

# CHLORINE AND CANCER

## Origin of the misconception

Chlorine (Cl) is a dangerous chemical. Inhalation of chlorine gas or drinking highly concentrated sources of chlorine (such as household bleach) can lead to vomiting, coma, and even death.<sup>1</sup> For this reason, many people fear that the chlorine in swimming pools and drinking water can be harmful for health, and cause cancer. This has been spread further by water filter manufacturers and makers of 'chlorine-free' pools, who may assert that chlorine can cause cancer.

## Current evidence

Since 1849, when Dr John Snow first suggested that disease could be transmitted through drinking water, many methods have been used to ensure clean and safe drinking water. Chlorination was first proposed in 1910 as a method for purifying water for troops in the field.

A consistent, safe supply of drinking water in the developed world is a major public health sanitation success. Millions of people still die from contaminated water in developing countries. Without clean water, most people would not live long enough to get cancer.

Chlorine dissolves in water to form hypochlorous acid (HOCl) that partially breaks down again to form the hypochlorite ion (OCl<sup>-</sup>). Hypochlorous acid and the hypochlorite ion are toxic to potentially harmful microorganisms and disinfect drinking water.<sup>2</sup>

## Chlorinated Drinking Water

The Australian Drinking Water Guidelines allow for up to 5 mg of chlorine per litre (mg/L) of drinking water. This is the same as the limit recommended by the World Health Organization (WHO). Concentrations found in Australian drinking water range from 0.1 mg/L to 4.0 mg/L, with a typical concentration of between 0.2 mg/L and 0.5 mg/L.<sup>2</sup> For comparison, the Western Australian Department of Health recommends maintaining chlorine in swimming pools over 2.0 to 3.0 mg/L depending on temperature.<sup>3</sup>

The Australian Drinking Water Guidelines report no adverse effects from the ingestion of chlorinated water. Long-term animal toxicity studies show that chlorine or its breakdown products do not act as carcinogens (cancer causing agents) or tumour initiators. According to the Australian Drinking Water Guidelines, there is very little risk from chlorine associated with drinking a lot of water. In one report, 150 people drank water with chlorine concentrations of 50 mg/L, during water mains disinfection, with no reported adverse health effects. Another study of military personnel, who often drink water with chlorine concentrations greater than 32 mg/L for extended periods, showed no adverse effects.<sup>2</sup>

The International Agency for the Research of Cancer (IARC) has evaluated the safety of chlorine in drinking water and concluded that there is insufficient evidence for its carcinogenicity (ability to cause cancer) in animals and humans. It has classified chlorine as neither a carcinogen nor a possible carcinogen.<sup>4</sup>

## Chlorinated Swimming Pools

Swimming pools are chlorinated using hypochlorite salts (sodium hypochlorite or calcium hypochlorite). The safety of hypochlorite salts has also been evaluated by IARC, which has concluded that there is inadequate evidence for the carcinogenicity of hypochlorite in animals. A similar conclusion could not be reached for humans because of the absence of human studies.<sup>4</sup>

## Chlorination Disinfection By-Products

Trihalomethanes (chloroform) and haloacetic acids are formed when chlorine reacts with organic matter in the water. These are called water disinfection by-products (DBPs).<sup>5</sup>

A number of studies have suggested a weak association between DBPs and cancers of the bladder and rectum.<sup>6,7</sup>

The IARC has concluded that chloroform is possibly carcinogenic to humans. This classification is based on research on animals that may or may not be relevant to human cancers.<sup>8</sup>

The Australian Drinking Guidelines state that, 'action to reduce the concentration of disinfection by-products is encouraged, but disinfection itself must not be compromised: the risk posed by disinfection by-products is considerably smaller than the risk posed by the presence of pathogenic microorganisms in water that has not been disinfected.'<sup>2</sup>

## Summary

There is no evidence for the myth that chlorine in drinking water or swimming pools can cause cancer. However, chlorine and chlorine gas can aggravate respiratory conditions and high concentrations of chlorine can lead to many health complications. There is limited evidence that DBPs in drinking water may be associated with a very small increased risk of cancer. The Australian Drinking Guidelines include guideline values for a number of DBPs to minimise their formation, but not so as to compromise disinfection because the presence of pathogens in water poses a much greater and more immediate risk to public health than exposure to DBPs.

## Further reading

- Australian Drinking Water Guidelines  
National Health and Medical Research Council  
[nhmrc.gov.au/guidelines/publications/eh52](http://nhmrc.gov.au/guidelines/publications/eh52)

## References

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4. International Agency for Research on Cancer. Working Group on the Evaluation of Carcinogenic Risks to Humans, [Chlorinated Drinking-water; Chlorination By-products; Some Other Halogenated Compounds; Cobalt and Cobalt Compounds](#). IARC monographs on the evaluation of carcinogenic risks to humans; Vol. 52. 1991, Lyon: International Agency for Research on Cancer.
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6. Michaud DS, Kogevinas M, Cantor KP et al. (2007) Total fluid and water consumption and the joint effect of exposure to disinfection by-products on risk of bladder cancer. *Environmental Health Perspectives*, 115(11): 1569-1572.
7. Villanueva CM, Cantor CP, Grimalt JO et al. (2007) Bladder cancer and exposure to water disinfection by-products through ingestion, bathing, showering, and swimming in pools. *American Journal of Epidemiology*, 165(2): 148-156.
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