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## Perspective

### The Clean Air Act and Health — A Clearer View from 2011

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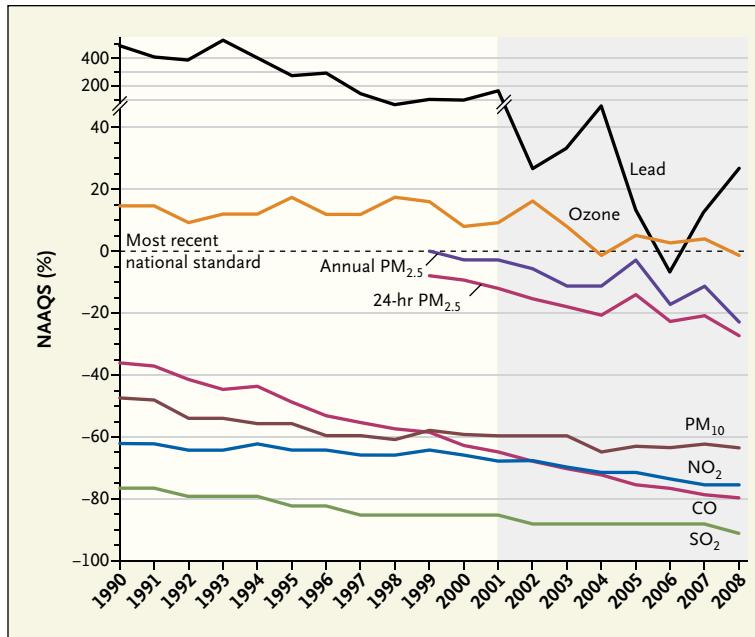
From my office, I have views of downtown Los Angeles and the San Gabriel Mountains. Air pollution infrequently obscures these views, and only rarely are my eyes and throat irritated by

smog when I'm outdoors. The Los Angeles air of today is far better than that of the mid-20th century, when severe oxidant pollution, initially of unknown origins, threatened the health and welfare of the city's residents. Severe smog was a common occurrence. Today, throughout the United States, air quality has improved greatly, and the last century's severe, life-threatening episodes of air pollution, such as one that caused about 20 deaths in Donora, Pennsylvania, over a 3-day period in 1948, have largely been forgotten. The Clean Air Act of 1970 (CAA) has driven this progress, but we now face new challenges in air-quality management.

The 20th-century pollution episodes and the pervasive smoke problem in cities motivated increasingly stringent and sweeping laws and programs to address air pollution. For more than 40 years, the CAA, aided by amendments passed in 1977 and 1990, has been the foundation for U.S. air-quality management. It provides a broad regulatory framework, covering air-pollution standards, various stationary and mobile sources, acid deposition, and stratospheric ozone protection. Two sections of the law address the major pollutants in ambient air, including particulate matter, ozone, carbon monoxide, nitrogen dioxide, and sulfur dioxide, as well as lead, which

ceased to be a widespread problem when it was removed from gasoline. These pollutants are referred to as "criteria pollutants," thanks to a passage in the law that requires the administrator of the Environmental Protection Agency (EPA) to issue "air-quality criteria," accurately reflecting the scientific evidence related to identifiable public health and environmental effects, for any substance designated as an air pollutant.

The CAA also requires the EPA administrator to set National Ambient Air Quality Standards (NAAQS) for pollutants for which air-quality criteria are listed. The language of the law on this point provides a strong public health mandate that has evolved through application and litigation. By intent, the NAAQS must protect susceptible groups within the U.S. population, although protection for the most susceptible may be



**National Levels of the Six Criteria Pollutants, as Percentages of the Levels Set in the Most Recent National Ambient Air Quality Standards (NAAQS), 1990–2008.**

PM<sub>2.5</sub> denotes particulate matter with particles less than or equal to 2.5  $\mu\text{m}$  in aerodynamic diameter, PM<sub>10</sub> particulate matter with particles less than or equal to 10  $\mu\text{m}$  in aerodynamic diameter, CO carbon monoxide, NO<sub>2</sub> nitrogen dioxide, and SO<sub>2</sub> sulfur dioxide. National levels are averages of levels provided by all monitors with complete data for the period. Air-quality data for PM<sub>2.5</sub> began to be collected in 1999. Data are from the U.S. Environmental Protection Agency.

unattainable. The achievement of what the CAA calls an “adequate margin of safety” does not imply that risk-free levels have been set, but that an acceptable level of risk has been reached, given uncertainties in the evidence. The costs of implementation and compliance are not to be considered in setting the NAAQS, although the law does call for costs to be considered in the setting of individual emission standards (e.g., for vehicles and electric utilities) that are intended to help meet the NAAQS. Under the CAA, the Clean Air Scientific Advisory Committee (CASAC, which I currently chair) provides peer review for the EPA’s reports and analyses that support NAAQS revisions.

