Current issues in the science of community water fluoridation

Howard Pollick, BDS, MPH
Health Sciences Clinical Professor
School of Dentistry, UCSF

The content of this presentation is the responsibility of the author and does not necessarily represent the official position of any organization.
Why Community Water Fluoridation

The problem

Tooth decay
Tooth Decay - Dental Caries: what happens when the rot sets in?

- Primary teeth
- Coronal surfaces:
  - Pit & Fissure
  - Approximal
- Root surface
- Pain
- Infection
- Abscess
- Restoration
- Root Canal
- Extraction
- Replacement
Enamel Fluorosis and Tooth Decay

Photographs of enamel fluorosis from Forum on Water Fluoridation in Ireland, 2002

Decay is more common, disfiguring and serious

Tooth Decay

Tooth Decay and abscesses

Photographs of enamel fluorosis from Forum on Water Fluoridation in Ireland, 2002
Optimum Goal – Minimal decay; minimal fluorosis

80% of 6-39 year-olds have no signs of enamel fluorosis in front teeth – NHANES 1999-2004

No severe enamel fluorosis in fluoridated communities

Urgent Dental Needs: Fluoridated: 4%
Non-fluoridated: 25%


Untreated Decay
Decay – Abscess
Fluoride in water: Caries and Fluorosis: Pre-1945 data
The scientific basis for fluoridation

Historical Background

- Over 7000 children
- 12-14-year-olds
- Midwest US
- 21 cities

Dean, H.T. in *Dental caries and Fluorine*, Washington, American Association Advancement Science, pp. 5-31, 1946

Sept 11, 2015
Fluoridation Science: 70th Anniversary of CWF
Fluoride in water: Caries and Fluorosis: Pre-1945 data
The scientific basis for fluoridation

- Suboptimal fluoride levels – benefits
- 0.5 – 0.9 ppm reduced DMFT compared to <0.5 ppm
- Greater benefit 1.0 – 1.4 ppm
- But increasing enamel fluorosis

Dean, H.T. in *Dental caries and Fluorine*, Washington, American Association Advancement Science, pp. 5-31, 1946
### Comparison of caries scores in controlled-fluoride areas and low-fluoride areas

<table>
<thead>
<tr>
<th>City</th>
<th>F status</th>
<th>Year</th>
<th>Age</th>
<th>Mean DMFT</th>
<th>% Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grand Rapids</td>
<td>No F</td>
<td>1945</td>
<td>12-14yrs</td>
<td>9.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1959</td>
<td></td>
<td>4.3</td>
<td>55.5</td>
</tr>
<tr>
<td>Evanston</td>
<td>No F</td>
<td>1946</td>
<td>12-14yrs</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>1959</td>
<td></td>
<td>4.7</td>
<td>48.8</td>
</tr>
<tr>
<td>Sarnia</td>
<td>No F</td>
<td>1959</td>
<td>12-14yrs</td>
<td>7.5</td>
<td></td>
</tr>
<tr>
<td>Brantford</td>
<td>F</td>
<td>1959</td>
<td></td>
<td>3.2</td>
<td>56.7</td>
</tr>
<tr>
<td>Kingston</td>
<td>No F</td>
<td>1960</td>
<td>13-14yrs</td>
<td>12.4</td>
<td></td>
</tr>
<tr>
<td>Newburgh</td>
<td>F</td>
<td>1960</td>
<td></td>
<td>3.7</td>
<td>70.1</td>
</tr>
</tbody>
</table>
Common Anti-fluoridation Argument and rebuttal: “It doesn’t work to reduce decay”

Allegation:
Some studies have not shown reduced tooth decay in fluoridated communities

- The majority of studies have shown benefit
- Some studies/analysis showing no benefit have been flawed or used inappropriate methods
- The 1986-87 NIDR National Survey of Dental Caries in U.S. School Children
  - [http://jdr.sagepub.com/content/69/2_suppl/723.abstract?ijkey=100237282cb667bd2254e78e9932567c124e6fa1&keytype2=tf_ipsecsha](http://jdr.sagepub.com/content/69/2_suppl/723.abstract?ijkey=100237282cb667bd2254e78e9932567c124e6fa1&keytype2=tf_ipsecsha)
The 1986-87 NIDR National Survey of Dental Caries in U.S. School Children

