The power of environmental protection: arsenic in drinking water

Published Online
October 22, 2017
http://dx.doi.org/10.1016/S2468-2667(17)30197-4

See Articles page e513

2017 has not been a good year for environmental protection in the USA. President Trump administration is attempting to roll back more than 400 rules and regulations that protect the environment and human health. In addition to announcing their intention to withdraw from the Paris Climate Accord,[1] the administration is undoing the Clean Power Plan, the Clean Water Rule, new source performance standards for oil and gas drilling, and a proposal to ban the neurotoxic organophosphate insecticide, chlorpyrifos.[2] These rollbacks are based on political and economic arguments that focus on the costs of regulation. They echo the long-held position of the Republican Party that environmental protections are unduly burdensome, stifle innovation, and hold back economic growth.

However, it is important to put these arguments into perspective and to consider not only the costs of environmental protections, but also their benefits—the diseases and deaths averted, and the health-care and other costs saved by cleaning up the environment. Calculating the benefits of environmental protection is not easy, because the diseases and deaths prevented by environmental interventions are spread across large populations over many years and the costs of these diseases are buried in health-care budgets, while the costs of regulation are concrete, tangible, and readily counted. Nonetheless such calculations are worth doing because data quantifying the benefits of environmental protection can provide a powerful counterpoint to one-sided arguments that focus solely on the costs of pollution control.[3,4]

An analysis of the 2003–14 cycles of the National Health and Nutrition Examination Survey (NHANES) reported in *The Lancet Public Health* by Anne Nigra and colleagues assesses the health benefits of a legally mandated intervention to reduce arsenic concentrations in drinking water in the USA.[5] Arsenic is a major public health problem, and apart from exposures in the workplace, drinking water is the main source of exposure worldwide. The WHO estimates that more than 200 million people worldwide are chronically exposed to unsafe levels of arsenic in drinking water.[6] Especially severe exposures are reported in southeast Asia, notably in Bangladesh, as well as in Taiwan, Chile, Argentina, and in areas of the USA in northern New England and the southwest. Arsenic is a human carcinogen and has been shown to cause dose-related increases in lung, bladder, and skin cancer, and is also associated with cancer of the kidney, liver, and prostate.[7] Arsenic is also linked to diabetes and cardiovascular disease.[8] Prenatal exposure is associated with neurodevelopmental impairment.[9] In 2006, in response to these data, the US Environmental Protection Agency reduced the legally permitted maximum contaminant level for arsenic in drinking water from 50 µg/L to 10 µg/L. However, this intervention applied only to public water supplies, and private wells were exempted.

To take advantage of this unplanned regulatory experiment, Nigra and colleagues[5] undertook a longitudinal analysis of arsenic exposure in the USA comparing changes in exposure levels between consumers of water from public and private supply systems. They obtained data for urinary arsenic concentrations from 14 127 participants from NHANES 2003–04 (before the reduction in the maximum contaminant level) to 2013–14 (ie, analysing six consecutive NHANES cycles). The main finding was that the geometric mean level of dimethylarsinate (DMA), the main metabolite of inorganic arsenic, fell by 17% among consumers of water from public supply systems over the 10-year period (from 3·01 µg/L in 2003–04 to 2·49 µg/L in 2013–14 [95% CI 10–24; p-trend<0·001]). By contrast, no reduction in arsenic exposure was recorded in consumers of water from private wells. The researchers estimate that this intervention could prevent between 200 and 900 cases of lung and bladder cancer in the USA each year.

This is a model analysis of the health benefits that can result from a carefully designed, evidence-based environmental intervention. The findings are consistent with data from previous studies of the health benefits of reducing arsenic concentrations in drinking water.[10] They are also concordant with analyses of the benefits of interventions against air pollution, which have been shown produced major gains both for human health and the economy.[11–13] Legally mandated improvements

in air quality in the USA since the passage of the Clean Air Act in 1970 have reduced concentrations of six common air pollutants by 70%,[11] improved pulmonary function,[12] and yielded an estimated economic benefit of US$30 (IQR 4–88) for every dollar invested, an aggregate benefit of $1·5 trillion against a total investment of $65 billion since 1970.[13] Moreover these health and environmental improvements occurred during a time when the US GDP grew by nearly 250%.[11]

