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# Scientific fact sheet:

# Health effects of chlorine disinfection by-products

1. **The best scientific summary of drinking water disinfection challenges to health are in the Position paper by Donald T Wigle.**

**Safe Drinking Water: A Public Health Challenge**
**http://www.phac-aspc.gc.ca/publicat/cdic-mcc/19-3/c_e.html**

2. **One of the most commonly occurring groups of CBPs (chlorine disinfection by-product), the trihalomethanes (THMs), was first identified at higher concentrations in chlorinated drinking water than in natural raw water by Rook and by Bellar et al during the early '70s.**

**The occurrence of organohalides in chlorinated drinking water. 4. Bellar TA, Lichtenberg JJ, Kroner RC.*J Am Water Works Assoc* 1974;66:703.**
During the course of the development of an analytical method for the determination of volatile organic solvents in water, it was observed that chloroform and other trihalogenated methanes consistently occur in drinking waters. Water supplies originating from both surface and ground water sources contain these compounds. Investigations reported here show that these compounds result from the water treatment practice of chlorination. They further show that drinking waters having surface water as their source contained higher concentrations of these compounds than those having ground water as their source. The maximum concentrations found were: chloroform--150 microgram/l, bromodichloromethane--20 microgram/l, and dibromochloromethane--2 microgram/l. Application of the method to a sewage treatment plant influent and effluent showed the presence of several other chlorinated aliphatic and aromatic compounds.

3. **Raw drinking water supplies are found to have low background levels of mutagenic activity with relatively large increases in mutagenicity after chlorination.**

**Mutagenicity of organic extracts from Canadian drinking water in the Salmonella/mammalian-microsome assay. Nestmann ER, LeBel GL, Williams DT, Kowbel DJ**. Environ Mutagen. 1979;1(4):337-45.
Organic extracts of chlorinated Ontario drinking water samples have been found to induce mutation and lethality in the Salmonella/mammalian-microsome histadine reversion assay. Collections of water were made at water treatment plants in five municipalities in June 1978. To determine the reproducibility of the positive mutagenic effects found, a second sampling at the same plants was performed in September 1978. Preparation of extracts involved passing 200 liter samples through XAD-2 resin columns which were eluted with a mixture of hexane

and acetone, and the eluent was evaporated to dryness. For those extracts with sufficient organic matter, dose-related increases in mutagenicity were observed. Extracts of untreated water from a river and a well were weakly mutagenic.

## 4. Other Papers on effects of chlorination

Water Chlorination: Essential Process or Cancer Hazard?
BULL et al. *Toxicol. Sci..*1995; 28: 155-166

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**ABSTRACT:** Chlorine has been successfully used for the control of waterborne infectious disease for nearly a century. In the 1970s it was found that chlorine reacted with natural organic matter present in surface waters to produce disinfection by-products (DBP). Concern focused initially on the trihalomethanes (THM), but a wide variety of DBPs are now known to result from chlorination. Chlorination of drinking water has been one of the most effective public health measures ever undertaken. There are a number of alternatives to chlorination that are in active use in many parts of the world, but the risks associated with their by-products are even less well established than for chlorination. Moreover, the use of these alternatives vary in their effectiveness and some require greater sophistication in their application. This can mean less protection to public health as a result of inappropriate application and control. Therefore, hazards associated with the use of such a clearly beneficial process as chlorination must be carefully considered not only in an absolute sense, but also in the context of alternative approaches for producing a safe drinking water. The key question is whether the hazards associated with by-products have been sufficiently well established to warrant regulations that will undoubtedly have both positive and negative impacts on the public health. This symposium examined the toxicological and epidemiological data on chemical hazards associated with chlorination and attempted to measure this hazard against competing microbial risks. The first presentation discussed the available analytical epidemiological studies. A second presentation dealt with the importance of chlorination to the prevention of waterborne infectious disease. Pharmacokinetic, mechanistic, and modeling information on the prototypical DBP, chloroform, were discussed and contrasted with data on brominated THMs to determine if it was scientifically appropriate to regulate THMs as a single toxicological class. The fifth presentation dealt with the carcinogenic properties of a potent mutagen that is produced by chlorination. The final presentation discussed the haloacetates, carcinogenic DBPs whose concentrations approach and occasionally exceed those of the THMs. Clearly, there is a need to carefully weigh these different types and sometimes competing risks when considering the delivery of drinking water to ever-increasing populations for which there are finite sources of fresh water.

## *5. King WD, Marrett LD. Case-control of bladder cancers and chlorinating by products in treated water (Ontario, Canada). Cancer Causes and Controls 1996;7:596-604.*

## *6. Koivusalo M, Vartianen T, Hakulinen T, Pukkala E, Jaakkola J. Drinking water mutagenicity and leukemia,*

*lymphomas, and cancers of the liver, pancreas, and soft tissue. Archives of Environmental Health 1995;50:269-276.*

7. *McGeehan MA, Reif JS, Becher JC, Mangione EJ. Case-control study of bladder cancer and water disinfection methods in Colorado. American Journal of Epidemiology 1993;138:492-500.*

8. *Meier JR. Genotoxic activity of organic chemicals in drinking water. Mutat Res 1988;196:211-45.*