- 39,207 US schoolchildren; aged 5-17 years
- 17,336 life-long resident schoolchildren
- Difference in methods of analysis: teeth vs surfaces
- If a tooth has more than one surface decayed or filled; or missing (caries)
- – it should count as a greater level of disease

<table>
<thead>
<tr>
<th>Analysis Methods</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brunelle J, Carlos J. (NIDR)</td>
<td>DMFS (surfaces) Lifelong CWF vs No CWF dfs 18% less in F areas 2.79 vs 3.39 (diff=0.6 DMFS) 25% less in F areas (no supplemental F) 26% less in F areas (5-9 year-olds)</td>
</tr>
<tr>
<td>Primary tooth surfaces</td>
<td></td>
</tr>
<tr>
<td>Yiamouyiannis J. (anti-fluoridationist)</td>
<td>DMFT (teeth) Lifelong CWF vs No CWF dft 4% less in F areas (non-significant) 1.97 vs 2.05 (diff=0.08 DMFT) 42-11% less in F areas (5-7 year-olds)</td>
</tr>
<tr>
<td>Primary teeth</td>
<td></td>
</tr>
</tbody>
</table>
1986-87 NIDR National Survey of Dental Caries in U.S. School Children

Effectiveness of water fluoridation

Percent Difference in Caries Severity by U.S. Region according to % on fluoridated water. (1986-87) Children 5-17 year-olds

60% difference in Pacific Coast
20% fluoridated

60% less caries in fluoridated areas

(data from: Brunelle JA, Carlos JP Recent Trends in Dental Caries in U.S. Children and the Effect of Water Fluoridation Journal of Dental Research. 1990 Feb; 69 (Special Issue); 723-727.
Effectiveness of water fluoridation: Halo or diffusion effect

Difference in Caries Prevalence by U.S. Region according to % on fluoridated water. (1986-87) Children 5-17 year-olds

No difference when 75% of the region is fluoridated

0% difference in Midwest
75% fluoridated

Explained by Halo or diffusion effect

(data from: Brunelle JA, Carlos JP Recent Trends in Dental Caries in U.S. Children and the Effect of Water Fluoridation Journal of Dental Research. 1990 Feb; 69 (Special Issue); 723-727.)
Annual incremental benefit of water fluoridation: depends how old you are

- NIDR 1986-87 US school-based oral examination survey (Brunelle and Carlos).
- Increasing preventive benefit of tooth surfaces saved from decay by age.
- While 5-6 years olds have few if any permanent teeth, all but the wisdom teeth are present by age 12 years or so.
- The overall benefit for 5-17 year-olds is a mean of 0.6 of a tooth surface, but that benefit increases to 1.5 tooth surfaces by age 17.
CARIES PREVENTION ASSOCIATED WITH WATER FLUORIDATION INCREASES WITH AGE


This chart shows the differences in mean DMFS (Decayed, Missing due to Caries, and Filled Permanent Tooth Surfaces) with a trendline created from Microsoft Excel. Note that the difference in means for all children 5-17 years was 0.6 DMFS, but the difference increases with age.

Severity of dental caries experience in PRIMARY teeth (dfs; 5-10-year-olds; single residence) and prevalence of enamel fluorosis (Dean’s Index; 7-17 year-olds; single residence): data from the 1986-87 National Survey of US School-children

Severity of dental caries experience in PERMANENT teeth (DMFS; 5-17-year-olds; single residence) and prevalence of enamel fluorosis (Dean’s Index; 7-17 year-olds; single residence): data from the 1986-87 National Survey of US School-children.

Heller KE, Eklund SA, Burt BA. 
Dental caries and dental fluorosis at varying water fluoride concentrations. 
J Public Health Dent. 1997 Summer;57(3):136-43
Prevalence of dental caries experience (DMFS; 5-17-year-olds; single residence) and (dfs 5-10 year-olds; single residence): data from the 1986-87 National Survey of US School-children.

Dental fluorosis types, by severity:
12-15 year-olds: the need to monitor exposure to fluoride.

Figure 3. Change in dental fluorosis prevalence among children aged 12–15 participating in two national surveys: United States, 1986–1987 and 1999–2004

NOTES: Dental fluorosis is defined as having very mild, mild, moderate, or severe forms and is based on Dean's Fluorosis index. Percentages do not sum to 100 due to rounding. Error bars represent 95% confidence intervals.

