Everything Is Bad: But the Dose Provides the Benefit

"Poison is in everything, and no thing is without poison. The dosage makes it either a poison or a remedy."
—Paracelsus[1]

Julie Frantsve-Hawley
Editor-in-Chief

People tend to categorize things into groups or buckets because this helps us make sense of the world and get by in daily life. When it comes to health, we categorize things as good or bad, healthy or not healthy. But this frequently results in false dichotomies and a false perception that something can only be good for you, or only be bad for you. In reality, there is usually a continuum of goodness (which we want to optimize) and badness (which we want to minimize). Sometimes less of a bad thing can actually be good, and too much of a good thing can actually be bad.

Consider two substances: substance A and substance B. Substance A is described as capable of causing harm: accidental inhalation of small quantities can cause death and prolonged exposure causes severe tissue damage; it can corrode metals; is found in biopsies of precancerous tumors and lesions; is used in nuclear power plants; and is an industrial solvent and coolant. Substance B is described as helping to maximize physical performance; has a positive effect on energy levels and brain function; may prevent and treat headaches, constipation, kidney stones, and prevent hangovers; and can help with weight loss. It is likely that we intuitively perceive substance A, which is dihydrogen monoxide,[2] as bad or unhealthy, and substance B, which is H_2O,[3] as good or healthy. The irony is that dihydrogen monoxide = H_2O = water. In other words, substance A and substance B are the exact same thing: water, just described differently. Water is essential for life and critical to our well-being, but even too much water can be a bad thing–for instance, it can lead to death from water poisoning (disturbance in brain functions that results when the normal balance of electrolytes in the body is pushed outside safe limits by overhydration).[4]

I was very surprised by an article that appeared in the Harvard School of Public Health Magazine in June 2016 that brought into question the safety of community water fluoridation.[5] The article mentions a 2012 systematic review that evaluated the possible association between fluoride exposure and IQ, alluding to neurotoxicity.[6] A dive into the data from this systematic review demonstrates that the dose of fluoride in water from the low-fluoride group ranged from 0.18 mg/L to 2.35 mg/L, and the dose in the high-fluoride group was as high as 11.5 mg/L (in water) to 1,361.7 mg/kg (from fluoride released from coal burning). The authors concluded that children in high-fluoride areas had lower IQ scores than those in low-fluoride areas and that there may be "the possibility of an adverse effect of high fluoride exposure on children's neurodevelopment."[6] If we are forced into a false dichotomy situation, this appears to put fluoride in the "bad" bucket. However, the level of fluoride currently recommended in the US is 0.7 mg/L, or 0.7 PPM, and within the systematic review's low-fluoride range. The devil is in the details, and the problem is in the dose.

We have always known that too much fluoride is a bad thing (the benefit of fluoride for caries prevention was discovered due to the Colorado Brown Stain[7]), just as too much of anything, including water, can be harmful. But when

doi: 10.11607/ebh.2016.3.e

looking at the data from this systematic review more closely and analyzing the actual dose, we see that the level of fluoride currently recommended in the US is not associated with any concern about changes in IQ. It is interesting to note that the authors also state the change in average IQ detected "may be within the measurement error of IQ testing," that there are significant flaws with the studies, and that the general body of evidence is of "insufficient quality."

So, are there potential harms to community water fluoridation? The only risk for an adverse effect identified by the Institute of Medicine (IOM) at levels recommended for community water fluoridation is enamel fluorosis, and this is categorized as a cosmetic effect, not a health effect.[8] Now, let's talk about the evidence on the benefits of community water fluoridation:

