Safeguarding Children’s Health: Time to Enact a Health-Based Standard and Comprehensive Testing, Mitigation and Communication Protocol for Lead in Drinking Water

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RTI International is an independent, nonprofit research institute dedicated to improving the human condition.

We began as the flagship institution of Research Triangle Park in 1958 with collaboration from UNC, Duke, and NC State.
Outline

- Background
- Clean Water for Carolina Kids Study
- Recommendations & Next Steps

INVITED COMMENTARY

Safeguarding Children’s Health: Time to Enact a Health-Based Standard and Comprehensive Testing, Mitigation, and Communication Protocol for Lead in Drinking Water

Jennifer Hoponick Redmon, Jacqueline MacDonald Gibson, Anna M. Aceituno, Katherine P. Woodward, Keith E. Levine

Lead was a known toxin before the Roman Empire, yet exposure remains a public health concern today. Although there is no safe lead exposure level, a health-based drinking water standard has not been established. The Clean Water for Carolina Kids Study highlights the need for a health-based standard.

However, in some areas, water may account for a higher percentage of total exposure. Factors affecting risk of lead exposure in water include geographic location, housing characteristics, water source and treatment, and socioeconomic status. An increasing body of evidence indicates that people living in lower socioeconomic communities, including rural areas and peri-urban neighborhoods, have higher lead exposure and are more susceptible to its effects.

http://www.ncmedicaljournal.com/content/79/5/313.full
Background on Lead Usage, Toxicity, and Exposure
“Desirable” Properties for Millenia
- High density
- Resistance to oxidation
- Relative abundance

Major uses Include:
- Paint (Banned 1978)
- Gasoline (Banned 1990, in effect 1995)
- Plumbing and solder (Restrictions in effect since 1988)
Lead was a known toxin before the Roman Empire, yet exposure remains a public health concern today. Children particularly bear the lifelong burden of lead exposure.
Indoor Sources of Childhood Exposure to Lead

Outside sources include:
- Soil
- Industrial emissions
Drinking water considered secondary lead exposure source by EPA (~20% total)

Certain factors associated with water as major exposure source:
- Geographic location
- Housing characteristics
- Water source, treatment, piping
- Socioeconomic status
Legal Context
Although there is no safe lead exposure level, a federal health-based enforceable drinking water standard has not been established.
**Benchmark Levels for Lead in Drinking Water**

<table>
<thead>
<tr>
<th>Concentration (ppb)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0</strong></td>
<td>The EPA MCLG for lead in drinking water.</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>U.S. Food and Drug Administration prohibits bottled water with lead levels above this.</td>
</tr>
<tr>
<td><strong>10</strong></td>
<td>Water filtration devices certified to American National Standards Institute standards must reduce lead to this level.</td>
</tr>
<tr>
<td><strong>15</strong></td>
<td>The EPA treatment-based lead action level for public utilities.</td>
</tr>
</tbody>
</table>

Unlike most other inorganic chemicals with a non-enforceable Maximum Contaminant Level Goal (MCLG), **lead does not have an enforceable maximum contaminant level (MCL)**.

Instead, this value is often cited as the action level, but it is **not health-based** and only applies to public utilities.
• No longer recommend flushing the day before
• No longer use 20 ppb as level for action
Lead in the National Spotlight
The Poisoning Of An American City

Toxic water. Sick kids. And the incompetent leaders who betrayed Flint.

By Michael Hudson
Headlines Continue Across the US

Report: Philadelphia's Water Test for Lead Among Worst in U.S.

Texas needs to eliminate lead from water in schools

Why Portland’s Water Hasn’t Gotten The Lead Out

REPORT HIGHLIGHTS 12 NYC NEIGHBORHOODS WITH HIGH LEAD LEVELS IN WATER

BY ANGI GONZALEZ | NEW YORK CITY
PUBLISHED 11:54 PM ET SEP 26, 2018

Luke Metzger, Contributor
“Based on the info we receive from EPA, we’ve come to the conclusion that it's acceptable to have some level of lead in there as long as it’s below the action level,” [Michael] Borchers said.

