Community Water Fluoridation – Past, present and future

Bradford Hill’s criteria for causality
- Strength, defined by the size of the association
- Temporal relationship: exposure always precedes the outcome
- Dose-response relationship
- Consistency: multiple observations different populations
- Plausibility: mechanism of action
- Experimental evidence
- Consideration of alternate explanations

Scientific method
- Try to understand something through objective study
- Transparent methodology
- Publication and peer review to expose bias
- Other researchers attempt to reproduce similar results
- Collaboration leads to better understanding
- Eyewitness – lowest form of evidence

1920s 1930s: Early observation; research
- Mottled enamel had less decay
- Identification of fluoride in water
- US Public Health Service: regular ingestion of fluoridated water reduces incidence of childhood tooth decay
- 1.0 ppm

Fluoride in water & Dental fluorosis
- Dean’s 21 City Graph
- Fluoride in water & Dental fluorosis

Dr. Luke Shwart
Dental Public Health Officer
luke.shwart@albertahealthservices.ca 403-943-6706
Community Water Fluoridation – Past, present and future

How does fluoride work?

1. Makes chemical structure of enamel more acid-resistant
2. Encourages repair of damage before it becomes permanent
3. Reduces ability of bacteria to produce acid
   - **Systemic**: ingested fluoride fortifies crystal structure of enamel of developing teeth
   - **Topical**: applying fluoride to enamel to remineralize outer layers and impact bacteria

Fluoridation in USA:
1945 January 25: Grand Rapids, Michigan
- Barrel of powdered sodium fluoride added to initiate city’s fluoridation system
- “…a modest public health measure became America’s longest-running political melodrama”
  

1945 Fluoridation begins in Canada
- Brantford-Sarnia-Stratford trial: “impressive for their adherence to a rigorous research protocol”
- Brantford: 1.0 – 1.2; Sarnia: 0; Stratford: ~1.6 (natural)
- “Striking results”; ↓ 39% in primary; ↓54% in permanent teeth
- Endorsement by professional organizations


1961: Caries-free 14 & 15 year-olds

Stratford: 1.6 ppm since 1919
Stratford: 15.5%

Brantford: Added F 1.2 ppm since 1945
Brantford: 16.5%

Sarnia: 1.04% (natural)
Sarnia: Negligible F

0 2 4 6 8 10 12 14 16 18
Community Water Fluoridation – Past, present and future

1961: 14/15 y.o:
# Decayed, Missing & Filled Teeth (DMFT)

<table>
<thead>
<tr>
<th>Location</th>
<th>DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stratford</td>
<td>3.23</td>
</tr>
<tr>
<td>Brantford</td>
<td>3.9</td>
</tr>
<tr>
<td>Sarnia</td>
<td>8.04</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Year</th>
<th>DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1961</td>
<td>3.23</td>
</tr>
<tr>
<td>2004</td>
<td>0.86</td>
</tr>
</tbody>
</table>

Canadian Oral Health Strategy target: 75%

1960 vs 2010

- 33% of Canadians received dental care
- 91% of children and 75% of Canadians visited dentist
- Dental health situation "a losing battle"
- 66% of Canadians have no dental needs
- 1 dentist/3,018 people
- 24% edentulous adults
- Fluoridation costs 1% of treatment; prevents 40-60% of disease

1962 target range: 0.7 – 1.2 ppm

- Children (0 – 10 y.o.) ingested more water in hotter climates, and less water in cooler climates
- US Public Health Service: vary fluoridation level re: differential water intake based on ambient temperature
- "70 is the new 45"

Temperature and water intake redux

- Contemporary studies: no association between water intake and maximum daily temperature
- Changes in children’s environments and behaviors
- ↑ air conditioning
- ↓ outdoor physical activity.

Recalculating the optimal level of fluoridation

- Sharpest declines in decay from increases in water fluoride levels between 0 and 0.7 ppm F
- Little additional decline between 0.7 and 1.2 ppm F.
- A suitable trade-off between caries and fluorosis appears to occur around 0.7 ppm.