Over the 40 years since NAAQS were first promulgated, they have

led to progressive reductions in levels of criteria pollutants (see graph). Economic analyses indicate that these reductions have been highly cost-effective.<sup>1</sup> However, as the EPA administrator now considers revisions to the NAAQS for particulate matter and ozone, the CAA’s tenets are being questioned. The questions are motivated by the possibility that even lower concentrations for the NAAQS will be proposed, leading to the designation of large regions of the country as out of compliance with the law; such a result would carry implications for many municipalities and states and multiple U.S. industries. The evidence supporting lowering of maximum levels comes largely from epidemiologic studies showing that current levels of particulate matter and ozone are ad-

versely affecting public health. Discussion of the NAAQS and the CAA has been further complicated by a U.S. Supreme Court finding that the EPA has authority to regulate greenhouse gas emissions.

Over the remainder of 2011, the EPA’s administrator, Lisa Jackson, will make key decisions with regard to lowering the NAAQS for particulate matter and ozone. For ozone, she has reopened the 2007 decision of then-administrator Stephen Johnson to set the standard at 0.075 ppm as the 8-hour average, which was made on the basis of the scientific evidence available at the time and the CASAC’s recommendation that the limit be in the range of 0.060 to 0.070 ppm. Subsequently, the CASAC has reaffirmed that recommendation and answered additional questions about the scientific foundation for the ozone NAAQS. There is great interest in the administrator’s final decision; in its teleconferences discussing the EPA’s questions on ozone, the CASAC received input from 57 public commenters. Some raised concern that the evidence was still too uncertain to warrant lowering the NAAQS and that any mandated reduction would be costly and lead to the elimination of jobs, whereas others claimed that such a reduction was needed to meet the CAA’s requirement for protecting public health. For particulate matter, a decision will be forthcoming by year’s end with regard to recommended reductions in the 24-hour and annual NAAQS. If the administrator follows the CASAC’s recommendations, the NAAQS will be set at lower levels for both particulate matter and ozone.

As the NAAQS have been re-

set at lower and lower concentrations, the gaps between acceptable concentrations and irreducible background levels have narrowed, raising the question of how much lower the limits can be pushed. For ozone and particulate-matter pollution, because no thresholds have been identified below which there is no risk at all, the EPA is using scenarios of risk and exposure to gauge the effects of setting the standards at various concentrations and giving consideration to the burden of avoidable disease. In promulgating the NAAQS for these pollutants, the administrator must weigh the public health burden against the uncertainty of the scientific evidence related to lower concentrations, keeping in mind the CAA's requirement for an adequate margin of safety. It is challenging for researchers to reduce this uncertainty, given the narrowing and low range of concentrations at issue and the difficulty of disentangling the effect of one pollutant from those of others.

As an alternative to regulating pollutants one at a time — the approach outlined in the CAA Amendments of 1990 — consideration is being given to multi-pollutant strategies that would enable the greatest possible reduction in the public health effects of the mixture of inhaled

pollutants.<sup>2</sup> Exposure to traffic-related pollution generally, for example, has adverse health effects but is not specifically addressed in the CAA.<sup>3</sup> Some multi-pollutant strategies have already been introduced. The CASAC has just reviewed a multi-pollutant approach for managing the combined effects of oxides of nitrogen and oxides of sulfur as they are deposited in sensitive aquatic ecosystems.<sup>4</sup> More integrated strategies for air-quality management might also improve control of greenhouse gas emissions, which come from the same sources as the criteria pollutants. New research approaches would be needed to support such integrated strategies.<sup>5</sup> Ongoing research may lead to more refined indicators for particulate-matter pollution, to replace the current mass-based standard, which includes a mixture of particles from many sources.

Further interpretation or amendment of the CAA may eventually be needed to advance multi-pollutant air-quality management. Revised interpretation can be controversial and subject to legal challenge; amendments have been passed infrequently and cautiously in the past. But the individual-pollutant approach no longer accords as well with our scientific understanding of air

pollution and its potential hazards for human and environmental health. More integrative strategies might well address air-quality problems extending from local to global levels. Any future Congressional action on the CAA should be consistent with the spirit of previous amendments, which recognized that U.S. standards for air quality should be grounded in the best available scientific evidence.

Disclosure forms provided by the author are available with the full text of this article at [NEJM.org](http://NEJM.org).

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