm or eggs more difficult.

Second, the chemical may act directly on an unborn baby (fetus). Since chemicals can be transferred from the mother's blood to the unborn baby's blood, the fetus can be affected when the mother is exposed to certain chemicals. A pregnant woman who drinks alcohol can have a baby with fetal alcohol syndrome. The health effects can range from birth defects to learning disabilities.

I. INTRODUCTION

And finally, some chemicals can have indirect effects on the development of the fetus. For example, smoking during pregnancy can reduce the amount of oxygen to the fetus. The lack of oxygen can affect the baby's growth.

Not all chemical exposures affect reproduction, but it is best to minimize exposure to all toxic substances during pregnancy.

When Health Effects Will Occur Immediate health effects happen right away. They can occur directly at the site of contact or elsewhere in the body. For example, inhaled ammonia can irritate the linings of the nose, throat and lungs. Alcohol can cause dizziness. Immediate health effects are sometimes reversible and may disappear soon after the exposure stops. However, some immediate health effects do not go away; acute exposure to a corrosive substance, such as battery acid, may cause permanent damage to skin or eyes.[1]

Delayed health effects may take months or years to appear and can result from either acute or chronic exposure to a toxic substance. The delay between the exposure and the appearance of health effects is called the latency period. Delayed health effects can be reversible or permanent. Permanent effects don't go away when the exposure stops. For example, breathing asbestos over a period of time may cause lung disease. Once the lung disease begins, it will continue even if the exposure stops or decreases.

Cancer is an example of a delayed health effect. Cancer is the uncontrolled growth and spread of abnormal cells in the body. There are many kinds of cancer. Cancer can be caused by a number of things, including exposure to toxic substances, ultraviolet sunlight and ionizing radiation. Exposure to some chemicals, such as benzene and asbestos, can produce cancer in humans. Some chemicals produce cancer in animals, but whether they will in humans is unknown. Because cancer may not appear until 5 to 40 years after exposure, determining the cause of cancer is difficult.

There are many materials used in the workplace that can be hazardous. However, in order for them to affect your health, they must come into contact with the body or be absorbed into the body. When assessing the potential health

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effects from working with a particular material, it is necessary to understand the difference between “toxicity” and “hazard”. [2]

II. DISCUSSION

1. TOXICITY is the ability of a substance to produce an unwanted effect when the chemical has reached a sufficient concentration at a certain site in the body.

The more toxic a material is, the smaller the amount of it is necessary to be absorbed before harmful effects are caused. The lower the toxicity, the greater the quantity of it is necessary to be absorbed. Generally, the toxicity of a chemical is determined through experiments on animals (quite often rats), and measured in terms of the amount of material necessary to cause death in 50% of the test animals. These values are called LD50 (lethal dose) or LC50 (lethal concentration), and are usually given in weight of material per kg of body weight or airborne concentration of material per set time period respectively. [3]

1. HAZARD is the probability that this concentration in the body will occur.

Toxicity is an inherent property of the material. A material may be very toxic, but not hazardous, if it is handled properly and is not absorbed into the body. On the other hand, a material may have a very low toxicity, but be very hazardous.

Routes of Entry

There are three primary routes of entry into the body: ingestion, skin or eye absorption, inhalation and injection.

Ingestion- This means taking a material into the body by mouth (swallowing). Ingestion of toxic materials may occur as a result of eating in a contaminated work area.

Absorption- Substances that contact the eye and the skin may be either absorbed into the body or cause local effects. For the majority of organic compounds, the contribution from skin absorption to the total exposure should not be neglected.

Inhalation- This means taking a material into the body by breathing it in. In the lungs, very tiny blood vessels are in constant contact with the air we breathe in. As a result, airborne contaminants can be easily absorbed through this tissue. In the occupational environment, this is generally the most important route of entry. [4]

Injection- This means taking in biological or chemical substances into the body when the skin is accidentally punctured with a sharp object (e.g. contaminated needle).

Health Effects – Chronic vs Acute

Once a toxic substance has contacted the body it may have either acute (immediate) or chronic (long term) effects.

Example: Spilling acid on your hand will cause immediate harm, i.e. a burn to the skin.

Exposure to asbestos or tobacco smoke may result in lung cancer after as much as twenty years (this is a long term effect).

Exposure – Chronic vs Acute

Exposure can be classified as chronic or acute. In chronic exposures, the dose is delivered at some frequency (daily or weekly usually) over a period of time. In acute exposures, the dose is delivered in a single event and absorption is rapid. Usually, a chronic exposure occurs at low concentration and acute exposure at high concentration. [5]

Some materials may only cause harm if given acutely, not having any effect in the long term. Other materials may not exhibit an effect in the short term, but may cause problems after prolonged exposure.

Physiological Classification of Materials

This classification identifies toxic materials on the basis of biologic action.

Irritants – refers to some sort of aggravation of whatever tissue the material comes in contact with. e.g. ammonia, nitrogen dioxide.

Asphyxiants – exert their effects through a depletion of oxygen to the tissues e.g. simple asphyxiants – carbon dioxide, nitrogen, methane, hydrogen chemical asphyxiants – carbon monoxide, hydrogen cyanide, hydrogen sulphide.

Narcotics or Anaesthetics – the main toxic action is the depressant effect upon the Central Nervous System. e.g. – many organics, chloroform, xylene.

Systemic Poisons – the main toxic action includes the production of internal damage e.g. Hepatotoxic agents – toxic effects produce liver damage. eg. carbon tetrachloride.

