Drinking Water Contamination and Cancer in Canada and USA

Policy Brief

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Executive Summary

The contamination of drinking water causes local and global public health problems, such as cancer. Although policymakers pay particular attention to the health impacts of drinking water contamination, they face challenges in reducing associated health risks for better management of drinking water. This policy brief uses ACSRC Report Series # 50-18 “Drinking Water Contamination & Cancer in Canada and USA: A Review” that reviews and analyzes 64 published studies. The purpose of this policy brief is to provide a summary and recommendations on assessing the health impacts of drinking water contamination. It outlines the main results from the report and provides recommendations for the policymakers regarding 1) appropriate quality criteria to use; 2) common study designs and methods to apply; 3) confounding factors to control.

Introduction

Environmental pollution has caused an increased burden of death and disease by imposing global public health risks. The burden of disease could be attributed to risks from poor water quality, vector-borne disease, poor ambient and indoor air quality, and global environmental change (WHO, 2005). According to Global Health Observatory data from WHO, 1.9% of the global burden of disease was caused by unsafe water, sanitation and hygiene in 2016 (WHO, 2016).

In western Canada, the contamination of drinking water draws particular attention due to its impact on public health problems, such as enteric disease, acute gastrointestinal illness, and cancer (Meliker & Nriagu, 2007; Christoforidou et al., 2013; OECD/WHO, 2003). In Canada, cancer is the leading cause of death. Although cancer management and research have advanced during the past years, rural cancer patients still receive less care than urban patients due to limited access to treatment, lower financial security and lower quality of life (Ahmed, S., R.K. Shahid, 2006). As a result, reducing risks of cancer is even more crucial for the rural areas in Canada.

One approach to reduce the risks of cancer is to improve drinking water quality. Poor drinking water quality is caused by several types of contaminants such as microorganisms (e.g. E. coli), organic chemicals (e.g. atrazine), and inorganic chemicals (e.g. lead, arsenic) (EPA, 2015). Drinking water contamination imposes risks to public health in two ways. Microbial contamination of drinking water can cause outbreaks of infectious water-related diseases and lead to serious epidemics. Chemical contamination of drinking water tends to cause chronic health risks. Arsenic, one of the chemical contaminants, may contaminate drinking water when it is present at high levels in the groundwater. The use of arsenic-contaminated groundwater for drinking and food preparation poses a threat to public health because long-term exposure to arsenic can increase risks of cancer and skin lesions (WHO, 2018).

In Canada, chemical contamination of drinking water is more relevant as there is lower likelihood of epidemics caused by microbial contamination. However, policymakers are having difficulties reducing the impact of chemical contamination of drinking water on public health (e.g. risks of cancer) for two reasons. First, drinking water contamination could be measured by various indicators based on the sources of contamination. Second, the relationship between drinking water contamination and public health problems is hard to assess because various public health risks

(especially cancer) are associated with environmental issues other than drinking water contamination (e.g. air pollution). In order for policymakers to better manage the quality of drinking water, it is important to identify the major public health problems caused by key drinking water contaminants and to assess the relationship between drinking water contamination and public health problems.

The objective of this document is to provide a summary and recommendations from the ACSRC Report Series # 50-18 "Drinking Water Contamination & Cancer in Canada and USA: A Review" on assessing health impacts of drinking water contamination. The main results are:

1) Arsenic contamination is by far the most commonly used drinking water contamination indicator associated with the risks of cancer;
2) Bladder cancer is the most common type of cancer associated with drinking water contamination;
3) Population-based, case-control studies along with statistical regression are the most common methods used for assessing the association between arsenic and bladder cancer;
4) Mixed evidence is found regarding the association between bladder cancer and exposure to the low-to-medium arsenic in drinking water across studies;
5) Water intake, smoking, and occupation are confounding factors that affect arsenic levels and the risk of bladder cancer;
6) Gender, education, age, race, and income are the main demographic factors necessary to be considered in order to assess the relationship between arsenic in drinking water and bladder cancer.

Approaches, Results and Limitations

Approaches

The main approaches used to obtain the results are keywords search and analysis on peer-reviewed articles published from 1980 to 2017 in the United States and Canada. Out of 279 articles, 64 most relevant and most recent articles (from 2000 to 2017) were selected with certain criteria to obtain the results.

