POLLUTED AIR— AND HEALTH

ERIC J. CASSELL, M.D.

A research investigator states that while air pollution is rarely, if ever, a sole and direct cause of disease, air pollutants—acting together—may intensify disease.

■ IN 1948 DONORA, PA., was a highly industrialized town of 14,000 people situated in a bend of the Monongahela River valley. Smoke and fumes poured from its industry, producing an atmosphere that was dirty and malodorous but which was not known to cause illness.

The disaster that occurred in October of 1948 in that city is now famous. Although the calamity at Donora was not the first or last air pollution disaster, many things about it are common to all others, and it provides the most concrete and inescapable evidence that under certain circumstances, uncontrolled air pollution can cause illness and death.

On Monday, October 25, a stable layer of air formed in the valley. From then until the smog was broken up by rain on Sunday, the 31st of October, this layer acted like a lid clamped down on the valley to prevent dispersal of pollutants. Two days after the episode started, the air was thick and heavy and visibility was markedly reduced.

Although a few persons started to feel ill on the second day, it was on the third day that large numbers became affected. Just as in other similar disasters, shortness of breath and cough were the most prominent symptoms, although some people experienced sore throat, headache, tears in the eyes, nausea and even vomiting. Between 8 p.m. and midnight of the third day, 40 per cent of the affected persons reported the onset of their illness. By the fourth day almost everybody who became ill during the episode was already sick. On the fourth day, 17 of the total of 20 deaths occurred. In all, 5,910 persons or 42.7 per cent of the population were affected to some degree by the smog.

As in all other disasters of this type, the elderly and those with pre-existing heart and lung disease were the most severely afflicted, although healthy persons and people in all age groups were affected.

Conditions that cause it not unique

The basic requirement for an air pollution episode—the concentration of numerous and active sources of smoke and gases—is not unique to Donora or to the Meuse Valley or London where similar disasters have occurred.

This requirement is met by many of our cities and industrial areas. The freak of weather that is necessary to produce an episode cannot be prevented, although it can be predicted. Episodes of markedly increased air pollution with concentrations of gases as high as those thought to have been present in Donora and London have occurred in New York City, although there is little or no evidence of an associated increase in illness.

The symptoms of tears in the eyes, nasal discharge, sore throat, and cough, observed in the episodes, are the symptoms of irritation of the mucus membranes; probably a non-specific irritating effect of a large number of substances rather than the effect of a specific poison such as carbon monoxide. The tightness in the chest and the shortness of breath are also—indirectly at any rate—the result of irritation of the respiratory tree. They are produced by a narrowing of the bronchial passages with consequent increased airway resistance. One might easily deduce that people whose airway resistance is already increased by disease or whose pulmonary reserve is already impaired would have an increased incidence and severity of illness during the episode. This certainly fits the Donora pattern and the pattern seen in virtually every other air pollution disaster.

Therefore, our tentative conclusions from examining the "clinical cases" of the air pollution episodes are that there are noxious substances in the air that cause irritation of the mucus membranes and increased airway resistance.

A great deal of research has been done in the years since 1948 that bears on these conclusions and supports them, but fails to amplify them as much as one would like.

Pollutants that affect health

A number of irritant and potentially toxic substances have been identified, studied, and generally found to be noxious agents. These include substances secondary to industrial processes, emissions from automobiles, waste products from home heating, and many other secondary products of modern urban life.

However, to assume that the substances already identified represent the complete list of agents in urban air that may be dangerous or potentially toxic would be naive. We are limited in our knowledge of the health effects of air pollution by our knowledge of the substances in the air. New substances are continually being found.

Air pollution legislation directed solely at specific substances runs the hazard of becoming obsolete and failing to protect people from other toxic and irritating substances that have not yet been identified.

The experimental monitoring station set up in New York City's Lower East Side in conjunction with the Cornell studies on Air Pollution and Family Illness has produced some precise information about pollutants.

