Arsenic exposure through well water and household behavior in a rural Maine community: Implications for mitigation

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ABSTRACT:
In the US, private well water is unregulated by federal drinking water standards and is solely the responsibility of the owner to ensure quality. The Columbia University Superfund Research Program found that 31% of domestic wells in its 17-town project area in Maine exceed the US EPA Maximum Contaminant Level (MCL) for arsenic (As), resulting in an estimated 13,300 population at risk of drinking As-contaminated water. Analysis of new household survey data on water testing and treatment practices reveals an estimated 66% of those at risk likely remain exposed at present. The different categories of exposed will require unique strategies for mitigation, as suggested by new research on behavioral factors favoring As testing and treatment.

BACKGROUND:
- ~15% of the US population, >43 million people, relies on private wells for their drinking water.
- Elevated As concentrations (>10 µg/L) in well water have been linked to increased risks for cancer, cardiovascular disease, and neuropathy.
- No authority ensures private water is in compliance with federal regulations; it is solely the well owner’s responsibility to monitor and maintain quality.
- Significant proportions of households in at-risk areas such as Maine’s greater-Augusta area remain exposed to elevated As through their drinking water.
- 17 towns of Kennebec County comprise the project area of Columbia University’s Superfund Research Program (SRP), where well water was sampled 2006-11 and household testing and treatment surveys were conducted in Jan 2013.

STUDY AREA: Kennebec Co., Maine

Figure 1: Between 2006-2011, the SRP of Columbia and the Maine Geological Survey (MGS) found that 31% of 1,428 domestic well water samples tested in the 17 towns exceeded the EPA MCL for As (Yang et al. 2012).

KEY FINDINGS (Flanagan et al., 2014):
- Only 46% of area households report having As included on their most recent well test.
- Among households who tested >10 µg/L, 43% report having since installed treatment systems for As, 30% report taking other mitigation actions such as drinking bottled water, but 27% did not act on test results.
- Treatment failure is a risk: Table 1. 2013 test kit results from 68 households (HHS) treating for arsenic.

EXPOSURE ROUTE 1: UNTESTED POPULATION
- Better educated, higher income homeowners who more recently purchased their homes are most likely to have included As when last testing their wells.
- Households agree water and As-related health risks can be severe, but feel low personal vulnerability and perceive low testing norms overall.
- Significant predictors of including As when last testing include: having knowledge that years of exposure increases As-related health risks (risk knowledge), knowing who to contact to test well water (action knowledge), believing regularly testing does not take too much time (instrumental attitude), and having neighbors who regularly test their water (descriptive norm).

EXPOSURE ROUTE 2: TESTED BUT NOT TREATING
- Well water As level appears to be a motivation for mitigation: 31% of households with well water level between 10-50 µg/L did not act, compared to 11% of households with well water >50 µg/L.
- The belief that the untreated water is not safe to drink (risk) and that reducing drinking water As would increase home value (instrumental attitude) were identified as significant predictors of mitigating As.
- Mitigation choice was influenced by socio-economic factors and use of a treatment system specifically was significantly predicted by confidence that one can maintain a treatment system, even if there are additional costs (self-efficacy).

EXPOSURE ROUTE 3: USING FAILED TREATMENT
- 15% of treatment units in the assessment failed to produce water <10 µg/L, suggesting there are continued risks for exposure even after the decision is made to treat, whether due to inappropriate technology or the influence of groundwater chemistry and homeowner behavior.
- After homeowners have taken action to treat it is important they vigilantly monitor the quality of the treated water, but surveys revealed that mitigating As exposure is associated with less worry about the As level (affective attitude), which may lead to lax monitoring or maintenance.

EXPOSER Routes for Rural Households in 17 towns of Kennebec County, Maine