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e.g. Nephrotoxic agents – toxic effects produce kidney damage eg. some halogenated hydrocarbons

Carcinogens – agents/compounds that will induce cancer in humans. e.g. benzene, arsenic, inorganic salts of chromium, nickel, beryllium.

Mutagens – agents that affect the cells of the exposed people in such a way that it may cause cancer in the exposed individual or an undesirable mutation to occur in some later generation. e.g. radiation, variety of chemical agents that alter the genetic message.

Teratogens – Agents or compounds that a pregnant woman takes into her body that generate defects in the fetus e.g. Thalidomide, possibly steroids[6]

Sensitizers – Agents that may cause allergic or allergic-like responses to occur.

After an initial exposure to a substance an individual may become sensitized to that substance. Subsequent exposures to the same substance, often at a much lower concentration than before, produces an allergic response. This response may be a skin rash (dermatitis) or an asthmatic-like attack, depending on the route of exposure. e.g. cutting oils, isocyanates in polyurethane foam operations and paint spraying operations, some laboratory solvents.

“It’s important for people to realize there are things you can do to lower your exposure to toxic chemicals, but some things you can’t do.”

For example, Woodruff explains, Americans would have had a hard time limiting their exposure to lead before leaded gasoline became illegal in 1996 (though the phaseout started in the mid-1970s). Until then, no amount of personal awareness could protect someone from lead – it was in the air that everyone breathed.

She offers another example specific to the PRHE’s efforts. “When California outlawed flame retardants,” she says, “we saw levels decrease by about two-thirds in the blood of pregnant patients at ZSFG. Through these studies, we can evaluate the effectiveness of public policy. It’s clear that when the government acts to reduce exposures to toxic chemicals ... we see a positive change. We do not always consider EPA a public health agency, but it is.”

Woodruff and her colleagues also have been working over the last several years to help strengthen the federal Toxic Substances Control Act (TSCA) of 1976. It was well recognized that the law was flawed and allowed thousands of chemicals to be used in the marketplace without testing for safety, she explains. When bipartisan calls to strengthen the law led Congress to amend it in 2016, PRHE experts partnered with obstetricians and gynecologists to provide scientific evidence about the need for improved standards, deadlines and transparency. As rules for the amended TSCA are rolled out over the next two years, “we’ll be right in there to promote the use of science for the public’s health,” says Woodruff.

She’s also bringing environmental toxics to the attention of her UCSF colleagues in other disciplines. “One of the reasons we love being at UCSF is we can learn from people who are doing completely different things,” she says. For example, she is working with researchers who study the placenta, since her 2016 study showed that environmental toxics permeate the placenta. And with developmental biologist Diana Laird, PhD, an associate professor in the Center for Reproductive Sciences, Woodruff is co-leading the Environmental Health Initiative (EHI). The EHI’s goal is to involve researchers from throughout UCSF – from the biological, population and translation sciences – in solving and preventing the environmental burden of disease, starting with ensuring healthy pregnancies.

“The EHI will link faculty across the campus, to add an environmental component to their work,” Woodruff says.

“We have already hosted several networking events and symposia with the Research Development Office toward our goal of ‘norming’ the environment within the research community. We want people to be saying, ‘We need to address the environmental consequences to fully solve health issues.’”[7]

III. RESULTS & CONCLUSION

“This is about prevention,” she concludes. “People talk about nutrition and social competencies of health. There’s another thing, which is the physical environment. The missing ingredient is toxics in the environment.”

Even though chemicals we use or are exposed to every day can be toxic, you can protect yourself and your family from chemical exposures. No matter how toxic a substance may be, if you are not exposed to the substance, it cannot affect your health. The important rule to remember is: minimize your exposure.

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- Before you use a product, read the label carefully and follow the instructions. Pay attention to warnings on the label.
- Use proper ventilation. Ventilation means getting fresh air into your home or workplace. When using strong chemicals, open your doors and windows whenever the weather permits. When you use a toxic chemical indoors, you may wish to blow air out the window with a fan. Have another window or door open to let fresh air into the room. If you use chemicals in your hobbies, use them outdoors or in a well-ventilated area away from your living space.[8]
- Wear appropriate protective gloves when handling chemicals. If you use substances that are harmful to breathe (like fiberglass which can lodge in the lungs), use an appropriate mask.
- Store chemicals safely and out of the reach of children. Label all containers and do not store liquids in commonly used household containers such as soda bottles or food cans.
- If clothes become soiled while handling chemicals, change the clothes as soon as possible to reduce exposure. Wash soiled clothes separately; then run the machine through a rinse cycle to clean it before washing more clothes.
- If you must use a toxic substance, buy only the amount needed so there will be less material left for storage or disposal.
- Try to avoid using a toxic substance. If that is not possible, choose products that have less toxic ingredients. For example, water-based paints are generally less toxic than oil-based paints.[9]
- Indoor air can contain chemicals from outside air, soil or water. Radon, a naturally occurring radioactive gas, can affect your health. It enters homes through holes or cracks in basement floors or walls. Learn how to test for radon. If the radon levels in your home are elevated, take corrective steps as soon as possible.
- Drinking water can contain harmful chemicals. Lead can leach from (dissolve out of) lead pipes or lead solder. Reduce the amount of lead in your water by using cold water and by running the water for a minute or two before using it for drinking or cooking. Filters can take out some chemicals from drinking water. Filters should only be used when necessary; be sure that the one you use takes out the chemical you are concerned about, and maintain the filters regularly.
- If you are concerned about chemicals in water, indoor air, household products, landfills or factories, the following agencies may be able to provide information and assistance:
 - your local county or city health department, or a district office of the New York State Department of Health;
 - your regional office of the New York State Department of Environmental Conservation

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