Environmental health

Study on Waterborne Arsenic and Cancer in Auvergne

Summary report

Background

Origin of arsenic and sources of exposure

Arsenic is a natural component of the Earth's crust. It can be found in the air, water resources, soils, sediments and in living organisms. In surface and ground waters naturally occurring arsenic concentrations are usually low, between 1 and 10 µg.L-1, but they can reach much higher levels (between 100 and 5,000 µg.L-1) in certain areas such as Taiwan, India, Bangladesh, Chile, Northern Mexico, Argentina, etc.

The presence of arsenic in the environment can also be linked to industrial discharges or the use of agricultural products (pesticides, herbicides, fungicides, insecticides, rat poison) and to wood preservation (preparation "CCA" for Chrome, Copper, Arsenic).

The main route of human exposure to arsenic is through the ingestion of food or drinking water. In children, the main vectors of direct contamination include the ingestion of soil or through contact with CCA-treated wood. Finally, breathing in particles containing arsenic is also a route of human exposure.

The initial assessment of arsenic-contaminated drinking water carried out in Metropolitan France in 1997 identified facilities that produced water with levels of arsenic higher than 10 µg.L-1 in several districts. Auvergne is a region that is particularly affected due to its geological features. In 2001, more than 140,000 people were being served by water distribution systems in which levels of arsenic were higher than 10 µg.L-1.

Effects on health

Inorganic arsenic has been classified as a human carcinogen (group 1) by the International Agency for Research on Cancer. The classification is based on the induction of skin cancer, lung cancer and bladder cancer. Epidemiological data on the dangers of arsenic are largely documented and concur for high levels of exposure (higher than 100 µg.L-1), but still remain fragmentary with regard to low levels of chronic exposure (lower than 50 µg.L-1). Furthermore, extrapolation of risk to high level of exposure to risk to low level of exposure with a linear-type dose-response curve is probably not fitted for arsenic.

Besides its carcinogenic effects, arsenic's long-term effects identified for high level of exposure include skin lesions (hyperpigmentation and hyperkeratosis) and a peripheral vascular disease (Blackfoot disease). Arsenic also promotes the development of diabetes.

Arsenic's acute effects on health consist mainly of gastrointestinal symptoms, cardiovascular disorders, neurological and hematopoietic disorders, haemolysis and melanosis.

Regulatory context

In France, since 2003, the quality limit of arsenic for drinking water has been decreased from 50 to 10 µg.L-1 (Sections 1321-1 and following of the Public Health Code pertaining to water for human consumption).

Study

Objective

The purpose of this study was to look for a link between chronic exposure to low-level doses of waterborne arsenic (lower than 50 µg.L-1) and the occurrence of cancers in the region of Auvergne over a period of time spanning 1998 to 2005.

Method

An ecological study has been carried out in the population aged 15 and above and residing in one of the three districts of the Auvergne region (Allier, Puy-de-Dôme, Cantal). Indicators for exposure and health were collected at district level, which serves as the spatial analysis unit.

A case was defined as any person aged 15 or above presenting a primary microinvasive or invasive tumor, located in the lungs, urinary tract, kidneys or on the skin (melanoma), that was diagnosed between 1 January 1998 and 31 December 2005, and confirmed through histo-cytology or by benefiting from an exemption of the patient's contribution towards the cost of medical treatment, and who was living in one of the three aforementioned districts (Allier, Puy-de-Dôme or Cantal) at the time of diagnosis. Incident cases were collected based on data from anatomo-cytopathology laboratories and from healh insurance funds (general scheme, agricultural insurance scheme, social scheme for self-employed workers).

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Previous exposure to waterborne arsenic was evaluated at district level based on data collected by the Ministry of Health and on changes made to the water distribution systems.

Some potentially confounding factors were taken into account: social and demographic data, health territories, industrial sites and winemaking. A link between the occurrence of cancer and exposure to waterborne arsenic was looked for though spatial analysis using a Poisson regression model.

Key findings

All anatomo-cytopathology laboratories took part in identifying the cases. The three health insurance schemes that were involved in identifying cases (general scheme, agricultural insurance scheme and social scheme for self-employed workers) cover nearly 80% of the population. The database used for analysis purposes contained 8,932 cases of cancer including 3,931 cases of lung cancer, 2,489 cases of urinary tract cancer, 1,376 cases of kidney cancer and 1,134 cases of skin cancer (melanoma).

Arsenic concentrations for those districts that were exposed averaged 15.7 µg.L-1 with a maximum value of 140.0 µg.L-1.

Findings highlight a significant link between the occurrence of lung cancer among men at district level and the presence of arsenic in drinking water (RR = 1.20 [1.05 – 1.37]). No link has been observed among women for the types of cancer studied, or among men for skin melanoma and cancer of the higher or lower urinary tract.

Discussion/Conclusion

This study is part of the very few research efforts looking for and showing a link between exposure to low levels of arsenic concentrations and the occurrence of lung cancer.

Nevertheless, interpretation of results must take into account the lack of recognition of some risk factors like smoking and the ecological approach used. It is not possible to transpose this result to the individual level or to quantify the portion attributable to arsenic in the development of lung cancer. However, these results are consistent with the international literature.

Furthermore, the ecological approach used in this study has the advantage of integrating a large number of subjects, but also increases the risk of biases that tend to decrease the study's statistical power. The resulting loss of overall power may partly explain the lack of significant findings for bladder cancer, which were highlighted elsewhere.

Scope of study and recommendations

Several recommendations focus on management and prevention measures. The authors call for vigilance about the risk factors for lung cancer such as arsenic, but also such as radon a strong presence in the region and known to be risk factor for lung cancer. For epidemiological surveillance it seems necessary to develop tools for observation of cancer at the regional level. Finally, the authors advocate for the future use of individual studies.

For further information...

Full report: : Mouly D, Jusot JF, Bérat B, Goria S, Stempfelet M, Beaudeau P. Étude de la relation entre l'exposition chronique à l'arsenic hydrique d'origine naturelle et la survenue de cancers en Auvergne. Rapport d'étude. Saint-Maurice: Institut de veille sanitaire; 2011. 75 p. Available at the following URL: http://www.invs.sante.fr [in French]

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