Scott McCully, chief operations officer at Guilford County Schools, released the following statement: "All of the schools tested are within safe water levels…”

Red = my emphasis
The RTI Clean Water for Carolina Kids Study
Objectives:
1. Characterize lead in drinking water at NC childcare centers.
2. Pilot a citizen-science led assessment, mitigation, and communication protocol.

Inclusion Criteria:
• Childcare provider licensed by the State of North Carolina
• Connected to public water supply systems
• Provider scheduled survey and training time in 2017
Enrollment

- Traditional Enrollment Protocol
  - NC Childcare Listing
  - Selected Triangle and Triad Areas
  - Random Call/Email
- Social Media Callouts
  - RTI Press Release
  - FB, LinkedIn, NextDoor

Clean Water for Carolina Kids
Safe Drinking Water in North Carolina Child Care Centers

Your child care center has chosen to partner with RTI International to ensure this center continues to provide the highest possible quality drinking water. Many children spend much of their week in child care, so safe drinking water at child care centers is very important. As part of the Clean Water for Carolina Kids study, RTI will test your child care center’s drinking water for lead and offer guidance on any appropriate solutions so that your children have safe drinking water while in child care.
Citizen Science Approach: Clean Water for Carolina Kids

- Childcare providers conducted brief training with RTI.
- RTI provided sample bottles and packaging.
- Providers collected first draw study samples and sent shipment.
Sample Shipping: Clean Water for Carolina Kids

An example of some of the steps used in shipping instructions

Step 2
Step 3
Step 4
Step 5
Step 6
Step 7
Step 8
Step 9
Laboratory Analysis – Clean Water for Carolina Kids

Samples were analyzed at RTI Laboratories with a detection limit of 0.1 ppb lead.

- EPA Method 200.8
- Careful sample preparation
- Analysis by inductively coupled plasma mass spectrometry (ICP-MS)
- Quality Assurance and Quality Control
Clean Water for Carolina Kids
Information on Lead in Drinking Water

As part of the Clean Water for Carolina Kids study, RTI International has compiled the following information for parents and child care providers on lead in drinking water; this information comes from reliable scientific and government resources. Please contact us for more information about the Clean Water for Carolina Kids study.

Include:
https://www.rti.org/sites/default/files/brochures/rti_cwck_wt_bwg_0.pdf
## School Enrollment and Sampling by County and Number – Clean Water for Carolina Kids

<table>
<thead>
<tr>
<th>County</th>
<th>Total # of Licensed Centers/ Schools</th>
<th># Visited</th>
<th>% Visited</th>
<th># Sampled</th>
<th>% Sampled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durham</td>
<td>300</td>
<td>27</td>
<td>9%</td>
<td>23</td>
<td>8%</td>
</tr>
<tr>
<td>Guilford</td>
<td>424</td>
<td>36</td>
<td>8%</td>
<td>30</td>
<td>7%</td>
</tr>
<tr>
<td>Orange</td>
<td>93</td>
<td>14</td>
<td>15%</td>
<td>13</td>
<td>14%</td>
</tr>
<tr>
<td>Wake</td>
<td>502</td>
<td>26</td>
<td>5%</td>
<td>20</td>
<td>4%</td>
</tr>
<tr>
<td>All (Total)</td>
<td>1,319</td>
<td>103</td>
<td>--</td>
<td>86</td>
<td>--</td>
</tr>
<tr>
<td>Average (Per County)</td>
<td>--</td>
<td>26</td>
<td>9.25%</td>
<td>22</td>
<td>8.25%</td>
</tr>
</tbody>
</table>
## Lead Concentrations in Water, by Sample

