West Virginia Chemical Spill: NTP Research Response and Findings

Summary

- The National Toxicology Program (NTP) completed a series of studies on the toxicity of chemicals spilled into the Elk River in West Virginia, January 2014.
- The peer-reviewed, collected findings from the studies supported the adequacy of the drinking water screening levels established at the time of the spill, and found little reason for concern for long-term health effects.

Background

In January 2014, approximately 10,000 gallons of chemicals used to process coal spilled from a storage tank into the Elk River in West Virginia. The Elk River is a municipal water source that serves about 300,000 people in the Charleston area.

The spilled liquid was a mixture consisting primarily of 4-methylcyclohexanemethanol (MCHM). Other chemicals, including dipropylene glycol phenyl ether (DiPPH) and propylene glycol phenyl ether (PPH), were also present in lower amounts. Residents in the nine counties that receive their water from this municipal water system were advised not to use the water for drinking, bathing, cooking, or washing.

A team of local, state, and federal public health officials reviewed the limited toxicology information that was available and developed short-term drinking water screening levels. They recommended a screening level of 1 ppm for MCHM and 1.2 ppm for PPH. These levels were judged not likely to be associated with any adverse health effects.

In July 2014, NTP received a nomination from the Centers for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry to conduct additional toxicity studies on the main chemicals known to be involved in the spill. In response, a partnership was formed to conduct additional research to reduce uncertainty about the screening levels that were being established for the drinking water.

Determining potential long-term health effects

NTP designed and performed studies, assessing MCHM alone, crude MCHM mixture, or other individual components in the mixture, using a variety of toxicological models and short-term assays. The studies included predictions of health effects based on computer models of chemical structure; toxicity studies in rodents; growth, development, and behavior in roundworms; developmental studies in zebrafish; toxicity to human cells in culture; and studies of gene mutations in bacteria.

Prenatal developmental toxicity studies

Because of public concern for the safety of pregnant women who may have been exposed to the chemicals, a high priority for NTP was to conduct studies that looked at potential developmental outcomes in animals.

These prenatal developmental toxicity studies allowed researchers to determine if pregnant rats, exposed to the chemical MCHM, gave birth to offspring with birth defects or other adverse health outcomes.

NTP found that MCHM caused lower birth weights and malformations of the skeleton and adrenal glands in the fetuses of rats, only at doses that are more than 1,000 times higher than estimated human exposure from consuming drinking water at 1 ppm, the recommended screening level for MCHM.

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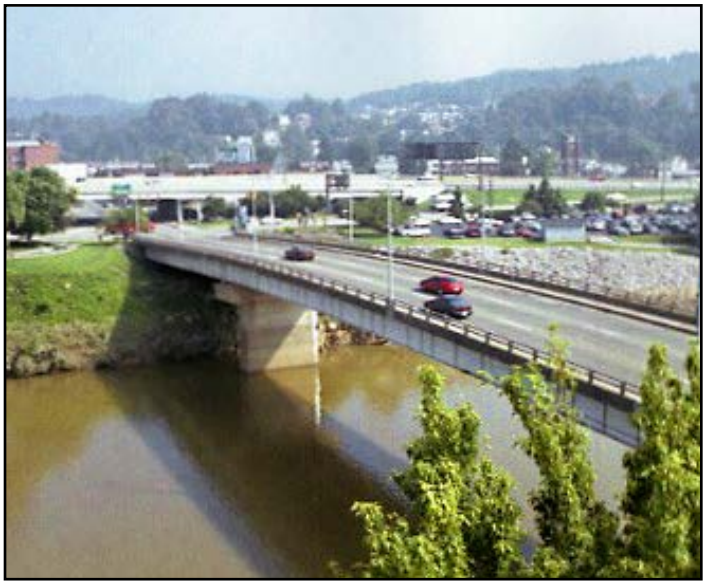
August 2019



At lower doses, approximately 200 times higher than the estimated human exposure at the 1 ppm level, there were minor changes in blood protein levels in pregnant rats; however, these changes were not expected to have to have a significant impact on maternal and/or fetal health.

Skin irritation and sensitization studies

NTP evaluated MCHM for its ability to irritate the skin or cause skin sensitization. NTP found MCHM is a skin irritant, however, it did not cause hypersensitivity, meaning it did not cause an allergic response in the skin.

NTP also tested the crude MCHM mixture. The mixture caused skin sensitization and, in one study, was also found to be a mild skin irritant. The concentrations that produced either irritation or sensitization were well above the highest levels found in the tap water.

Studies in lower animal species

NTP used lower animal species, including Danio rerio (zebrafish) and *C. elegans* (roundworms), to look at effects of MCHM and some of the other chemicals.

None of the chemicals tested in *C. elegans* affected growth, development, feeding, or reproduction. MCHM and crude MCHM were also not found to be toxic to developing zebrafish. One minor component of the spill, dimethyl 1,4-cyclohexanedicarboxylate (CHDM), did cause developmental toxicity in zebrafish. However, existing studies in rodents indicate there is limited concern for developmental effects of CHDM in humans at the concentrations people may have been exposed to during the spill.

Evaluating cell-based, high-throughput screening assay studies

NTP evaluated the data available for four of the chemicals that were tested using cell-based, high-throughput screening (HTS) assays. HTS assays are useful for rapidly evaluating large numbers of chemicals and providing insight into their potential health effects. None of the tested chemicals showed biological activity in the assays for which data were available.

Toxicogenomic studies

NTP also looked for more subtle biological changes that may occur during short-term exposures. In particular, NTP scientists examined changes in the expression of genes in the livers and kidneys of rats. These types of toxicogenomic studies were conducted on MCHM, the MCHM mixture, and PPH.

These short-term studies, coupled with powerful molecular analysis, help determine what biological systems may be affected. For MCHM, the lowest biological effect level was a dose that is considerably higher than estimated potential human exposures.

Bacterial mutagenicity studies

NTP tested spill chemicals for their ability to cause mutations, or permanent changes in DNA sequence, using the using the Ames test for bacterial mutagenicity. The Ames test assesses the ability of a chemical to cause mutations in any of several different strains of bacteria.

NTP found that the MCHM and the crude MCHM mixture did not cause mutations in any of the bacterial strains that were used in the studies. However, a minor component, dimethyl 1,4-cyclohexanedicarboxylate, when tested at much higher levels than those found in the crude mixture, was found to be weakly mutagenic.

Modeling efforts

NTP also used computer modeling to help predict potential toxicities of MCHM and other chemicals.

The results were used to inform and prioritize the studies to reduce uncertainty regarding the toxicity of MCHM and other spill chemicals.

For more detailed information about the NTP studies, visit https://ntp.niehs.nih.gov/go/wvspill.

The Centers for Disease Control and Prevention has information about federal efforts after the spill at https://emergency.cdc.gov/chemical/MCHM/westvirginia2014

The National Toxicology Program is an interagency program headquartered at the **National Institute of Environmental Health Sciences** that tests and evaluates chemicals in our environment.

For more information on NTP, go to **https://ntp.niehs.nih.gov**.