Results

This section presents details associated with the main results as summarized in the above section.

Result 1: Drinking water contamination indicators and associated common types of cancer

Based on the 64 peer-reviewed articles, arsenic contamination (around 40% of the articles used) is the most common drinking water contamination indicator. Among these studies, arsenic concentration in drinking water injection is the most common exposure metric. Secondary data sources and direct measurements are generally used to measure the arsenic level. Inductively coupled plasma mass spectrometry is largely used for the detection of arsenic.

Bladder cancer (around 26%) is the most common type of cancer associated with arsenic contamination.

Result 2: Association between arsenic and bladder cancer studies

Within the selected studies, the arsenic studies are highly correlated with the bladder cancer studies, indicating that the impact of arsenic in drinking water on bladder cancer is considered in the majority of the selected studies.

The association is mostly assessed by population-based, case-control studies along with statistical regression.

Result 3: Association between bladder cancer and arsenic in drinking water and confounding factors

The association between bladder cancer and exposure to the low-to-medium levels (<100 μg/L) of arsenic in drinking water is inconsistent within the selected 7 studies. Differences in the sample size and method of data analysis might contribute to the inconsistency of the findings. Studies considering relatively large samples (e.g. 10498 and 31000 samples) of arsenic in drinking water found statistically significant associations while studies considering relatively small arsenic samples found insignificant associations. The studies that use spatially structured Poisson regression analysis and/or incorporate confounding factors find significant associations while those that use simple regression analysis without controlling for confounding factors do not find significant associations.

Confounding factors that might contribute to the risk of bladder cancer include increasing arsenic water intake, old, shallow and private wells, smoking and diet, as well as a longer exposure duration to arsenic.

Result 4: Major demographic factors associated with bladder cancer

The demographic factors associated with the risk of bladder cancer include gender (higher risk in men), education (higher risk with lower education), occupation (higher risk in high risk occupation), age (higher risk in population older than 65 years), race (lower risk in Hispanic), groundwater dependence (lower risk if more dependent on public groundwater), income (higher risk with higher income), residential mobility (higher risk with low mobility) and family history.

Limitations

There are a few limitations that should be considered when applying the results from this policy brief.

As the results are drawn from a limited number of selected studies (64 for preliminary analysis, 7 for secondary analysis), one should be cautious when generalizing the results into a more complicated context.

The report aims to assess the health impacts of drinking water contamination, specifically the association between arsenic in drinking water and bladder cancer risk. However, one should note that:

- There are alternate sources of arsenic, other than drinking water, that could be associated with bladder cancer;
- There are potential factors other than arsenic could contribute to the risk of bladder cancer;
- There are health risks rather than bladder cancer that could be caused by arsenic.

Policy Recommendations

1) Overarching objective: reducing arsenic contamination in drinking water to reduce the risk of bladder cancer

2) Using arsenic contamination as the main indicator of drinking water contamination with the following components:
    - Exposure metric: arsenic concentration in drinking water injection
    - Measurement of the arsenic level: secondary data sources and direct measurements
    - Detection of arsenic: inductively coupled plasma mass spectrometry
3) Considering bladder cancer as the main type of cancer associated with drinking water contamination
4) Sample and methods: finding as many representative samples of measurements and study participants as possible, to examine the impacts of arsenic contamination in drinking water and bladder cancer risk; applying population-based, case-control studies along with statistical regression
5) Affecting the confounding factors associated with bladder cancer, such as reducing arsenic-contaminated water intake, replacing old and shallow wells, and promoting a healthy diet.
6) Considering programs that are tailored to the population with specific demographics to reduce bladder cancer risk.

Conclusion

Although it is challenging to reduce the health impacts of drinking water contamination, policymakers could make an impact by better understanding the association between bladder cancer and low-to-medium levels of arsenic in drinking water. This requires using appropriate indicators/criteria (e.g. arsenic contamination, bladder cancer), and then applying the most common methods through considering large sample size, population-based, case-control designs, confounding risk factors and demographics. These indicators and methods/factors are main aspects where policymakers could take actions to reduce the health impacts of drinking water contamination. This is of particular importance to rural areas due to the disparity in cancer care between rural and urban areas in Canada.

References

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