Prevalence of severe enamel fluorosis and water fluoride concentration

No severe enamel fluorosis below 2 mg/L (ppm) fluoride in water

Guideline Value W.H.O., Canada, EU
1.5 ppm

MCLG – 4 ppm

SMCL – 2 ppm

Fluoridation
0.7 – 1.2 ppm

Fluoride Level (mg/L)

Prevalence Severe Fluorosis (%)

Each red diamond represents a different survey of enamel fluorosis

Sept 11, 2015

Fluoridation Science: 70th Anniversary of CWF
Water intake no longer varies by climate

http://www.cdc.gov/fluoridation/factsheets/totalwaterintake.htm
Recommended concentration of fluoride in drinking water

- US Public Health Service
- 1962 standard
- 0.7 – 1.2 ppm (mg/L)
  - According to annual average maximum temperature
- 2011 Proposed standard
- 2015 Final Recommendation
  - National Oral Health Conference
  - Public Health Reports
  - Federal Register
- 0.7 ppm (mg/L)
  - Nationwide
Reasons for proposal to standardize to 0.7 ppm

1. **Strong supporting evidence on the safety and cost-effectiveness of optimally fluoridated community water for caries prevention;**

2. **Public access to more fluoride sources than in the past, including fluoride toothpaste that young children swallow;**

3. **Reducing the potential development of enamel fluorosis, which has increased in prevalence due to greater access to more sources of fluoride;**
   - So why reduce water F concentration instead of reducing F in other sources?

4. **Levels of total water intake among children aged 1 to 10 are similar across U.S. climate zones.**
Comparing three recent reviews

US Community Preventive Services Task Force – 2013

USPHS/CDC New Guidelines – 2015

Cochrane Review - 2015
The Community Preventive Services Task Force established in 1996 by the U.S. DHHS
to identify population health interventions that are scientifically proven to save lives, increase lifespans, and improve quality of life.
produces recommendations (and identifies evidence gaps) to help inform the decision making of federal, state, and local health departments, other government agencies, communities, healthcare providers, employers, schools and research organizations.
Community Preventive Services Task Force – 2013

• Reaffirmed and updated its 2000 recommendation for water fluoridation
• **Strong** evidence of effectiveness in reducing tooth decay (dental caries) across populations.
Community Preventive Services Task Force – 2013

• Based on 28 studies about the effect of CWF on caries; 16 about oral health disparities, and 117 about dental fluorosis.

• Most of these studies were included in an existing systematic review - McDonagh 2000 (York)
  – search period 1966-1999; 26 studies on caries; 13 on oral health disparities; 88 on fluorosis

• Combined with more recent evidence
  – search period 1999-2012; 2 on caries; 3 on oral health disparities and 29 on fluorosis
CWF Effectiveness

- **Community Preventive Services Task Force (2013):**

  Found **strong** evidence that community water fluoridation (CWF) was effective in reducing tooth decay.

  - Increase in percent of caries free (mean difference)
    - Median: 14.6%; range -5.0% to 64% (11 studies)
    - Median: 25.1%; range 19.8% to 31.6% (1 study)

  - Decrease in number of dmft/DMFT (mean difference)
    - Median 2.25 teeth; range 0.5 to 4.4 (10 studies)

- **Task Force recommended CWF to prevent or control caries in communities**

---

DFMT: Decayed, missing, or filled teeth (primary or permanent)

CWF: community water fluoridation
HHS Recommendation on Community Water Fluoridation


Barbara Gooch, DMD, MPH
Associate Director for Science, Division of Oral Health
National Center for Chronic Disease Prevention and Health Promotion, CDC
Community Water Fluoridation
HHS Recommendations

• 2010 - HHS panel of federal scientists reviewed relevant evidence to update 1962 recommendations
• 2011 - Proposed HHS recommendation: 0.7 mg/L fluoride in water
• Intent of the action
  – Balance the health benefits of preventing tooth decay across the lifespan while reducing fluoride exposure in children
• Status
  – 0.7 mg/L has been widely implemented by public water systems.
  – Of all persons receiving fluoridated drinking water in the U.S. about 68% were receiving water with 0.7 mg/L fluoride by Summer 2011 – just 6 months after the proposed recommendation was announced
Community Water Fluoridation
HHS Recommendations

• April 27, 2015: Online in Public Health Reports. July-August 2015

• May 1, 2015: Federal Register
• Public Health Service Recommendation for Fluoride Concentration in Drinking Water for Prevention of Dental Caries
• https://www.federalregister.gov/articles/2015/05/01/2015-10201/public-health-service-recommendation-for-fluoride-concentration-in-drinking-water-for-prevention-of
2015 HHS Community Water Fluoridation Recommendations

