TerranearPMC Safety Share

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Anyone who has attended a HAZWOPER course should be familiar with the three major health hazard categories: carcinogens, mutagens and teratogens. And while all three agents manifest unique health effects, they *can* all be derived by the same contaminant; be it a radionuclide or chemical.

Carcinogens are defined as substances that cause abnormal growth of cells which tend to proliferate in an uncontrolled manner and, in some cases, to metastasize (spread). Cancer is not one disease as it is a group of more than 100 different and distinctive diseases.

A mutagen is a physical agent (such as ionizing and non-ionizing radiation) or a chemical agent (i.e. benzene and polycyclic aromatic hydrocarbons) that changes genetic material (i.e. DNA). And while many mutations can cause cancer, that is not always the case.

Teratogens have the ability to target – not just the person that is directly exposed and receives an uptake of a contaminant - but also the fetus, as these materials interfere with embryonic development within a pregnant female.

Thus, teratogens are agents that cause abnormalities to the fetus following exposure during pregnancy. It is unfortunate, but teratogens are usually discovered after an increased prevalence of a particular birth defect. For example, in the early 1960's, a drug known as thalidomide was used to treat morning sickness. Exposure of the fetus during this early stage of development resulted in cases of phocomelia; a congenital malformation in which the hands and feet are attached to abbreviated arms and legs. Teratogens can be found at home or the workplace. The specific effects of any teratogen are directly related to dose and duration, and time of exposure. It is during the first half of the gestation period where the fetus is most vulnerable.

The word teratogen originates from the Greek word for monster, *teratos*. Isidore Geoffroy Saint-Hilaire, a French physician, defined it in 1832. People had sought explanations for abnormal human and animal development, for centuries. In Babylon, it was believed that infants with congenital malformations, or structural abnormalities present at birth, were constellations in human forms as well as fortune-tellers. Many early Hebrews said that abnormal development resulted from the deformed person's association with the devil. But it was Aristotle, the famous Greek philosopher from the fourth century, B.C., who suggested that birth defects were caused by disturbances in reproduction rather than supernatural occurrences.

Teratogenic agents include infectious agents (rubella, cytomegalovirus, varicella, herpes simplex, toxoplasma, syphilis, etc.); physical agents (ionizing agents, hyperthermia); maternal health factors (diabetes, maternal PKU); environmental chemicals (organic mercury compounds, polychlorinated biphenyl or PCB, herbicides and industrial solvents); and drugs (prescription, over-the-counter, or recreational). In general, when pregnant women require medication, the lowest dose possible should be used. And during the first trimester, medications should be completely avoided – if possible.

In the case of a pregnant woman working in an area where radionuclides are present, there are certain regulations to help prevent teratogenic effects. An example is the DOE regulation, 10 CFR 835.206, "Limits for the Embryo/Fetus" where a woman that has declared herself pregnant shall not have an exposure of 0.5 rem during the period of conception to birth. This is one tenth the typical

regulation for workers at 5 rem for an entire year. However, the woman must declare her condition to her employer for this limit to be implemented.

One of the most publicized events where teratogenic effects were studied were the atomic bombs dropped on Hiroshima and Nagasaki at the end of World War II. Studies have verified that fetuses exposed to the radiation during this period had a significant increased rate of such conditions as mental retardation as well as physical abnormalities (defects); especially when pregnant women where within 1200 meters of ground zero (studies have also supported that mutagenesis and various cancers were a direct result of exposures during these atomic events).

The types and severities of abnormalities caused by a teratogenic agent is also dependent on the genetic susceptibilities carried by the mother and fetus. For example, variation in maternal metabolism of a particular drug will determine what metabolites the fetus is exposed to and the duration of exposure. The genetic susceptibility of the fetus to a particular teratogenic agent will also have an effect on the final outcome. During the first two weeks of gestation, teratogenic agents usually kill the embryo rather than cause congenital malformations. Major malformations are more common in early embryos than in newborns; however, most severely affected embryos are spontaneously and naturally aborted during the first six to eight weeks of gestation. During organogenesis (the period of pregnancy between days 15 to 60 days), teratogenic agents are more likely to cause major congenital malformations.

It is difficult to determine whether a particular chemical or medication will causes congenital abnormalities. This is because many women take medications during pregnancy, and most studies have to rely on the mother's memory of what she took while she was pregnant. Some environmental chemicals are known to lead to congenital abnormalities. Mercury, which is found in fish, has been linked with the development of neurological problems resembling cerebral palsy, as well as intellectual disability. Lead has been associated with fetal growth restriction and neurological disorders. Polychlorinated biphenyls, also known as PCBs, are shown to cause fetal growth restriction and skin discoloration.

Two of the leading preventable causes of birth defects and developmental disabilities are alcohol and smoking. Alcohol use in pregnancy has significant effects on the fetus and the baby. Alcohol can pass from the mother’s blood stream through the placenta to the fetus. Since alcohol is broken down more slowly in a fetus than in an adult, alcohol levels tend to remain high and stay in the baby’s body longer. Birth defects associated with prenatal exposure to alcohol can occur in the first 3 to 8 weeks of pregnancy, before a woman even knows that she is pregnant.

In 2001, the estimated prevalence of smoking during pregnancy for all U.S. women was 11.4 percent, ranging from 3.9 percent in DC to 26.2 percent in West Virginia. Smoking nearly doubles a woman’s risk of having a low birth-weight baby as a result of poor growth before birth, preterm delivery or a combination of both. Premature and low birth-weight babies face an increased risk of serious health problems during the newborn period, chronic lifelong disabilities (e.g., cerebral palsy, mental retardation) and possibly death. More recent studies have suggested a possible link between prenatal smoking exposure and behavioral problems in later childhood and adolescence.

Hope lies in dreams, in imagination, and in the courage of those who dare to make dreams into reality - Jonas Salk