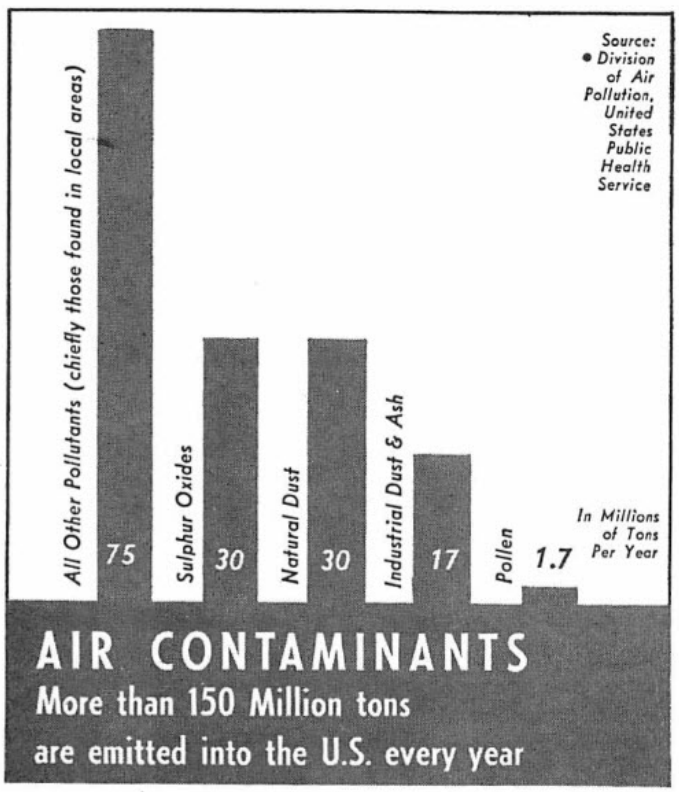
Of the pollutants generally indicted for their effect on health, sulfur dioxide has been studied most extensively. The Cornell monitoring station in New York shows that the average values for sulfur dioxide are in the neighborhood of .15 to .2 parts per million (p.p.m.). This level is considered quite high—higher than expected and easily as high as that of London or any other American city.

One group of investigators has reported no change in pulmonary air flow resistance in man following exposure to sulfur dioxide in the range of 1 to 3 p.p.m. At 4 to 5 p.p.m. a small increase in airway resistance was noted, and at levels over 8 p.p.m. a definite increase in airway resistance was obtained.

In addition to the effect on airway resistance, sulfur oxides have been demonstrated to decrease the efficiency of the cleansing mechanism of the respiratory tract, thus slowing down the removal of mucus, debris, and foreign particles from the respiratory tree.

In these and most animal studies, the levels of sulfur dioxide required to produce the effects were considerably higher than the levels usually found in atmosphere air.

Ozone also has these irritating effects, as do several other substances. In the case of ozone, desensitization may occur, and a tolerance to the lethal effects of ozone may be developed. Again, these effects are seen at concentrations higher than those found in urban air.



Even the famous Los Angeles oxidant smog when faithfully reproduced in the laboratory requires higher concentrations to cause eye irritation than are required for similar irritation in downtown Los Angeles.

Therefore, although the air pollution disasters give us reason to believe these pollutants should have distinct effects, when studied in the laboratory, out of the urban context, adverse effects are not seen at realistic pollutant levels.

The "unhealthy" man

Despite scientific evidence that low concentrations of substances such as sulfur dioxide are not harmful to healthy men, there is a further problem: we are not solely concerned with healthy men.

For example, within the "normal" population there would appear to be a group not otherwise distinguished who have an increased sensitivity to sulfur dioxide or who become sensitized after repeated exposure. These people show an increase in airway resistance more marked than the majority of subjects experimentally exposed to the same concentrations of sulfur dioxide and sulfuric acid mists. In one series of experiments, the investigators noted in themselves an increasing sensitivity to sulfur dioxide and sulfuric acid mist over the ten-month period in which the experiments were conducted. One of them developed "a moderately severe but extremely persistent bronchitis."

Within our population there are also an increasingly large number of individuals who already have chronic obstructive ventilatory disease—for example, asthma, bronchitis, and emphysema. In these diseases in which there is increased airway resistance, there appears to be an increased sensitivity to sulfur dioxide and sulfuric acid mists. Atmospheric levels of these substances which produce no apparent change in normal persons may be capable of producing measurable worsening of the airway obstruction in individuals whose lungs are already compromised.

Pollution levels in cities

Polluted air is a complex reactive mixture. It may be that it is the interactions between pollutants, or as yet undiscovered pollutants, or other factors such as rates of change of pollutant concentration which cause illness.

Our understanding of air pollution is still primitive and does not allow us to find the specific causes of illness. Still, if ordinary levels of air pollution do produce harmful effects, there should be evidence in urban populations of illness that is different in type or degree or mortality rates that are increased over those illnesses and mortality rates of rural populations. There have been extensive surveys of morbidity and mortality in urban versus rural populations. Studies of the prevalence of chronic bronchitis and its relation to residence have been done in great detail in Great Britain where chronic