- A Cochrane systematic review found that community water fluoridation reduces the number of decayed, missing, and filled primary teeth (dmft) by 35%, reduces the number of decayed, missing, and filled permanent teeth (DMFT) by 26%, and increases the percentage of caries-free children by 15%.[9]
- A 2016 systematic review on the results of terminating community water fluoridation concludes that there is an increase in dental caries when community water fluoridation is ceased.[10]
- A 2016 systematic review on economic analysis of community water fluoridation concludes that community water fluoridation continues to be a cost-effective public health measure, with a per capita annual benefit ranging from $5.49 to $93.19.[11]
- A 2000 systematic review concludes that community water fluoridation is associated with a 14.6% increased proportion of children without caries and a reduction in the number of teeth affected by caries.[12,13]
- The 2013 US Community Preventive Services Task Force systematic review recommends community water fluoridation "based on strong evidence of effectiveness in reducing dental caries (tooth decay) across populations. Evidence shows the prevalence of caries is substantially lower in communities with community water fluoridation."[14]

One way of looking at this situation is to note that everything can be bad or unhealthy at an excessive dose. Many refer to the first law of toxicity: "the dose makes the poison."[1] But this perspective primes people to think intuitively of harm and instills a sense of caution and fear. A converse perspective can be given, and so I would like to propose a new first law of health and wellness: the dose provides the benefit. This primes people toward thinking of how to optimize health.

In reality, all health and prevention interventions have trade-offs, and in an evidence-based approach we talk of both harms and benefits. Only when the benefits outweigh the risk for harm is an intervention considered for an individual patient or as a public health initiative. In the case of community water fluoridation, the evidence is clear. The benefits outweigh the risk of harm and the dose has been optimized for maximal health. Consistent with the new first law of health and wellness, for community water fluoridation, the dose provides the benefit.

Julie Frantsve-Hawley, RDH, PhD
Editor-in-Chief

References

1. Paracelsus. The Seven Defenses of Paracelsus: (Against Those Who Seek to Defame Me). 1538. Edmonds, WA: Alchemical, 1994.
2. Dihydrogen Monoxide FAQ. http://www.dhmo.org/facts.html. Accessed 15 June 2016.
3. Leech J. 7 science-based health benefits of drinking enough water. Authority Nutrition: An Evidence-Based Approach. https://authoritynutrition.com/7-health-benefits-of-water/. Accessed 15 June 2016.
4. Timbrell J. The Poison Paradox: Chemicals As Friends and Foes. Oxford: Oxford University, 2005.
5. Davis N. Is fluoridated water safe? Harvard School of Public Health. https://www.hsph.harvard.edu/news/magazine/is-fluoridated-water-safe/. Accessed 24 June 2016.
6. Choi AL, Sun G, Zhang Y, Grandjean P. Developmental fluoride neurotoxicity: A systematic review and meta-analysis. Environ Health Perspect 2012;120:1362–1368.
7. Peterson J. Solving the mystery of the Colorado Brown Stain. J Hist Dent 1997;45:57–61.
8. Standing Committee on the Scientific Evaluation of Dietary Reference Intakes, Food and Nutrition Board, Institute of Medicine. Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride. Washington DC: National Academy, 1997.
9. Iheozor-Ejiofor Z, Worthington HV, Walsh T, et al. Water fluoridation for the prevention of dental caries. Cochrane Database Syst Rev 2015;6:CD010856.
10. McLaren L, Singhal S. Does cessation of community water fluoridation lead to an increase in tooth decay? A systematic review of published studies [epub ahead of print 13 May 2016]. J Epidemiol Community Health doi: 10.1136/jech-2015-206502.
11. Ran T, Chattopadhyay SK, Community Preventive Services Task Force. Economic evaluation of Community Water Fluoridation: A community guide systematic review. Am J Prev Med 2016;50:790–796.
12. McDonagh MS, Whiting PF, Wilson PM, et al. Systematic review of water fluoridation. BMJ 2000;321:855–859.
13. Treasure ET, Chestnutt IG, Whiting P, McDonagh M, Wilson P, Kleijnen J. The York review--a systematic review of public water fluoridation: A commentary. Br Dent J 2002;192:495–497.
14. Community Preventive Services Task Force. Preventing Dental Caries: Community Water Fluoridation. http://www.thecommunityguide.org/oral/fluoridation.html. Accessed 23 May 2016.