- **Clean Water for Carolina Kids**

<table>
<thead>
<tr>
<th>Concentration (ppb)</th>
<th>&lt;0.10</th>
<th>0.10 - 3.00</th>
<th>3.00 - 15.00</th>
<th>&gt;15.00</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Sample Results</td>
<td>298</td>
<td>907</td>
<td>62</td>
<td>17</td>
<td>1,284</td>
</tr>
<tr>
<td>Percentage of Total Samples</td>
<td><strong>23.30%</strong></td>
<td><strong>70.60%</strong></td>
<td><strong>4.80%</strong></td>
<td><strong>1.30%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
### Maximum Lead Concentration By Building Age – Clean Water for Carolina Kids

<table>
<thead>
<tr>
<th>Lead Concentration (ppb)</th>
<th>1987 or older</th>
<th>1988-2014</th>
<th>2015 or newer</th>
<th>Total % for all buildings*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.10</td>
<td>1%</td>
<td>2%</td>
<td>0%</td>
<td>3%</td>
</tr>
<tr>
<td>0.10 - 3.00</td>
<td>26%</td>
<td>31%</td>
<td>1%</td>
<td>58%</td>
</tr>
<tr>
<td>3.00 - 15.00</td>
<td>13%</td>
<td>8%</td>
<td>1%</td>
<td>22%</td>
</tr>
<tr>
<td>&gt;15.00</td>
<td>7%</td>
<td>8%</td>
<td>1%</td>
<td>16%</td>
</tr>
<tr>
<td>% of sites tested</td>
<td>47%</td>
<td>50%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>No. of centers/schools</td>
<td>40</td>
<td>43</td>
<td>3</td>
<td>86</td>
</tr>
</tbody>
</table>

*Maximum concentration found in a childcare center or school. Buildings included only once (inclusion determined by highest value per building).
Key Findings – Clean Water for Carolina Kids

- While only 1.3% of total samples contained lead above 15 ppb, 16% of the tested childcare centers and schools contained at least one sample above 15 ppb.

- While 23% of samples did not contain detectable lead, only 3% of buildings did not contain detectable lead.

- Based on our findings, 97% of childcare centers are expected to have at least one outlet with detectable lead, and 16% at levels above the treatment-based action level.
Comparison to Well Water Testing at Childcare Centers

- Childcare centers with well water subject to Safe Drinking Water Act testing. Data from NC DHHS.
- A recent study by Dr MacDonald Gibson of UNC found 28% of tap water samples above 15 ppb at Wake Co. homes with unregulated private wells, comparable to the prevalence of elevated lead in Flint during the recent water crisis.

<table>
<thead>
<tr>
<th>Water Type</th>
<th>Conc. (ppb)</th>
<th>&lt;0.10</th>
<th>0.10 - 3.00</th>
<th>3.00 - 15.00</th>
<th>&gt;15.00</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Supply</td>
<td>No. buildings</td>
<td>53</td>
<td>19</td>
<td>14</td>
<td></td>
<td>86</td>
</tr>
<tr>
<td>Well</td>
<td>No. buildings</td>
<td>78</td>
<td>13</td>
<td>11</td>
<td></td>
<td>102</td>
</tr>
<tr>
<td>Public Supply</td>
<td>% buildings</td>
<td>62%</td>
<td>22%</td>
<td>16%</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>Well</td>
<td>% buildings</td>
<td>76%</td>
<td>13%</td>
<td>11%</td>
<td></td>
<td>100%</td>
</tr>
<tr>
<td>% Difference</td>
<td></td>
<td>-15%</td>
<td>9%</td>
<td>5%</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

The detection limit for well samples was 3 ppb, so public supply samples merged the <0.1 and 0.1-3 ppb values.

Buildings only included once (range determined by highest value per building).
No-Cost or Low-Cost Risk Mitigation Measures

- Designate consumption points
- Use cold water
- Clean your aerator
- Install and maintain a filter certified to remove lead
- Flush the pipes regularly
- Replace faucet fixtures if they are causing elevated lead

Reduce Your Exposure To Lead

- Use only cold water for drinking, cooking and making baby formula. *Boiling water does not remove lead from water.*
- Regularly clean your faucet’s screen (also known as an aerator).
- Consider using a water filter certified to remove lead and know when it’s time to replace the filter.
- Before drinking, flush your pipes by running your tap, taking a shower, doing laundry or a load of dishes.

