Municipal Water Contamination By Perfluorinated Alkyl Substances (PFAS): Lessons Learned

Alan D Woolf, MD, MPH
Director, Region 1 New England Pediatric Environmental Health Specialty Unit

Karen Simone, PharmD
Director, Northern New England Poison Center
President, AACT
This Region 1 PEHSU presentation was funded (in part) by the cooperative agreement award #1U61TS000237-02 subcontract 771100-CHA, from the Agency for Toxic Substances and Disease Registry (ATSDR).

Acknowledgement: The U.S. Environmental Protection Agency (EPA) supports the PEHSU by providing funds to ATSDR under Inter-Agency Agreement number DW-75-92301301-0. Neither EPA nor ATSDR endorse the purchase of any commercial products or services mentioned in PEHSU presentations.
Disclosure Statement

In the past 12 months, we have had no relevant financial relationships with the manufacturer(s) of any commercial product(s) and/or provider(s) of commercial services discussed in this CME activity. We do not intend to discuss an unapproved/investigative use of a commercial drug/product/device in our presentation.
Learning Objective

At the end of this session the audience should be able to describe three community-level strategies to consider implementing upon discovery of a PFAS contamination event in municipal drinking water.
Properties of PFAS

- Water/Oil Repellant
- >350 different congeners
- Non-volatile
- PFOA half-life 4-8 yrs
- Passes placenta, into breast milk
- Thousands of tons per year
- PFOA - perfluorooctanoate
- PFOS – perfluorooctane sulfonate
- PFHx – perfluorohexanoate
Uses of PFAS
Pathways of PFOS Exposure

PORTSMOUTH, NEW HAMPSHIRE WATER EVENT
PFOS above the EPA Provisional Health Advisory (PHA)

- April 2014: USAF asked to test wells at PEASE Tradeport for PFCs
  - [594 Fire/Crash/Training DoD sites in U.S.]
- 3 wells that supply drinking water: Haven, Harrison, & Smith Wells (blended prior to tap)

<table>
<thead>
<tr>
<th>Wells</th>
<th>PFOS μg/L (April)</th>
<th>PFOA μg/L (April)</th>
<th>PFOS PHA: 0.2 μg/L</th>
<th>PFOA PHA: 0.4 μg/L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haven</td>
<td>2.5</td>
<td>0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harrison</td>
<td>0.048</td>
<td>0.009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smith</td>
<td>0.018</td>
<td>0.0035</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Site</td>
<td>PFOS (EPA 0.4 ppb or ug/L)</td>
<td>PFOA (EPA 0.2 ppb or ug/L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------------------------</td>
<td>----------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEASE, NH (3 wells mixed)</td>
<td>&lt;2.5</td>
<td>&lt;0.35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cologne, GR</td>
<td>8.35</td>
<td>0.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ohio &amp; West Virginia “C8”</td>
<td>0.05</td>
<td>3.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ronneby, Sweden</td>
<td>4.0</td>
<td>0.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decatur, Alabama</td>
<td>0.114</td>
<td>0.394</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottage Grove, MN</td>
<td>120</td>
<td>105</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yangtze River, China</td>
<td>0.014</td>
<td>0.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>River Po, Italy</td>
<td>0.01</td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arctic Cap</td>
<td>pg/L</td>
<td>pg/L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rumsby et al. Phil Trans R Soc A 2009; 367</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Timeline

   - 1970 - ??: Use of PFAS in firefighting foam for plane crashes/training
   - 1983: USAF begins environmental cleanup
   - 1990: Listed: National Priority List (NPL) Superfund Site

1992 – 2000: USAF + Pease Development Authority = redevelop site (Pease International Tradeport)
   - 1992:
     - Transfer: development of public airport (1,700 acres)
     - Transfer: NH Air National Guard (200 acres)
     - Transfer: US Dept Interior’s Fish and Wildlife Services - Great Bay National Wildlife Refuge (1,100 acres)
   - 1997: Transfer: develop commercial/industrial park (1,300 acres)

2000: USAF completes Superfund cleanup construction; Pease remains on NPL

Currently:
- Over 250 businesses
- More than 9,000 workers
Timeline

• April 16, 2014: U.S. Air Force (USAF) collects water samples

• May 12, 2014:
  — U.S. Air Force informs NH DHHS of elevated PFAS
  — NH DHHS immediately informs City of Portsmouth
  — City shuts down wells

• April 23, 2015: Community Advisory Board formed (1st meeting May 6, 2015)