Recommendation
- Rationale
- Importance of Community Water Fluoridation
- Trends in Availability of Fluoride Sources
- Dental Fluorosis
- Relationship Between Dental Caries and Fluorosis at Varying Water Fluoridation Concentrations
- Relationship of Water Intake and Outdoor Temperature Among Children and Adolescents in the United States
- Process
- Comments That Opposed the Recommendation as Too High
- Dental Fluorosis
- Bone Fractures and Skeletal Fluorosis
- Carcinogenicity

- IQ and Other Neurological Effects
- Endocrine Disruption
- Effectiveness of Community Water Fluoridation in Caries Prevention
- Cost-Effectiveness of Community Water Fluoridation
- Safety of Fluoride Additives
- Ethics of Community Water Fluoridation
- Comments That Opposed the Recommendation as Too Low
- Comments That Supported the Recommendation
- Monitoring Implementation of the New Recommendation
- Summary and Conclusions
- References
- Appendix A—HHS Federal Panel on Community Water Fluoridation
“The full federal panel considered these responses in the context of best available science but did not alter its recommendation that the optimal fluoride concentration in drinking water for prevention of dental caries in the United States be reduced to 0.7 mg/L, from the previous range of 0.7–1.2 mg/L”

I would have preferred standardized to 0.7
June 18, 2015

Water Fluoridation for the prevention of dental caries

Objectives

To evaluate the effects of water fluoridation (artificial or natural) on the prevention of dental caries.

Water with a fluoride concentration of 0.4 parts per million (ppm) or less (arbitrary cut-off defined a priori) was classified as non-fluoridated.

Reviewed 20 studies examined tooth decay, most of which (71%) were conducted prior to 1975.

Compared to 28 studies from the 2013 Community Preventive Services Task Force Review

Cochrane did not review outcomes other than caries and dental fluorosis
• For caries data, only prospective studies
• concurrent control
• comparing at least two populations
  – one receiving fluoridated water and the other non-fluoridated water
  – Groups comparable in terms of fluoridated water at baseline.

• “due to the nature of the research question, randomised controlled trials are unfeasible”.
Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

• Findings on caries and CWF
• 35% reduction in decayed, missing or filled baby teeth - mean difference was 1.8 dmft
• -absolute during period of the study or yearly?
• 26% reduction in decayed, missing or filled permanent teeth - mean difference was 1.2 DMFT
• increased the percentage of children with no decay by 15%.
• applicability of the results to current lifestyles is unclear because the majority of the studies were conducted before fluoride toothpastes and the other preventative measures were widely used
• For studies assessing the *cessation* of water fluoridation, groups had to be from fluoridated areas at baseline

• with one group subsequently having fluoride removed from the water.

• *insufficient information* available to understand the effect of stopping water fluoridation programmes on tooth decay
• Water fluoridation and dental fluorosis

• Objectives
• To evaluate the effects of water fluoridation (artificial or natural) on dental fluorosis.
• However, that was changed
• Fluoride at any concentration present in drinking water – up to 5 ppm
• Reviewed 135 studies on dental fluorosis.
Dental fluorosis types, by severity:
12-15 year-olds: the need to monitor exposure to fluoride.

Figure 3. Change in dental fluorosis prevalence among children aged 12–15 participating in two national surveys:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaffected</td>
<td>47.1</td>
<td>39.6</td>
</tr>
<tr>
<td>Questionable</td>
<td>30.2</td>
<td>19.7</td>
</tr>
<tr>
<td>Very mild</td>
<td>17.2</td>
<td>28.5</td>
</tr>
<tr>
<td>Mild</td>
<td>4.1</td>
<td>8.6</td>
</tr>
<tr>
<td>Moderate and severe</td>
<td>1.3</td>
<td>3.6</td>
</tr>
</tbody>
</table>

NOTES: Dental fluorosis is defined as having very mild, mild, moderate, or severe forms and is based on Dean’s Fluorosis index. Percentages do not sum to 100 due to rounding. Error bars represent 95% confidence intervals.

Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

• Cochrane definition of dental fluorosis
  – classified children with a DDE, TSIF, TFI score greater than zero or
  – Dean’s classification of ’questionable’ or higher as having dental fluorosis.

