

## My Recent Epiphany Regarding Major Cause of Lead Exposure

As a toxicologist, I've always considered the length of exposure as more important than the peak exposure, looking at the area under the curve as being more important than actual lead levels of children. The Canfield et al<sup>1</sup> study clearly illustrates this concept that, even at low levels of lead exposure and blood lead levels, the effects can be pronounced.

The recent revelations of lead contamination of water in Flint, Michigan, served as an epiphany for me. I examined the evidence that water lead may be an important factor, particularly at the lead levels that Canfield et al reported. If you use the US Environmental Protection Agency's own model, the Integrated Exposure Uptake Biokinetic Model,<sup>2</sup> a child drinking tap water, or having tap water used to mix his/her formula, with a lead concentration of 15 ppb will sustain blood lead levels in the range of 3 µg/dL over the first 60 months of his/her age, and even at a concentration of 4 ppb (the default value) the range is similar. That area under the curve might produce a deleterious effect on cognitive development.

As a clinician, I saw elevations in blood lead levels during the warmer, summer months. I was never able to find a reasonable explanation for this observation. It does appear that there was some relationship to temperature. Recent literature reveals a seasonal change in water lead levels, even after flushing, suggesting that there may be a change in lead water concentrations in the supply system that may relate to outdoor temperature.<sup>3</sup> Changes in the planting zones as published by the US Department of Agriculture reveal that there may be demonstrable climate change that may relate to soil temperature and thus the temperature of supply water. Recent reports support that lead in water can be an

appreciable etiologic factor for elevated blood lead levels.<sup>4</sup>

I was previously accustomed to explaining that there are more laws to protect the municipal water supply, urging parents not to spend the money for bottled water. I now believe that this may not be the case as to potential lead exposure and caution families with lead-exposed children. I now caution them to avoid using tap water; substituting with the use of either a National Science Foundation-certified water filter or bottled water. Given the paradox of numbers of IQ points killed for low levels of lead, my observation may be generalizable.

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**CONFLICT OF INTEREST:** None declared

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doi:10.1542/peds.2016-3662A

### Author's Response

Thank you for sharing your epiphany on the impact of low levels of lead on children's intellectual abilities and the

contribution of lead from water, as well as your question about seasonal variation in blood lead concentrations. It is difficult to appreciate how exceedingly small amounts of lead can impact brain function, especially for pediatricians who can recall when blood lead concentrations <30 µg/dL (<300 ppb) were considered "acceptable." The Canfield et al<sup>1</sup> study, along with dozens of other studies from around the world,<sup>2,3</sup> have confirmed that blood lead concentrations <5 µg/dL (<50 ppb) can adversely impact brain development. This shouldn't be surprising; the concentrations of toxic chemicals in children's blood that are harmful, like lead, polybrominated diphenyl ethers, and polychlorinated biphenyls, are comparable to the therapeutic range of chemicals administered as drugs to alter behaviors, like methylphenidate.<sup>3</sup> Moreover, on an evolutionary scale, the levels found in contemporary children aren't small; they are 10 to 100 times higher than in our preindustrial ancestors.<sup>4</sup>

Seasonal variation in lead poisoning is one of the enduring mysteries of childhood lead poisoning. Cases of lead poisoning and children's blood lead concentrations appear to increase during summer months for various reasons. As Dr Marcus noted, warmer temperatures enhance water's ability to leach lead from lead service lines and lead solder.<sup>5</sup> The amount of lead in house dust also increases during summer months.<sup>6</sup> Windows are frequently opened; dust trapped in the window troughs is blown indoors or accessible to children's curious hands. Soil that was contaminated by lead from past use of leaded gasoline or lead-based paints can also be "tracked in" from outdoors or become resuspended and settle in house dust, which is then readily accessible to children.<sup>7</sup> Children also spend more time outdoors in the summer<sup>6</sup>; a sizable fraction of children (~30%) are reported to put soil or dirt in their mouths, especially during the second

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*Pediatrics* 2017;139;

DOI: 10.1542/peds.2016-3662A originally published online January 31, 2017;

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