Dynamic Chiropractic

HEALTH & WELLNESS / LIFESTYLE

Toxicology: A Foundation of Occupational and Environmental Medicine

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The specialty areas of occupational and environmental medicine are in their infancy. As the complex world in which we live continues to expand its knowledge and use of chemicals, these specialty areas are increasingly important. One of the unique features of these specialized areas is our need to understand the principles of toxicology. Toxicology as a field of study helps us to predict the adverse health effects to those exposed to chemicals in their homes, community, and workplaces. That risk has been stated to be very significant by some authorities. Landrigan (1992) estimates that 50,000 to 70,000 people die each year from toxic exposure and the resulting chronic diseases.

The chiropractic occupational health consultant is aware of the potential adverse affects of chemical exposure in the workplace, and strategies to advise clients on control measures aimed at minimizing or eliminating exposure. Understanding toxicological principles of exposure, absorption, distribution, action, and elimination are the basis for dealing with chemicals.

Technology has given industry amazing ways to create, change, and develop new methods for production, processing, and researching new products unimaginable 100 years ago. This has resulted in the proliferation of new chemicals present in the workplace. New chemicals are created at a rate of 100,000 per year (Williams & Burson, 1985). It is estimated that at least 60,000 chemicals are continually being used in today's workplaces. New chemicals are created at an alarming rate; there is not adequate time to test these chemicals for all their properties and toxicity. Only 20% have been tested for carcinogenicity; even fewer have been tested for other types of toxicity (Landrigan, 1992). Chemical properties present unique risks of toxicity: hematotoxicity, hepatotoxicity, nephrotoxicity, neurotoxicity, dermatotoxicity, pulmonotoxicity, as well as mutagenicity, teratogenicity, and carcinogenicity (Williams & Burson, 1985).

Exposure to chemicals and toxic substances occurs when the worker or individual comes in contact with a given medium contaminated with a toxic substance, compound, element, or mixture. Routes of exposure are usually by one of four pathways:

Ingestion -- Inadvertently someone may eat contaminated food, drink, or medication. Children are the most common offenders of this route of exposure. Children have been known to eat lead based paint off window sills and soils contaminated with hazardous waste. Lead is a notorious toxicant which may leach from plumbing fittings and then be absorbed by people who are innocently drinking from a water fountain. Ingestion may be intended as in consumption of alcohol.

Skin Absorption -- The absorption of substances through the skin is common with chemical splashes, spills, broken containers, or explosions. Normally engineering designs and personal protection equipment provide adequate protective barriers from direct exposure. However, precautions may fail and exposure occurs. Certain chemicals are extremely liposoluble and can access the blood stream rapidly following absorption through the skin. Airborne contaminants may be dissolved by a worker's perspiration and be absorbed quickly through their otherwise effective skin barrier. Solvents are nefarious for this route of exposure. The palms of our hands are layered with thick cornified epithelium for protection, but it's porous and allows rapid access to the blood stream for some chemicals, such a pesticides. Gloves should always be worn to protect your hands.

Inhalation -- The inhalation of toxic substances is the most common route of exposure to people, both on and off the job. Inhalation of toxicants can be inadvertent such as breathing vapors, mists, fumes, and gases of toxic substances in the course of work or life because of environmental contamination. Air particulates, carbon monoxide, carbon dioxide, methane, ozone, nitrogen dioxide, hydrocarbons, and other gasses are common air pollutants present in nearly all major American cities.

- Inhalation exposure can be intentional, as when smoking cigarettes that contain over 4,000 toxic chemicals in a puff of smoke.

- Inhalation of mercury vapors is more toxic by magnitude than ingestion because of quick access to the blood stream. Inhalation provides rapid access to the richly profused alveolar capillary beds of the lung.

- Inhalation of asbestos does not access the blood stream, but becomes imbedded in the lung tissue and sets up a pathological process than can culminate in lung cancer decades after exposure.

Parenteral -- The parenteral route is through the skin by puncture, most common in needle sticks, cuts, or debris lacerations. The major parenteral concerns are not toxic chemicals, but the biohazards HBV and HIV. There are select cases of parenteral toxicity and death, usually intended as an assisted suicide.