• Traditionally Dean’s ‘questionable’ category has not been included in prevalence of dental fluorosis

• 20-30% of U.S. 12-15 year-olds had questionable dental fluorosis
Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

- Cochrane definition of dental fluorosis of aesthetic concern
- Any dental fluorosis scoring ≥ 3 (TFI), ≥ 2 (TSIF) and
- ‘mild’ or worse (Dean’s)
- Note that studies of the public perception of aesthetic concern show that less than 15% of mild dental fluorosis is considered to be aesthetically objectionable.
Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

• McDonagh et al. 2000 York systematic review:
  – at a fluoride level of 1 ppm an estimated 12.5% people would have fluorosis that they would find aesthetically concerning.

• Cochrane 2015:
  – At a fluoride level of 0.7 ppm in the water, approximately 12% of the people evaluated had fluorosis that could cause concern about their appearance.
CDC Comments Regarding the Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

- July 2, 2015
- One key difference between this USPHS review and the Cochrane review is that Cochrane used more restrictive criteria for including studies in their analyses.
- Although valid, peer-reviewed studies document the effectiveness of community water fluoridation in children and adults even after the use of fluoride toothpaste became widespread, these studies were not considered by Cochrane.
CDC Comments Regarding the Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

- July 2, 2015
- **Effectiveness of Water Fluoridation in Reducing Caries in Children:**
- estimates of fewer teeth affected by cavities in fluoridated communities and a higher percentage of caries-free children are similar to findings of other evidence-based reviews (e.g., the Task Force in 2013).
  - Cochrane
  - Task Force
  - USPHS
CDC Comments Regarding the Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

- **Effectiveness of Water Fluoridation in Reducing Caries in Adults:**
- No studies met Cochrane’s criteria regarding the effectiveness of water fluoridation in adults.
- Cochrane includes only studies where the outcomes are evaluated at two points in time in the same sample of adults. Clearly, such an evaluation over a long time period could be difficult.
- Research published in the peer-reviewed literature (in Australia and the United States) found differences in caries experience (i.e., numbers of teeth or tooth surfaces with caries) between adults who have access to community water fluoridation and those who do not.

X Cochrane
✓ Task Force
✓ USPHS
CDC Comments Regarding the Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

Effectiveness of Water Fluoridation in Reducing Caries in Adults:

✓ Task Force
✓ USPHS

Lower caries levels in adults who were exposed to fluoridation even after other sources of fluoride, such as fluoride toothpaste, became widely available.


- Meta-analysis of 5 cross-sectional studies published after 1979 and among adults with lifetime residency in F and NF communities (N=2530)
- Tooth decay reduced overall by 27% (95% CI 19–34%)

Evidence supporting water fluoridation is strong

✔ Task Force
✔ USPHS
× Cochrane - these studies did not meet Cochrane’s criteria for inclusion

CDC Comments Regarding the Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

• Of studies that were included in the review by Cochrane, only one – the most recent – showed no effect on severity of tooth decay.

• Cochrane noted in their discussion that this study had a low level of tooth decay at the beginning of the study and the shortest duration of follow-up.

• Cochrane also noted that the study was conducted in Australia – a country where water fluoridation is widespread.

• Low caries levels may reflect the diffusion of fluoride from fluoridated to non-fluoridated regions through the commercial distribution of processed foods and beverages.
July 2, 2015

CDC Comments Regarding the Cochrane Review of Water Fluoridation for the Prevention of Dental Caries

• Cochrane concluded that there was insufficient information to show that fluoridation works to reduce differences in tooth decay across socio-economic groups.
• Data from national surveys in the U.S. show that prevalence of tooth decay for groups of adolescents defined by poverty status or race/ethnicity has continued to decline over time.
• The biggest advantage of community water fluoridation is that it is the best method of delivering fluoride to all members of the community, regardless of age, education, income level or access to routine dental care.
Identified Evidence Gaps

• Task Force (2000):
  • What is the effectiveness of CWF in reducing socioeconomic or racial and ethnic disparities in caries burden?
• Task Force (2013):
  – Inconsistent results (3 studies)
• Cochrane (2015):
  • There was insufficient information available to find out whether the introduction of a water fluoridation programme changed existing differences in tooth decay across socioeconomic groups.
Identified Evidence Gaps

- Task Force (2000):
  - What is the effectiveness of CWF among adults (aged >18 years)?
  - How effective is CWF in preventing root-surface caries?
- Task Force (2013):
  - Because all the included studies examined the effectiveness of CWF in children, research on the effectiveness among adults is needed
- Cochrane:
  - No studies met the review’s inclusion criteria that investigated the effectiveness of water fluoridation for preventing tooth decay in adults.
Identified Evidence Gaps

• Task Force (2013):
  • More research also is needed to understand the following.