To find out for certain if you have lead in drinking water, have your water tested.
If possible, replace fountains suspected or identified as containing detectable lead with new NSF-certified fountains with built-in filters, and perform routine maintenance.

Otherwise, use an alternative water source or flushing water fountain every morning prior to use or pipes throughout the school for 10 minutes depending on school size (EPA, 2018)
Risk Mitigation via Lead Service Line Replacement

- More costly and time-consuming
- Can remove major lead source in certain cases
- May be difficult for schools and childcare centers to implement due to cost, building ownership, school closures, and other concerns
Communication Best Practices with Childcare Providers

✓ Use email, phone, and mail – preference is different for everyone
✓ Keep it simple – they are busy running their business and it’s not science research
✓ Keep it positive – if there’s a problem, what’s the solution?
✓ Provide the results with mitigation options based on cost feasibility
✓ Have educational flyers for interested and/or concerned parents or providers
✓ Be prepared for a range of responses
What’s Next

From Reactive to Proactive - Toward an era of precision public health

“Providing the right intervention to the right population at the right time”

- Muin J, Khoury, MD, PhD, et al.

*American Journal of Preventive Medicine, 2016*
Machine-learned “Bayesian network” models can predict health outcomes from complex interactions among genes, environmental exposures, and socioeconomic, behavioral, and demographic variables.
Model can predict risks at new locations

The proof-of-concept model has high accuracy

<table>
<thead>
<tr>
<th>Predicted Lead (ppb)</th>
<th>Measured Lead (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 15 (72)</td>
<td>≥ 15 (14)</td>
</tr>
<tr>
<td>≤ 15 (67)</td>
<td>93%</td>
</tr>
<tr>
<td>&gt; 15 (19)</td>
<td>7%</td>
</tr>
</tbody>
</table>

7% false-positive rate. 100% detection rate.
Next Steps
Lead in Water Testing in NC: An Update

- Two recent failed legislative attempts to require testing and mitigation in child cares and schools in NC
- The Sanitation Rules for childcare centers, enforced by the NC Division of Public Health (DPH), allow for regulatory lead testing and mitigation
  - The 2017 RTI Clean Water for Carolina Kids Study showed feasibility
  - A draft proposed rule was prepared as a collaborative effort (NC DPH, NC Department of Environmental Quality, Duke Environmental Law and Policy Clinic and NC Child, and stakeholder comments)
- Proposed rule will be presented at Commission on Public Health by DPH in February 2019, with a request to officially publish the rule.
- Comment period expected
Key Aspects of Feasible Implementation

Assessment
- Use citizen scientists for sample collection with minimal training.
- Use standardized assessment packages for sampling and shipping.

Communication
- Use standardized communication protocols.
- Provide testing results with risk mitigation measures from no-cost to low-cost to more cost.

Mitigation
- **No-cost**: Clean water habits – cold water for drinking and cooking, designating specific outlets for use, flushing water before use, regularly cleaning aerators, and fixing plumbing issues.
- **Low-cost**: replacing fixtures with lead, installing and maintaining point-of-use filters certified to remove lead; replacing water fountains with new fountains with filters and a bottle filling station.
- **More cost**: service line replacement or other building and piping upgrades, if possible and when necessary
The Clean Water for Carolina Kids study demonstrates that no or low-cost, feasible solutions can eliminate lead exposure in drinking water below laboratory detection limits and near the health goal of 0.

Further, we show it is possible to implement a program that assesses lead in drinking water, communicates results, and recommends risk mitigation measures in North Carolina childcare centers.
Investing in access to quality water - a new way to improve standardized test scores?

Lead exposure is known to cause reductions in IQ.

Preventing exposure will help students learn at their full potential.
Lead exposure is preventable.

To safeguard both children’s health and public health overall, a health-based standard must be considered with comprehensive testing, mitigation, and communication protocols for lead in drinking water that reflects the current state-of-the-science.
Acknowledgements

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Text references from this presentation are located at Redmon et al., 2018
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