Considerations for improving the accuracy of exposure to disinfection by-products by ingestion in epidemiologic studies

Howard S. Weinberg, Vanessa R.P.J. Pereira, Philip C. Singer, David A. Savitz

Presentation by Myron Arnowitt
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Disinfection By-Products: Background

- Created in chlorinated drinking water systems through contact between chlorine and organic compounds in the source water.
- Wide variety of chemicals comprise chlorinated disinfection by-products (DBP) generally grouped into trihalomethanes (THM) and haloacetic acids (HAA).
Disinfection By-Products: Health Effects

• Epidemiological studies have identified two major health outcomes from DBP exposure: bladder cancer and reproductive effects including spontaneous abortion (miscarriage).

• Poor exposure assessment has been identified as a key problem with many studies of DBP.
Exposure Assessment Issues

- Variations in time
- Variations in space, related to residence time of chlorine in the finished water
- Variations in behavior, including handling of water prior to consumption (heating or cooling) and use of Point of Use (POU) devices
Results: Composite Samples

- Grab samples taken every four hours for five days (30 total) and were composited.
- For THMs and HAAs, levels in the composited samples were 94% - 105% of the mean of the grab samples.
- For Total Organic Halogens (TOX), however, composite sample results were 130% of mean of the grab samples.
Results: Time of Day

• Samples were compared from 1) Point of Entry into the distribution system, at 3pm on Day 1, 2) at the tap at 6pm on Day 2, and 3) at the tap at 6am on Day 3.

• THM levels increased 70% between sampling point 2 and 1, and there was an additional increase of 22% between point 3 and 2.
Results: Water Use

• THM levels were compared between tap water, boiled water, and refrigerated water.
• There was an over 98% reduction in THM levels in the boiled water.
• Refrigerated water had an 8% reduction in THM levels.
Results: Water Filters

• Tap water was compared to water filtered by four activated carbon point of use devices and one reverse osmosis system. The test was repeated after 50% of the filters capacity had been used.

• Activated carbon filters removed 68% to 99+% of THM and HAA. Performance declined to 51% to 90% after filter use.

• The reverse osmosis system removed 48% of THM and 100% of HAA.
Conclusions

- Compositing samples may provide a more accurate measure of exposure over days.
- Residence time in finished water of chlorine could impact exposure levels.
- Behaviors of individuals exposed could significantly impact exposure.
- Behaviors to consider include: time of day of water consumption, boiling of water, and use of point of use devices.
Limitations

• The study used very few samples, especially for time of day (3), water use (1), and point of use devices (1).

• The study did not consider inhalation exposures which could be significant and behavior driven.

• The study did not consider the impact of losing data on peak exposures through compositing samples.