  • The contribution of fluoride from sources other than water
  • The effects of bottled water use (with fluoride naturally present, added, or removed) on caries incidence in fluoridated communities
  • Role of water hardness and calcium related to the bioavailability of fluoride among individuals and communities
  • Effect of CWF over and above other caries preventive measures, namely dental sealants and fluoride varnishes
  • Accumulation of fluoride in calcified tissues (predominantly bone) over time
  • Other potential positive or negative health effects
Identified Evidence Gaps

• Both the Cochrane Review and the latest review conducted by the Task Force identified the need for more research to address the effectiveness of fluoridation in the current environment of widespread use of fluoride toothpaste and other measures to prevent tooth decay, such as fluoride varnish and dental sealants.
Filling the gaps:
**CDC monitors benefits and risks of CWF**

**NHANES (from 2013):**

- Fluoride content of home water samples for children
- Exposure to other sources of fluoride (toothpaste, fluoride drops and tablets)
- Dentist-assessed measures of caries, fluorosis, and dental sealants
- Researchers will continue to examine data for tooth decay as well as dental fluorosis on a national level and for selected socioeconomic and racial groups.
Safety
Review by National Research Council (2006)

- Focused on naturally-occurring fluoride concentrations in drinking water of 2–4 mg/L
- Notably higher than recommendations for CWF (~1 mg/L)
- Found substantial evidence only for increased risk of severe dental fluorosis
- Noted prevalence of severe dental fluorosis was near zero with fluoride concentrations in drinking water of <2.0 mg/L
- Concluded that lifetime exposure to fluoride at drinking water concentrations of 4.0 mg/L is likely to increase bone fractures compared to exposures at 1.0 mg/L
Concerns: Measures of Intelligence

- NRC review (2006)
  - Considered several Chinese studies reporting lowered IQ among children exposed to higher fluoride concentrations (2.5 – 4.1 mg/L) in drinking water
  - Stated that “the significance of these Chinese studies is uncertain” because important procedural details were omitted; called for more research

- Meta-analysis (Choi, 2012)
  - Found association; lower IQ scores among children residing primarily in rural China with high fluoride concentrations in drinking water
  - Authors noted low quality of included studies; called for studies with measures of exposure at the individual level over time
  - Findings cited to support “raised fluoride concentrations” in drinking water as a potential developmental neurotoxicant (Grandjean and Landrigan, 2014)

- Cohort study (Broadbent, 2014)
  - Found no association between fluoride exposure during childhood and repeated IQ measures during childhood and at age 38 years.
Concerns: Attention Deficit and Hyperactivity Disorder (ADHD)

Ecologic study (Malin, 2015)

- Found that prevalence of ADHD was higher in states with higher percentages of persons receiving fluoridated water (CWF)
- Exposure to CWF was measured at the state level
- **No control for other possible explanatory factors for ADHD**
  - prenatal exposures to alcohol or tobacco, other environmental exposures (e.g., lead), premature delivery, and low birth weight

CWF: community water fluoridation
http://www.cdc.gov/ncbddd/adhd/facts.html
Concerns: Hypothyroidism

- Ecologic study (Peckham, 2015)
  - Found a higher prevalence of hypothyroidism among primary care practices located in fluoridated vs. non-fluoridated areas in England
  - No control for other explanatory factors at the individual level, such as iodine sufficiency, or common risk factors

- NRC review (2006)
  - Considered potential association between fluoride exposure (2 – 4 mg/L) and changes in thyroid function
  - Noted limitations of available studies of the effects of fluoride exposure on endocrine functions
    - Many did not measure actual hormone concentrations; some did not report nutritional status or other potential confounders
  - Called for better measurement of fluoride exposure, other potential explanatory factors, and outcomes at the individual level
Summary

- All three recent reviews agreed that CWF has been demonstrated to reduce the burden of tooth decay.
- There are evidence gaps.
- Surveillance of dental caries, dental fluorosis, and fluoride intake will monitor changes that might occur following the implementation of the recommendation to 0.7 mg/L.