• March 19, 2015: NH DHHS announces blood draws anticipated in May

• June and July, 2015: Initial blood testing results-related communications
  — June 17, 2015: Community Meeting (Release of 100 adult results)
  — June 22, 2015: Healthcare Provider Webinar
  — July 17, 2015: Pediatric environmental toxicology expert presentation
Timeline

• August - September, 2015: Additional blood testing communications
  — August 17, 2015
    ▪ Announce impending release: 244 additional blood results
    ▪ Health alert to MDs
  — September, 2015
    ▪ September 9, 2015: Pediatric presentation at public meeting
    ▪ September 22, 2015: Pediatric webinar by clinical environmental tox expert

• August - October, 2015: Second round of blood testing offered
  — 471 completed – 1st round
  — 1,104 completed – 2nd round (3 laboratories required)
PFOA Comparison to Other Study Populations

PFOA Geometric Mean Serum Concentration (µg/L) in Various Study Populations (Environmentally Exposed Communities, & General U.S. Population)

- Ohio River Valley (2005-2006)
- Decatur, Alabama (2009)
- Red Cross Donors in 6 cities (2006)
- NHANES (2005-2006)
- NHANES (2011-2012)
- Pease Tradeport NH, age ≥12 (2015)
- Pease Tradeport NH, age <12 (2015)
PFAS: Animal Studies

- Altered gene expression and testosterone synthesis (Shi 2007)
- Behavioral (Ciu 2009; Onischenko 2010)
- Reproductive (Fuentes 2006)
- Tumors (ATSDR 2009)
- Neonatal mortality (Luebker 2005)
- Increased liver weight (ATSDR, 2009; Ciu 2009)
- Reduced immunological function (Dewitt 2012)
- Adverse effects on mammary gland development (mice) (Post, 2012)
C8 (PFOA) Health Project, 2005-2006

No “Probable Link” N=41

- HTN
- Coronary Heart Disease
- Stroke
- Chronic kidney disease
- Liver disease
- Osteoarthritis
- Parkinson’s disease
- Other autoimmune diseases (not UC)
- “Common infections” (i.e. influenza)
- Neurodevelopmental disorders, including ADHD and learning disabilities
- Asthma or COPD
- DM type 2
- Birth defects, miscarriage or stillbirths
- Preterm birth or low birth weight

“Probable Link” N=6

- High cholesterol
- Thyroid disease
- Ulcerative colitis
- Testicular cancer
- Kidney cancer
- Pregnancy-induced hypertension

Study of 69,030 participants from West Virginia and Ohio (Ohio-River Valley) exposed to PFOA from a Chemical Plant

http://www.c8sciencepanel.org/prob_link.html
Government Agencies Speak

- Levels of PFOA, PFOS in the Pease adult/pediatric community similar to, or lower than, other U.S. populations in last 10 yrs
- Levels of PFHxS in Pease are slightly higher compared to other U.S. populations, but still within range of levels seen
- NH (June 2015) “…the levels found in blood do not predict what, if any, health impact may occur.”
- ATSDR (June 2015) ”test results cannot currently be used to predict health effects, nor can they be linked to specific health problems”
- ATSDR (June 2015) “test results cannot, in general, be used to specifically predict sources of exposure”
Communicating With Families: Lessons Learned
**Perceived Risk = Hazard + Outrage**

<table>
<thead>
<tr>
<th>High Perceived Risk:</th>
<th>Whether Present:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Involuntary</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Controlled by others</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Unfairly distributed</td>
<td>• Maybe</td>
</tr>
<tr>
<td>• Caused by Humans</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Groupings of injuries and/or fatalities</td>
<td>• Maybe</td>
</tr>
<tr>
<td>• Unknown/unfamiliar</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Children</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Poorly understood</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Relatively unknown/uncertain</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Evokes fear/anxiety</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Potentially irreversible adverse effects</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Perceived as ethically/morally wrong</td>
<td>• Yes</td>
</tr>
<tr>
<td>• Produces identifiable victims</td>
<td>• Yes</td>
</tr>
</tbody>
</table>
The Best Way to Say It . . .