Community Water Fluoridation – Past, present and future

2011 January: new USA target level

- Proposal to replace previous range of 0.7 – 1.2 based on differences in water intake
- 0.7 ppm
  - Calgary (1998)
  - Ireland (2002)
  - Canada (2008)

U.S. Department of Health & Human Services 2011. HHS and EPA announce new scientific assessments and actions on fluoride

Mild dental fluorosis

% of children with enamel fluorosis

Alberta dental fluorosis - trend

1960 Controversy in Canada

- "Fluoridation is a nation-wide issue which agitates Canadians as no other single event in the history of public health."
- "Viewed by many as the long-sought answer to dental ill-health, to others it represents no more than a thinly-veiled intrusion into civil liberties."
- "A large body of public opinion which is indifferent"
- "Issue becomes more controversial from day to day"

Compton F, A public health perspective of fluoridation. 1960 Canadian Journal of Public Health
Community Water Fluoridation – Past, present and future

1955 – 1963 Toronto
- 1955 Metro Council approved fluoridation
- Forest Hill municipality objected – court case
- Ontario Court of Appeal – prohibited fluoridation
- Supreme Court Canada – outside Municipal Act
- 1959 Ontario Royal Commission into fluoridation
- 1961 Commission report – no denial of rights or liberties
- Ontario legislation for referendums
- 1962 Dec: 50.7% of Toronto voters in favour

2006 Toronto vs. Vancouver
Dr Doug Johnston, Head of Pediatric Dentistry
- 30 years @ Hospital for Sick Children in Toronto
- 1 year @ BC Children’s Hospital
- Small cavities get big faster in Vancouver
- More aggressive dental treatment required in Vancouver
- Renewed respect for CWF

1957 – 1998 Calgary
- 1957 plebiscite (26,538 vs 26,158: against)
- Dr Hill Calgary MOH campaigned against fluoridation
- 1961 fluoridation outside Municipal Act
- 1966 plebiscite (41,033 vs 31,434: against)
- Fluoride drops and tablets program
- 1971 (56,148 vs 45,181: against)
- 1989 (53% yes)
- Court battle; 1991 start fluoridation @ 1.0 ppm
- 1998 (55% yes)
- Expert panel; reduction to 0.7 ppm

Fluoridation in Alberta
about 75% currently fluoridated
- Edmonton, St Albert, Spruce Grove, Red Deer, Lethbridge, Grande Prairie, Okotoks, Wetaskiwin, Whitecourt
- Calgary (Airdrie, Chestermere)

Canada: Reconstituting infant formula
- Formula made with water at 0.7 ppm F minimizes risk of dental fluorosis while maximizing protective benefit during tooth development.
- Infant formula is safe for consumption when made with fluoridated or non-fluoridated water
  - Water from wells should be tested before using to make infant formula
- Moderate dental fluorosis has not been associated with consumption of infant formula

Infant Formula – Systematic review
- Infants to age 24 months, formula consumption associated with ↑ risk of developing detectable fluorosis.
- Unable to determine if ↑ risk was from formula, water, other beverages, toothpastes or supplements

Hujoel P. Infant formula and enamel fluorosis: a systematic review 2009 JADA
Community Water Fluoridation – Past, present and future

**2011 Infant Formula: Evidence-based Recommendations**

*Breastfeeding,* but if formula is main source of nutrition:
- Suggest use of formula reconstituted with optimally-fluoridated water while being cognizant of potential for enamel fluorosis
  - Strength C (based on Level III or extrapolated from Level I or II evidence)

When potential risk is a concern, suggest ready-to-feed or reconstituting with low or fluoride-free water
- Strength D (based on Level IV or extrapolated from Level I, II or III evidence)
- Barsden A. Risk periods associated with dental fluorosis. 1999

**Formula vs. toothpaste**

- From research @ 1 ppm
  - Formula use *after* age one year associated with 3.5x risk of dental fluorosis
    - Advise: cease use of formula after age one year
  - Fluoride toothpaste use before age 25 months associated with 11x risk of dental fluorosis
    - 2010 guideline from Health Canada: grain of rice size amount of toothpaste for children at risk of caries

Osuji O et al. Risk factors for dental fluorosis in a fluoridated community. 1988

**1999 Ontario Review**

- Re-examining early dose response data suggests levels as low as 0.6 ppm would achieve similar reduction in the prevalence of dental decay
- Levels as low as 0.5 ppm may be optimal in some communities
- Half the fluorosis in contemporary child populations living in fluoridated communities can be attributed to fluoride from discretionary sources (i.e. toothpaste, supplements)
- Ontario range: 0.5 – 0.8 ppm