Government leaders who might be tempted by the siren call of deregulation, blinded by its promised short-term economic benefits, and pressured by powerful vested interests opposed to any form of environmental control, need to pay attention to these findings. Environmental pollution is now recognised to be a major cause of disease, death, and environmental degradation. It was responsible in 2015 for an estimated 9 million deaths, 16% of total global mortality, as well as for 268 million disability-adjusted lifeyears.[3] However, it is far from being an insoluble problem. Interventions to control pollution have been shown to be technically and economically feasible. They include targeted reductions in emissions of pollutants; transitions to non-polluting, renewable sources of energy; the adoption of non-polluting technologies for production and transportation; and the development of efficient, accessible, and affordable public transportation systems.[3] Interventions to control pollution provide an extraordinary opportunity to improve public health and also to slow the pace of global climate change. Pollution prevention is a winnable battle.[14]

Philip J Landrigan
Icahn School of Medicine at Mount Sinai, New York, NY 10029 USA
phil.landrigan@mssm.edu

I declare no competing interests.

1 Eilperin J, Dennis B. Trump administration to terminate Obama's climate plan: 'The war on coal is over'. Chicago Tribune. Oct 9, 2017. http://my.chicagotribune.com/#section/-1/article/p2p-94828029/ (accessed Oct 11, 2017).
2 Greshko M. A Running list of how Trump is changing the environment. National Geographic. Aug 23, 2017. http://news.nationalgeographic.com/2017/03/how-trump-is-changing-science-environment/ (accessed Oct 12, 2017).
3 Landrigan PJ, Fuller R, Acosta NJR, et al. The *Lancet* Commission on pollution and health. *Lancet* 2017; published online Oct 19. http://dx.doi.org/10.1016/S0140-6736(17)32345-0.
4 Institute of Medicine. Cost of environmental-related health effects: a plan for continuing study. Washington, DC: National Academies Press, 1981.
5 Nigra AE, Sanchez TR, Nachman KE, et al. The effect of the Environmental Protection Agency maximum contaminant level on arsenic exposure in the USA from 2003 to 2014: an analysis of the National Health and Nutrition Examination Survey (NHANES). *Lancet Public Health* 2017, published online Oct 22. http://dx.doi.org/10.1016/ S2468-2667(17)30195-0.
6 Naujokas MF, Anderson B, Ahsan H, et al. The broad scope of health effects from chronic arsenic exposure: update on a worldwide public health problem. *Environ Health Perspect* 2013; **121:** 295–302.
7 International Agency for Research on Cancer. Arsenic, metals, fibres, and dusts. IARC Monogr Eval Carcinog Risk Hum 100C. 2012. http://monographs.iarc.fr/ENG/Monographs/vol100C/ (accessed Oct 5, 2017).
8 Moon K, Guallar E, Navas-Acien A. Arsenic exposure and cardiovascular disease: an updated systematic review. *Curr Atheroscler Rep* 2012; **14:** 542–55.
9 Tyler CR, Allan AM. The effects of arsenic exposure on neurological and cognitive dysfunction in human and rodent studies: a review. *Curr Environ Health Rep* 2014; **1:** 132–47.
10 Steinmaus CM, Ferreccio C, Romo JA, et al. Drinking water arsenic in northern Chile: high cancer risks 40 years after exposure cessation. *Cancer Epidemiol Biomarkers Prev* 2013; **22:** 623–30.
11 Samet JM, Burke TA, Goldstein BD. The Trump administration and the environment: heed the science. *N Engl J Med* 2017; **376:** 1182–88.
12 Gauderman WJ, Urman R, Avol E, et al. Association of improved air quality with lung development in children. *N Engl J Med* 2015; **372:** 905–13.
13 US Environmental Protection Agency: Office of Air and Radiation. The benefits and costs of the Clean Air Act from 1990 to 2020. April, 2011. https://www.epa.gov/sites/production/files/2015-07/documents/fullreport_rev_a.pdf (accessed Oct 5, 2017).
14 Frieden TR, Ethier K, Schuchat A. Improving the health of the United States with a "Winnable Battles" initiative. *JAMA* 2017; **317:** 903–04.