<table>
<thead>
<tr>
<th>PFC Tested</th>
<th>Your Child’s Result ($\mu$g/L)</th>
<th>Schecter Study Results ($\mu$g/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Median</td>
</tr>
<tr>
<td>PFOA perfluorooctanoic acid</td>
<td>4.97</td>
<td>2.85</td>
</tr>
<tr>
<td>PFOS perfluorooctane sulfonic acid</td>
<td>7.29</td>
<td>4.10</td>
</tr>
<tr>
<td>PFHxS perfluorohexyl sulfonate</td>
<td>2.15</td>
<td>1.2</td>
</tr>
<tr>
<td>PFUA perfluoroundecanoic acid</td>
<td>0.732</td>
<td>Not reported in Schecter study</td>
</tr>
<tr>
<td>PFOSA perfluorooctane sulfonamide</td>
<td>0.6</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>PFNA perfluorononanoic acid</td>
<td>1.74</td>
<td>1.2</td>
</tr>
<tr>
<td>PFDeA perfluorodecanoic acid</td>
<td>0.759</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Me-PFOSA-AcOH₂ 2-(N-methyl-perfluoroctane sulfonamido) acetic acid</td>
<td>0.372</td>
<td>&lt;0.2</td>
</tr>
<tr>
<td>Et-PFOSA-AcOH 2-(N-ethyl-perfluoroctane sulfonamido) acetic acid</td>
<td>&lt;0.1</td>
<td>&lt;0.2</td>
</tr>
</tbody>
</table>

($\mu$g/L) = micrograms per liter
Median = middle PFC value of all 300 children tested

Note: A value reported as <0.1 or < 0.2 indicates the result was less than the Limit of Detection (LOD) for that PFC by that testing method. Samples were analyzed at the National Center for Environmental Health, US Centers for Disease Control and Prevention, Chamblee, GA.

A health level concern has not been established for perfluorochemicals in blood.
Best message not received . . .

Your PFC Blood Test Results Compared with Children in the Schecter Study

*The Schecter Study did not report PFUA (perfluoroundecanoic acid) results.
Note: A value reported as <0.1 or <0.2 indicates the result was less than the Limit of Detection (LOD) for that PFC by that testing method.
Samples were analyzed at the National Center for Environmental Health, US Centers for Disease Control and Prevention, Chamblee, GA.
A health level of concern has not been established for perfluorochemicals in blood.
A different perspective . . .

**PFOS Geometric Mean Serum Concentration (µg/L) in Various Study Populations**

<table>
<thead>
<tr>
<th>Study</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>3M Workers, Decatur AL (2000)</td>
<td>High</td>
</tr>
<tr>
<td>Ohio River Valley (2005-2006)</td>
<td>Moderate</td>
</tr>
<tr>
<td>Decatur, Alabama (2009)</td>
<td>Low</td>
</tr>
<tr>
<td>E. Metro Minnesota Pilot (2008-2009)</td>
<td>Low</td>
</tr>
<tr>
<td>Red Cross Donors in 6 cities (2006)</td>
<td>Low</td>
</tr>
<tr>
<td>Pease Tradeport NH, First 98 (2015)</td>
<td>Low</td>
</tr>
<tr>
<td>NHANES (2005-2006)</td>
<td>Low</td>
</tr>
<tr>
<td>NHANES (2011-2012)</td>
<td>Low</td>
</tr>
</tbody>
</table>

Legend:
- High
- Moderate
- Low
PFOS Geometric Mean Serum Concentration (μg/L) in Various Study Populations (Environmentally Exposed Communities, & General U.S. Population)

- Ohio River Valley (2005-2006)
- Decatur, Alabama (2009)
- Red Cross Donors in 6 cities (2006)
- Pease Tradeport NH, First 98 (2015)
- NHANES (2005-2006)
- NHANES (2011-2012)
NH CITIZEN INQUIRIES

• Young Mother: Will my baby require a liver transplant?
• Female Adult: Will blood donation lower my PFAS levels faster?
• Male Adult: Can herbs or cholestyramine lower the PFAS in my blood?
• 60 Year Old Male: Did the water cause my erectile dysfunction?
Risk Communication Goals

**Community Engagement**

- Identify stakeholders early
- Anticipate Q&A; develop responsive messages
- Concise; transparent; enhance understanding
- Build trust and credibility; speak with one voice
- Influence attitudes, decisions, and behaviors
- Encourage open dialogue
Message Mapping:

What does this mean for my child’s health?

• PFAS are toxic in experimental animals.
• Further study required in humans.
• Studies of potential health impacts on children have not yet shown definitive results

What can I do to protect the health of my child?

• Since these chemicals are only measured experimentally and since exposure usually occurs only from contaminated sites, testing your child is not recommended.
• Since there is no treatment to 'remove' PFAS from the body, efforts should focus on preventing further exposure including avoiding the use of consumer goods known to contain PFAS.
• Routine Well Child Care visits with your child’s MD are recommended
Summary:
Recommendations

• Use familiar language and concepts
• Community Advisory Board
• Message Mapping
• Act as soon as information allows
• Open assessment to independent review
• Admit what you don’t know