Toluene

Updated: December 2015

Toluene is a clear, colorless liquid with an aromatic odor. It is an aromatic hydrocarbon. It is a natural constituent of crude oil and is produced from petroleum refining and coke-oven operations. At room temperature, toluene is both volatile and flammable [1]. The name *toluene* was derived from the older name *toluol* that refers to tolu balsam, an aromatic extract from the tropical American tree Myroxylon balsamum, from which it was first isolated. It was originally named by Jöns Jakob Berzelius.

Usage

Toluene is used mainly as a solvent in industry, a cleaner and degreaser, a solvent for paint, varnish, and rubber adhesives, and in the production of gasoline. It has some uses as a raw material for production of toluene diisocyanate (TDI), phenol, benzyl alcohol and other benzyl derivatives, vinyl toluene.

Technical grades of toluene contain benzene in variable proportions, reaching 25% in some products.

Routes of exposure

Toluene may be absorbed via inhalation, ingestion, and transdermal routes of exposure. The main route of uptake is through the lungs.

Approximately 50% of toluene is retained in the body after inhalation of vapor. The uptake of toluene in the blood is doubled during physical activity compared to uptake at rest.

The absorption via intact skin is believed to be minimal. Dermal absorption is important when toluene comes into direct contact with skin. Increased solvent absorption can occur when solvent is trapped between wet clothing and skin.

The ingestion of toluene in clinically significant amounts occurs very infrequently in the occupational setting [2].

Toluene may be used for sniffing.

Metabolism

The metabolism of toluene involves hydroxylation of the methyl group followed by an oxidation to benzoic acid. This is then conjugated with glycine to hippuric acid. About 80% of the inhaled toluene can be found as hippuric acid and the rest of toluene is exhaled unchanged. The major portion of toluene is biotransformed within 12 hours of inhalation [3].

Target organs: CNS

Health effects

Acute exposure

Toluene can cause conjunctivitis and keratitis upon direct contact with the eyes. These damages are reversible. Toluene vapor can cause irritation to the eyes and the respiratory tract.

The predominant effect of toluene is on the CNS. The early signs of acute exposure consist of feelings of euphoria, and disinhibition. Acute high exposure may result in pre-narcotic symptoms such as dizziness, lightheadedness, impaired judgment, nausea and vomiting, lack of coordination, paresthesias, increased salivation, and tachycardia. These symptoms are mostly transitory, and resolve quickly once exposure ceases. High levels of exposure may cause coma or seizures and even death in severe cases.

Chronic exposure

Chronic exposure to toluene produces both neurological and neuropsychological impairment.

Repeated exposure may result in the gradual development of persistent symptoms: headache, fatigue, irritability, memory impairment, depression, emotional instability, sleep disturbance, alcohol intolerance. Further exposure can lead to chronic toxic encephalopathy.

Neuropsychological effects of toluene inhalation include general intellectual decrement and increased emotional reactivity.

Toluene is the most widely abused solvent. Toluene abuse causes toxic effects in any organ system, including the liver, heart, kidneys, and bone marrow, although the main effect is on the nervous system [Xiao].

Toluene cardiac toxicity is not commonly observed in human exposure.

In most studies of human exposure to toluene, hepatic damage has not been observed [4].

There are several reports of acute renal failure occurring with toluene inhalation ("glue-sniffing"); most case reports describe reversible acute tubular necrosis, with a few documenting acute interstitial nephritis. Metabolic acidosis associated with toluene abuse is much more common [5].

Dermatitis is more likely to appear with prolonged and repeated skin contact, as commonly occurs among workers who use solvents for cleaning and degreasing, or who wash their hands with solvents to remove glue, plastics, or other material from their skin [Xiao].

The first report of a possible ototoxic effect of toluene in rats was published in 1983. Evidence suggests that toluene exposure causes a permanent peripheral damage to the outer hair cells of the cochlea and affects the auditory sensitivity. In human studies the association between occupational exposure to solvents and hearing

impairment has been suggested. Combined exposure to solvents and noise leads to a higher degree of hearing loss than could be expected from noise exposure alone [6].

Developmental disability, intrauterine growth retardation, renal anomalies, and dysmorphic features have been described in the offspring of women who abuse toluene during pregnancy. Experimental results confirm adverse developmental effects: skeletal abnormalities and low fetal weight were observed after toluene exposure in several animal studies [Xiao].

Some studies examined individual solvent exposures, showing statistically significant increases in the risk of spontaneous abortion among women exposed to tetrachloroethylene (dry cleaners), toluene and aliphatic hydrocarbons (in several industrial settings monitored for exposure). One Finnish study with documented exposure by biological monitoring found an increased risk for reduced fertility among primiparous women with higher exposures to toluene. Among those exposed to organic solvents (compared with those not exposed), the probability of conceiving was reduced by half [7].

A case-control study of the relationship between the risk of colon cancer in men and exposures to occupational agents showed evidence of increased risks by increasing levels of exposures to toluene [8].

The results suggest that occupational exposure to organic solvents, mainly n-hexane, toluene, MEK and FA, may cause cytogenetic damage in buccal cells and that use of exfoliated buccal cells seems to be appropriate to measure exposure to organic solvents [9].

Carcinogenicity

There is inadequate evidence for the carcinogenicity of toluene in humans. It is not classifiable as to its carcinogenicity to humans (Group 3) [10].

References

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