

Environmental Teratogens

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Environmental teratogens are external agents that can increase the risk for carcinogenesis, malformations, mutagenesis, or deficient growth in an embryo or fetus. There are two general categories of teratogenic agents, which include errors in genetic processing, and environmental agents or factors. Both genetic and environmental teratogens can lead to embryopathology, but they have different pathologic processes. Errors in genetic processing can lead to abnormal development via gene abnormalities, chromosome deletion, chromosome excess, or chromosome rearrangement. Environmental teratogens, on the other hand, interact with the embryo during development, which can lead to congenital malformations and a multitude of other deficits. Environmental teratogens can include chemicals, drugs, radiation, and other factors.

Environmental teratogens have certain characteristics in common. The first common characteristic is dose-response relationships. This process states that as the dosage or exposure of a teratogen increases, then the severity or frequency of the effects increases. Threshold effect is another commonality, which suggests that a certain level of exposure to a teratogen is needed to induce malformations, a deficit, or death. The third common characteristic is stage sensitivity. This principle involves three stages of development, which include fertilization through post-implantation, day 18 to day 60, and the fetal period. During the first stage, the effect of a teratogen is either embryo death, or no effect and the embryo can repair itself. The second stage is the most vulnerable period to teratogens. During this period anatomical malformations can occur in response to teratogens. In the last period, exposure to teratogens can lead to growth

retardation or fetal death. Genetic variability is another commonality among environmental teratogens, which suggests that responses to teratogens can vary between individuals and species.

One well known environmental teratogen is thalidomide, an immunomodulator, which was marketed in the 1950's as a safe drug to reduce morning sickness. However, exposure to thalidomide during pregnancy led to limb reduction defects, skeletal defects, malformations of the heart, and other anomalies. The most obvious consequence was severe shortening or absence of the limbs. This tragedy led to the beginning of rigorous drug approval and monitoring, which we have today through the United States Food and Drug Administration (FDA). The thalidomide incident is a good example of the effects environmental teratogens can have during pregnancy. Other toxic substances that are considered to be extra hazardous during pregnancy include: aniline, benzene, carbon disulphide, carbon monoxide, chlorinated hydrocarbons, lead, mercury, nitrobenzene, phosphorus, and turpentine.

Alcohol is a prevalent environmental teratogen. Exposure to alcohol in utero can lead to numerous detrimental effects. Neural tube defects have been found to be associated with binge drinking early in a pregnancy. Chronic alcohol use during pregnancy, 6oz per day, is associated with high risk for fetal alcohol syndrome. Reported effects of fetal alcohol syndrome include intrauterine growth retardation, microcephaly, a reduction in width of the palpebral fissure, cardiac abnormalities, and intellectual disabilities. Additionally, alcoholism is often associated with smoking, other drug use, and poor nutrition, which can also influence the development of a fetus. Intrauterine growth retardation is the most common effect of exposure to narcotics during pregnancy. Cocaine use is also associated with increased spontaneous abortion rates, and decreased neurologic functioning. More research is needed to examine if amphetamines, barbiturates, and hallucinogens have specific effects on a fetus, as the current research is unclear.

Radioactive substances, such as X-rays, are another common environmental teratogen. Exposure to radiation in utero can lead to cell death or mitotic delay, which can result in intrauterine growth retardation, malformations, or embryonic death. The most common indicator of exposure to radiation in utero is microcephaly. Infants who had a mother receiving radiation treatment during her pregnancy display central nervous system defects. During later stages of fetal development, the central nervous system is the most vulnerable, and exposure can lead to brain malformations as a result of cell death and inhibition of cell migration. Additionally, exposure to radiation over time can increase the risk of gene mutations, leading to cancer and other health problems.

Lead and methylmercury are frequently discussed teratogens because they are common in the environment, and can result in toxic effects. Exposure to lead in utero has been linked with spontaneous abortion, low birth weight, and impaired neurodevelopment. Lead accumulates in the body over time, and affects multiple bodily systems. Young children absorb four to five times the amount of an adult, so they are particularly vulnerable. Exposure to high levels of lead in children is associated with adverse development of the brain and nervous system. Long-term exposure to lead is associated with kidney damage and high blood pressure in adults. Methylmercury exposure is most common via the consumption of fish and shellfish. Exposure in utero can result in impaired neurological development. It can also have toxic effects on the digestive and immune systems, skin and eyes, kidneys, and lungs.

Environmental teratogens can have a significant impact at all stages of life. Toxins can result in fetal malformations and death, impaired intelligence, and further health problems in adulthood. Previous and current research has determined that there is a plethora of environmental

teratogens. For more information on the mechanisms of teratogenesis and the effects of other teratogens, please reference the resources provided.

Further Readings

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