The Wilmington Childhood Cancer Study

An Epidemiologic Investigation of
Childhood Cancer from 1990-2000

QUESTIONS AND ANSWERS

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BUREAU OF
ENVIRONMENTAL
HEALTH

1. *Why was this study conducted*?

In 1999, in response to community concerns raised by residents and the local board of health, the Massachusetts Department of Public Health (DPH) reviewed childhood cancer incidence data for Wilmington, MA from 1987-1995 and identified an unusual pattern of elevated cancer rates within certain areas of town. Since there were no known risk factors, environmental or otherwise, thought to sufficiently explain the unusual cancer rates, DPH initiated an environmental epidemiologic study to investigate.

2. *What was the objective of the study?*

The study began as exploratory in nature, with the objective of identifying potential risk factors that could help explain the high rates of childhood cancer observed in Wilmington in the 1990s. In 2003, sampling efforts by Olin Corporation, directed by the Massachusetts Department of Environmental Protection (MassDEP), found a carcinogenic chemical (n-Nitrosodimethylamine or NDMA) in the town's water supply. The study shifted focus to concentrate on the potential for historical exposure to NDMA and whether such exposure may be related to childhood cancer incidence. A second chemical, trichloroethylene or TCE, had previously been found in the water distribution system, so the study also focused on the potential role of TCE.

3. *Who conducted the study?*

The water modeling and exposure assessment components of the study were conducted by engineering consultants. The study design, questionnaire development, participant recruitment, and interviews were conducted by DPH. The data analysis, epidemiologic interpretation of results, and report preparation were also completed by DPH staff.

4. *How was the community involved in the study?*

Wilmington residents, community groups, and the Wilmington Board of Health (BOH) provided the original impetus for this study. A community advisory committee made up of residents, local officials, and political representatives met regularly with DPH to provide input on the study's development to ensure that it was maximally designed to answer the community's concerns. The advisory committee provided feedback on the study's scope, data collection process, and focus.

5. *Was the study peer reviewed?*

An independent peer review committee provided two rounds of scientific review for the Wilmington Childhood Cancer Study. The peer review committee was

comprised of three scientists, one with expertise in childhood cancer, one with expertise in NDMA, and a third with expertise in water modeling.

6. *What were the recommendations of the peer review panel?*

During round one of the peer review process, the committee suggested additional groundwater modeling work to evaluate possible uncertainty in the exposure assessment of NDMA. The committee also recommended more work to evaluate the levels and distribution of TCE in the town's drinking water. DPH conducted new groundwater modeling to estimate historical exposure to TCE and to test the sensitivity of the study's results to uncertainty within key model parameters.

Round two of the peer review was conducted at the end of 2019. Each reviewer independently concluded that the study's methodology was sound and that the conclusions reached were supported by the results. They recommended public release of the report.

7. *What did the study conclude about the risk of childhood cancer in Wilmington and its relationship to the consumption of water contaminated with NDMA and/or TCE?*

The study found that children whose mothers were likely exposed to NDMA in their residential drinking water during pregnancy were more likely to develop cancer, particularly leukemia or lymphoma, than those whose mothers were thought to have had no exposure to NDMA. The odds of childhood cancer were incrementally higher across three exposure categories (zero, low, high) of estimated NDMA concentrations in maternal residential drinking water during the year before the child's birth. These findings were statistically significant for the relationship between diagnosis of leukemia or lymphoma and estimated maternal exposure to the highest NDMA concentrations compared to no estimated exposure.

The study found similar results for potential exposure to TCE, but only a portion of the study participants were able to be evaluated for TCE exposure due to limitations in the historical record. Therefore, associations observed between estimated TCE exposure and childhood cancer are less robust and not statistically significant. Furthermore, no mother was found to be exposed to TCE alone whereas many were estimated to have been exposed to both TCE and NDMA. So it is impossible to evaluate the effect of TCE alone using the available data.

The study found no positive association between childhood exposure to NDMA or TCE and later development of childhood cancer.

8. ***My child lives/lived in Wilmington and was diagnosed with cancer. Was his or her cancer due to exposure to contaminants in our drinking water?***

We understand a parent's desire to know what caused your child's illness. The study's findings suggest that maternal exposure to contaminants in drinking water (NDMA and/or TCE) increased the likelihood of some children developing cancer. However, many factors can influence the development of cancer and some children living in Wilmington during the years of the study were likely to develop cancer for other reasons. Therefore, it is not possible to attribute any particular child's illness to NDMA or TCE exposure. Note that 50% of children with cancer in the study were estimated to have experienced no exposure to NDMA or TCE and 34% of control children were exposed to one or both contaminants. The study's findings are most appropriately understood as a possible increase in risk on a population level rather than a determination of causation at an individual level.

