Environmental Toxicology

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Spectrum of Undesired Effects

Allergic reaction: The chemical allergy is an immunologically mediated adverse reaction to a chemical resulting from previous sensitization to that chemical or structurally similar ones. The most of chemical and their metabolic products are not sufficiently larger to be recognized by the immune system as foreign substances and thus must first combine with an endogenous protein to form an antigen. This kind of molecules is called a hapten. The hapten protein complex (antigen) is then capable of eliciting the formation of antibodies. The pattern of allergic response differ in various species. For example, in human skin (dermatitis, urticaria and itching) and eyes (conjunctivitis) are most common.

Idiosyncrasy Reaction: The chemical idiosyncrasy refers to a genetically abnormal reactivity to a chemical. The response observed is usually qualitatively similar to that observed in all individual but may take the from of extreme sensitivity to low doses or extreme insensitivity to higher doses of the chemical. For example idiosyncratic reaction is provided by the patients who exhibit prolonged muscular relaxation and apnea lasting several hours after the standard dose of succinylcholine.

Immediate versus Delayed Toxicity: Immediate toxic effect occur or develop rapidly after a single administration of a substance, whereas delayed toxic effect occur after the lapse of some period of time. The carcinogenic effect of chemicals usually have long latency periods, often 20 to 30 years after the initial exposure, before tumor are observed in humans. For example, the vaginal cancer produced by dietylstilbestrol in young women was due to their exposure in utero to diethylstibestrol taken by their mothers to prevent miscarriage.

Reversible versus Irreversible Toxic Effect : The some toxic effect of chemicals are reversible, and others are irreversible. If a chemical produces pathological injury to a tissue, the ability of that tissue to regenerate largely determines whether the effect is reversible or irreversible. Thus

tissue of liver which has a high ability to regenerate most injuries are reversible, whereas injury to CNS is largely irreversible because differentiated cell of the CNS can not divide and be replaced. For example, carcinogenic effect of chemical are usually considered irreversible (cancer, necrosis in tissue of liver), whereas teratogenic are usually considered as reversible toxic effect.

Local versus Systemic Toxicology: The local effect occur at the site of first contact between the biological system and the toxicant. For example chlorine gas react with lung tissue causes hepatotoxicity (damage and swelling of tissue). The systemic effect require absorption and distribution of a toxicant from its entry point to a distant site at which deleterious effect are produced. For example, tetraethyl lead produces effect on skin at the site of absorption and then is transported systemically to produce its typical effect on the CNS and other organs.

Interaction of chemicals

The chemical interaction occur due to number of mechanisms such as absorption, protein binding, biotransformation and excretion. The study of these interaction often leads to a better understanding of the mechanism of toxicity of the chemical involved. A number of term have been used to described pharmacological and toxicological interaction.

Additive effect: An additive effect when the combined effect of two chemicals is equal to the sum of the effect of each agent given alone (example: 2+3= 5). For example, when two organophosphate are given together, the cholinesterase inhibition is usually additive.

Synergetic effect: A synergetic effect occur when the combined effects of two chemicals are much greater then sum of the effects of each agents given alone (example: 2+2 = 20). For example, both carbon tetrachloride and ethanol are hepatotoxic compound, but together they produce much more liver injury than the mathematical sum of their individual effects at given dose.

Potentiation: The potentiation occurs when one substance does not have a toxic effect on certain organ or system but when added to another chemical makes that chemical much more toxic (example: 0+2 = 20). For example, isopropanol is not hepatotoxic, but when it is administered

with carbon tetrachloride, the hepatotoxicity of carbon tetrachloride is much greater than is the case when it is given alone.

Tolerance

The tolerance is a state of decreased responsiveness to a toxic effect of a chemical resulting from prior exposure to that chemical or to a structurally related chemical. The two major mechanisms are responsible for tolerance: 1) One is due to a decreased amount of toxicant reaching the site where the toxic effect is produced (dispositional tolerance), and 2) The other is due to reduced responsiveness of a tissue to the chemical. For example, two chemicals such as CCl_4 and Cd produces dispositional tolerance.