**2000 York systematic review – results**

- Generally: lack of strong evidence
  1. Level B evidence suggests it reduces caries prevalence
  2. Level B evidence shows continuing effect in studies after 1974
  3. Level C evidence “appears to suggest a benefit” (↓ DMFT); needs further clarification
  4. Dose-response relationship to dental fluorosis. Level C evidence shows no association with bone fractures or cancer. No good evidence on other effects
  5. No major differences apparent; not enough evidence to reach a conclusion

**2006 National Research Council (USA)**

- Severe enamel fluorosis causes structural damage compromising its health-protective function
- Severe enamel fluorosis occurs in 10% of children in communities with 4 ppm
- Current USA maximum of 4 ppm does not adequately protect from this condition
  - Studies published in “Fluoride” referenced (although not indexed in PubMed)

Fluoride in Drinking Water – a scientific review of EPA’s standards. 2006
Community Water Fluoridation – Past, present and future

2007 Australia: Systematic Review

- Update of 2000 York; research 1996 – 2006
- 1. one additional study didn’t change conclusion: CWF is effective in preventing caries
- 2. Additional studies meta-analysis consistent with York: CWF results in ↑ dental fluorosis
- 3. Additional studies support conclusion CWF levels have no effect on bone fracture risk
- 4. Additional studies show mixed evidence re cancer and mortality – small variations on either side of no effect

A Systematic Review of the Efficacy and Safety of Fluoridation - NHMRC

2007 Health Canada Expert Panel

- Advice & recommendations on fluoride in water
- Assess “all identified human health risks, taking into account new studies and approaches”
  - Literature review
  - Total diet study
  - International experts
- Recommend new 0.7 ppm Canadian standard
- Max. Acceptable Concentration remains 1.5 ppm

2007 Nuffield Council on Bioethics

- Adding anything to the water supply should not be ruled out, if it may bring health benefits.
- The acceptability should be considered in relation to:
  (i) balance of risks and benefits
  (ii) potential for alternatives
  (iii) role of consent where there are potential harms
- Do: rely on democratic decision-making procedures at the local and regional level because the need for, and perception of, water fluoridation varies between areas.

Public health: ethical issues. 2007

Opposing Views

- Physician co-author
- Lay audience
- Summary of current arguments
  - Back cover ads for books by same publisher:
    - “Poisoned for profit – how toxins are making our children chronically ill”
    - “Exposed – the toxic chemistry of everyday products”
- Summary of positive information about CWF: Fluoridation Facts American Dental Association 2005

2011 Literature Review: Fluoridation in Canada

- In contrast to early experiments, subsequent evidence of effectiveness is more equivocal
  - toothpaste
  - halo effect
  - better access, daily care
- Locker: From an ethical point of view, drawing on principles of beneficence, autonomy, and truthfulness, the controversy over fluoridation may be unresolvable.


Societal Trends

- Concern about environment, toxins
- Skepticism of political process
- Individuality, freedom of choice
- ↓ Government involvement in social/economic aspects of life

Community Water Fluoridation – Past, present and future

### 2003 Tap Water: Calgary vs. Vancouver

Only 73% of residents would drink tap water in the city where they live; fewer than half would drink tap water elsewhere in Canada. (Krueger P. Drinking water attitudes and perception 2003 Simon Fraser U.)

### 2009 Canada: knowledge & support

46% adults read or heard about fluoridation. Of those:

- 80% understood its intended use
- 60% believed that it was safe and effective
- 62% supported the idea of having fluoride added to their local drinking water.


### Plebiscites

- Proponents must create confidence in all aspects of issue
- Opponents only need raise a single concern or doubt
- Media covers dramatic events (“fluoride linked to…”)

(Quinonez CR, Locker D. Public opinions on community water fluoridation. 2009)

### 10 reasons to support fluoridation

1. Fluoride is naturally found in the water supply
2. Single most effective population-based measure to ↓ tooth decay
3. Better oral health means better overall health
4. Weight of evidence indicates it is effective
5. Weight of evidence indicates it is safe
6. More children are cavity-free with fluoridation
7. Children have lower decay rates with fluoridation
8. Health organizations continue to monitor and investigate it
9. Cost-effective universal public health measure
10. One of the Great Public Health Achievements of 20th Century

### Conclusion

- Fluoridation is effective in reducing risk of tooth decay
- It is most cost effective way to provide fluoride benefits to communities
- We need continuing research