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Perchlorate Concentrations in Boston's Charles River After the July 4th Fireworks Spectacular

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Dear Editor:

Perchlorate is an inorganic anion formed by natural processes and is a byproduct from fireworks, solid rocket fuel, road flares, matches, and airbag inflation systems. It is a competitive inhibitor of the sodium–iodide symporter on the basolateral membrane in thyrocytes and can inhibit thyroidal iodine uptake to decrease thyroid hormone synthesis. The potential effects of low-level environmental perchlorate exposure on human health have generated significant controversy. In particular, the concern is greatest in pregnant and lactating women, fetuses, and infants, groups who are vulnerable to even mild abnormalities of iodine nutrition and thyroid function.

In the United States, perchlorate is ubiquitous and has been detected in tobacco, alfalfa, tomato, cow's milk, cucumber, lettuce, soybeans, eggs, and vitamins. From the 2001–2002 National Health and Nutrition Examination Survey, perchlorate was detected in all spot urines from 2820 U.S. adults (median 3.6 μg/L) (1) and negatively associated with the serum thyroxine and positively associated with thyrotropin levels in women, primarily those with urine iodine concentrations <100 μg/L (2). In a large European study of thyroid function in iodine-deficient pregnant women, these observations were not confirmed (3).

Fireworks have often been cited as a source of environmental perchlorate exposure, but data are sparse regarding their potential impact on human health. Perchlorate concentrations were reported from groundwater and soil samples collected from 2004 to 2006 at the University of Massachusetts Dartmouth campus to determine the effect of cumulative fireworks displays in the area over the preceding 11-year period (4). Perchlorate levels ranged from nondetectable to 62.2 μg/L from groundwater-monitoring wells and reached a maximum of 560 μg/kg in the 1-inch topsoil samples from the launch area. From a small Oklahoma lake, perchlorate concentrations in water ranged from 0.005 to 0.081 μg/L over 2 years of fireworks displays; one 2006 display was associated with a perchlorate spike of 44.2 μg/L in the lake water (5).

We now report our measurements of perchlorate concentrations in Boston's Charles River before and immediately after the July 4, 2012, night-time fireworks spectacular, one of the largest fireworks presentations in the United States, in which over 3000 shells were used. Triplicate water samples from the same location in the Charles River (~280 m from the launch) were collected one hour before, immediately after, and the next morning after the fireworks spectacular and measured for perchlorate in duplicate by ion chromatography–mass spectrometry (6). Perchlorate concentrations (mean ± standard deviation) were 0.082 ± 0.012 μg/L before the fireworks, and increased 330% to 0.270 ± 0.022 μg/L immediately afterward, and returned to baseline the next morning (0.100 ± 0.011 μg/L). The peak mean perchlorate concentration in our study is far less than the maximum contaminant limit (MCL) of 0.002 mg/L in drinking water recommended by the Massachusetts Department of Environmental Protection for pregnant women, infants, children up to the age of 12, and individuals with hypothyroidism (7).

Although the U.S. Environmental Protection Agency has not established an MCL for perchlorate, it has placed perchlorate on its Candidate Contaminant List and in February 2011, announced that perchlorate regulation of drinking water will begin (8), with anticipated monitoring costs at up to $140 million/year (9) and estimated cleanup costs approaching billions of dollars (10). This report provides novel data regarding this controversial environmental and public health topic. We urge that continued research is necessary to further delineate the potential impact of low-level environmental perchlorate exposures on human health.

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