9. ***Is Wilmington's public drinking water still contaminated with NDMA or TCE? Does the water supply currently pose a risk to Wilmington residents today?***

Wilmington's public drinking water is no longer contaminated with NDMA or TCE and currently poses no known risk to health. The Wilmington Water and Sewer Department provides drinking water to 99% of all the residents and businesses in Wilmington. The source of the water is groundwater, pumped from four wells located throughout Wilmington. Since the discovery of NDMA in the five Maple Meadow Brook aquifer wells, the town has not used these wells.

10. ***Has the Olin Chemical site been cleaned up?***

Olin Chemical is an active Superfund Site managed by the US Environmental Protection Agency (EPA). For information about the current status of the Olin Chemical site, please visit the site's Superfund home page on the EPA's website.

12. ***What should I do if I have a private well?***

Some private wells near the Olin Chemical site were found to contain NDMA. For private wells within the area of potential NDMA contamination—wells drawing water from the Maple Meadow Brook aquifer—the EPA is working with private well owners to ensure that NDMA contamination is identified and that owners are provided with appropriate guidance regarding water usage based on their well sampling results. For other residents with private wells, DPH recommends that they have their well water tested for contaminants at varying frequencies using guidance from their local Board of Health and from MassDEP. This guidance is given to all private well owners in Massachusetts.

13. ***Who can I contact for more information about private well testing related to the Olin Chemical Site?***

You may contact Melanie Morash, the EPA project manager for the Olin Chemical Superfund Site at (617) 918-1292 or morash.melanie@epa.gov.

14. ***Does the DPH have plans to further evaluate childhood cancer incidence in Wilmington?***

DPH's Environmental Epidemiology Program has reviewed childhood cancer incidence data from 2001 to 2015, the most current data available. Childhood cancer incidence has remained at expected rates since 2001. DPH is committed to continued monitoring of all cancer diagnoses in Wilmington. DPH will conduct annual qualitative reviews of available data through 2020 and will review standardized incidence ratios (SIRs) when complete data are available for the five year period 2016-2020.

15. ***What is NDMA?***

N-nitrosodimethylamine, or NDMA, is a yellow liquid which has no distinct odor. It is no longer used industrially or commercially in the US or Canada. NDMA is, however, unintentionally formed during various manufacturing processes at many industrial sites and in air, water, and soil from reactions involving other chemicals. NDMA precursor compounds are both natural and man-made and are found widely throughout the environment.

16. ***How might I be exposed to NDMA and what should I do to limit possible exposure?***

The principal source of exposure to NDMA in the general population, both past and present, is from the ingestion of food. NDMA has been found in beer, cured meat, fish products, and some cheeses. Although levels of NDMA in these products have decreased in recent years as a result of changes in food processing, ingestion of food containing NDMA precursors (e.g., nitrites and nitrates) can lead to the formation of NDMA in the body. Ingestion of food containing NDMA or NDMA-precursors appears to be responsible for most human exposure to NDMA. Limiting your intake of these products can help limit possible exposure to NDMA.

NDMA can be formed in water treatment plants that use chloramines for disinfection or in groundwater contaminated by industrial effluents. When compared to food, most drinking water sources contribute only a small proportion of NDMA because concentrations are generally low. In unique circumstances, drinking water exposure can be more substantial if there is a specific contamination source with higher concentrations of NDMA.

17. ***How is NDMA regulated in drinking water?***

NDMA is listed as a priority pollutant by the EPA, but no federal drinking water standard has been established. EPA risk assessments indicate that the drinking water concentration representing an increased risk of cancer of one in a million is 0.7 nanograms per liter (ng/L) or parts per trillion (ppt) of NDMA. Massachusetts has established a guideline of 10 ng/L in drinking water, which is the concentration of NDMA that most analytical laboratories are capable of detecting in drinking water.

18. Can NDMA cause cancer?

NDMA has been classified by the International Agency for Research on Cancer (IARC) as "probably carcinogenic to humans." In the US, the EPA classifies NDMA as a "probable human carcinogen (category B2)" under its 1986 carcinogen assessment guidelines. The European Union categorizes NDMA as a category 1B carcinogen (i.e., presumed to have carcinogenic potential for humans; largely based on animal evidence). Although epidemiological studies are limited, some study results suggest an association between exposure to NDMA and several forms of cancer, most consistently with gastric and lung cancer. Exposure to NDMA in these studies has been from the ingestion of foods containing NDMA. There have been no human epidemiological studies of NDMA in drinking water or associations reported between NDMA exposure and leukemia or lymphoma.