Distribution and action of toxicants in the body are dependent upon physiological pathways and predilection of organs and systems to certain types of chemicals. These are refereed to as target organs and body compartments. Toxicants may either inhibit or promote certain physiological functions. At toxic levels adverse health effects occur. Ingesting a neurotoxin like grain alcohol is rapidly absorbed in the mouth, esophagus, and stomach. It easily crosses the blood brain barrier and exerts its major toxicity on the brain. * Benzene is a common solvent found in gasoline that is frequently absorbed as a vapor through the lung, but it exerts its toxicity on the hemopoetic system, potentially causing cancer. Pesticides like organophosphates may be absorbed through multiple routes, but exert their toxicity on the neural transmission synapse causing the overstimulation of the PNS and CNS until convulsion, paralysis, respiratory failure, and death occur.

- Lead may be ingested by drinking contaminated water and may exert a neurotoxic effect, but it is primarily stored in the skeletal system in an inert form. The individual's health status, age, gender, diet, co-morbid diseases, and other variables may also affect the distribution, action, and toxicity of chemical and substances.

Excretion by the body is also dependent on certain physiological pathways. The body's ability to biotransform the toxicant and render it more soluble to discard may be hampered by dose of the substance and the efficiency of this process. Two primary pathways eliminate or biotransform xenobiotics or toxicants in the body through cytochrome P-450 enzymes or synthesis and conjugation.

- Cytochrome P-450 is a group of enzymes found in the liver, kidney, and lung that add functional groups to deactivate and increase solubility of the toxicant for elimination by the body. Bioactivation is the most common type of elimination pathway. This process can tax the liver and thus damage it, such as in cirrhosis from chronic alcoholism or chemical exposure.

- Synthesis and conjugation is the addition of a larger, more complex molecule that alters the toxicity of the original substance and ultimately helps to deactivate and eliminate the toxicant. Glucuronidation is an example. This process is more complex and is used by the body if simple bioactivation fails.

Excretion and elimination are also affected by individual variables of age, gender, diet, health status, co-morbid disease, etc. Efficiency of elimination may vary greatly between individuals.

Toxicity of substances is also variable. Acute toxicity is defined as the adverse health effect following a single exposure incident. Chronic toxicity is defined as those adverse health effects that follow long-term uptake of toxicants. Toxicity is affected by dose. Dose is the total amount of the toxicant taken up by the victim. Dose response is the linear relationship between the quantity of a given toxicant and the adverse health effect. LD 50 refers to that amount of a toxicant that killed 50% of its test subjects. In regulating acceptable chemical exposure in the workplace, OSHA has mandated certain exposure limits: PELs and TLVs.

- Permissible exposure limits (PELs) have been established by OSHA and are listed in the 29 CFR 1910.1000 Subpart Z -- Toxic and Hazardous Substance standard. NIOSH provides the Pocket Guide to Chemical Hazards which also lists exposure limits, protective and remedial actions, and adverse health effects. This is a very helpful reference available from NIOSH.

- Threshold limit values (TLVs) have been established by the American Conference of Governmental Industrial Hygienists (ACGIH). This group of scientists have historically helped to set safe exposure standards in the workplace. References for TLVs can be obtained from many publications by ACGIH.

Prevention of chemical exposure incidents can be achieved through good hazard communication and training. OSHA's 29 CFR 1910.1200 establishes the protocols and content for a quality chemical hygiene and hazard communication program for any employer. Proper training of employees, personal protection equipment, and engineering design are all critical to successful chemical safety of our communities and workplaces.

Occupational and environmental specialties blend a unique mixture of knowledge, talent, and skills to understand and treat the effects of toxic substance exposure. Despite the growing body of knowledge about toxicology, so much is not known. Toxicology has enhanced the practice of these specialties. The chiropractic occupational health consultant plays an important role in understanding principles of toxicology and an even bigger part in the prevention of chemical exposure through workplace safety program development, implementation, and training. Doctors of chiropractic are part of the workplace health care team.

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