19. ***What is my risk of cancer if I drank water containing NDMA and/or TCE?***

The risk associated with environmental exposures depends on how much, how long, and through what route (inhalation, ingestion, or dermal contact) a person is exposed as well as the person's individual susceptibility to the exposure. Therefore, the precise increase in cancer risk associated with exposure to NDMA and/or TCE in drinking water for an individual is impossible to estimate. It would require detailed exposure data along with information about the individual's hereditary conditions, lifestyle factors, medical conditions and treatments, infections, and other environmental exposures. Different types of cancer have different causes, risk factors, and characteristics. Some individuals who have risk factors may not get cancer, and some individuals who get cancer may not have any known risk factors.

20. ***What is TCE?***

TCE is a synthetic, volatile organic chemical. It is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives, paint removers, varnishes, office correction fluid, and spot removers. It is also used in

the manufacture of other chemicals. TCE can be found in consumer products such as metal degreasing solvents for use on cars, bikes, or as an ingredient in hobbyist products. Due to widespread use of TCE and its volatility, TCE has been detected in air and water, and it is a common environmental contaminant at hazardous waste sites.

21. ***How and when was TCE introduced into the Wilmington public water supply?***

The Wilmington Water and Sewer Division began testing for chlorinated volatile organic compounds, including TCE, in 1979 following the discovery of contamination of municipal wells in nearby Woburn, MA. At that time, TCE was discovered in one of the town's water supply wells and the well (Chestnut St #1) was taken offline until June 1981 when the Butters Row Water Treatment Plant began operation. Although water was then being treated, testing results show that some TCE was still entering the water distribution system. Concentrations were highest from 1983 through 1987, reaching a maximum monthly average of 26 µg/L in August 1985. In 1987, the concentrations fell rapidly and were consistently below the detection limit starting in 1991. The source(s) of TCE contamination is not known. One theory is that septic system cleaners used by homeowners in the area were the main source of the solvents to the aquifer.

22. ***How is TCE regulated in drinking water?***

The Massachusetts drinking water standard or maximum contaminant level for TCE in public drinking water is 5 micrograms per liter (µg/L) or 5 parts per billion (ppb). This standard was adopted by EPA in 1987 and has, thereafter, been applicable in Massachusetts.

23. ***Can TCE cause cancer?***

The US Department of Health and Human Services, US EPA, and the IARC have all determined that TCE is a human carcinogen. Epidemiological data provide convincing evidence for a causal association between TCE exposure and kidney cancer in humans based on occupational cohort and case-control studies. There is also some evidence for increased risks for non-Hodgkin lymphoma and liver cancer. However, the human data for these two cancer types are less convincing because reliable information is limited to a few occupational cohort studies. Short-term (e.g., several months or several years) exposure to low levels poses lower risks of developing cancer than a lifetime of daily exposure.

A population that ingested well water contaminated with TCE in Woburn, Massachusetts was reported to have an increase in childhood leukemia (Costas et al. 2002). This was supported by a second study of New Jersey communities, where a significant elevation of total leukemia, childhood leukemia, acute

lymphocytic leukemia (ALL), and non-Hodgkin lymphoma in females was found after exposures to >5.0 ppb of TCE (Fagliano et al. 2003). However, the associations drawn from these studies between the incidence of leukemia and other cancers and oral exposure to TCE are suggestive and not definitive because exposure was known to be of a mixture of contaminants (ATSDR 2019).

24. ***Who can I contact if I have additional questions or concerns about NDMA or TCE exposure and my health?***

If you have any questions about this study, you may contact the DPH Bureau of Environmental Health using the information below. For personal health questions, you should speak to your physician.

Bureau of Environmental Health
Massachusetts Department of Public Health
250 Washington Street
Boston, MA 02108
(617) 624-5757

REFERENCES

ATSDR. 2019. Toxicological Profile for Trichloroethylene. Atlanta, GA: US Agency for Toxic Substances and Disease Registry.

Costas K, Knorr RS, Condon SK. 2002. A case-control study of childhood leukemia in Woburn, Massachusetts: the relationship between leukemia incidence and exposure to public drinking water. Sci Total Environ 300:23–35.

Fagliano JA, Berry M, Kohler BA, Klotz JB, Imtiaz R. 2003. Case-control study of childhood cancers in Dover Township, Ocean County, New Jersey. Vol I-Vol V. Trenton, New Jersey. New Jersey Department of Health and Senior Services in cooperation with the Agency for Toxic Substances and Disease Registry.