Air Pollution and Asthmatic Attacks in the Los Angeles Area

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FOR THE PAST decade, the people of Los Angeles have been exposed to air pollution commonly known as smog. During the smog episodes, some persons complain of eye irritations and coughing. Several physicians in the area have noted that occasionally an asthmatic patient appears to be worse on smog days. To determine whether asthmatic attacks in a group of patients are related to community-wide air pollution, a study was undertaken in the Pasadena area in the fall of 1956.

Organization of the Study

The Pasadena area was selected for the study because (*a*) episodes of air pollution were frequent and severe, (*b*) continuous recording instruments for measuring air pollution were being operated by the Los Angeles County Air Pollution Control District in downtown Pasadena, and (*c*) several physicians had expressed interest in the effects of air pollution on their patients.

Five physicians practicing in or near Pasadena selected for the project 157 patients whom they were treating for bronchial asthma. Only patients who both resided and worked in or around Pasadena were included. Twenty of the patients selected, however, did not participate in the study for a variety of reasons including (*a*) patient had no telephone, (*b*) parent would not assist asthmatic child in completing the forms, and (*c*) patient did not understand what was wanted. The study group was not expected to be representative of the general population.

Characteristics of the study group are given in table 1. For most of the patients, it was not possible to determine from the data whether migration into the Los Angeles basin preceded the onset of bronchial asthma. Of those whose records were adequate, 13 were asthmatic before arriving in Los Angeles, and 49 became asthmatic after arriving in Los Angeles either by migration or birth. Even if residence and illness data were available in sufficient detail for all 137 patients, it would not be possible to assess the role of residence in the etiology of asthma because the role of other factors, such as selective migration, could not be ascertained.

Each physician sent a form letter to his selected patients asking for a report of the onset of every attack of asthma occurring from September 3 through December 9, 1956, a period which roughly corresponded to the smog season experienced in previous years. The patient mailed the reports each week to his physician, who, in turn, sent them to the study staff. Each week a member of the study staff telephoned patients for whom no records were received, ask-

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The study was directed by Lester Breslow, M.D., then chief of the bureau of chronic diseases of the California Health Department. The physicians who selected the patients were Drs. Walter R. MacLaren, Francis M. Pottenger, Jr., David T. Proctor, Willard S. Small, and Charles A. Wagner.

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ing them to supply the missing records. Approximately 20 percent of the study group had to be called each week. At no time was air pollution or smog mentioned to the patient.

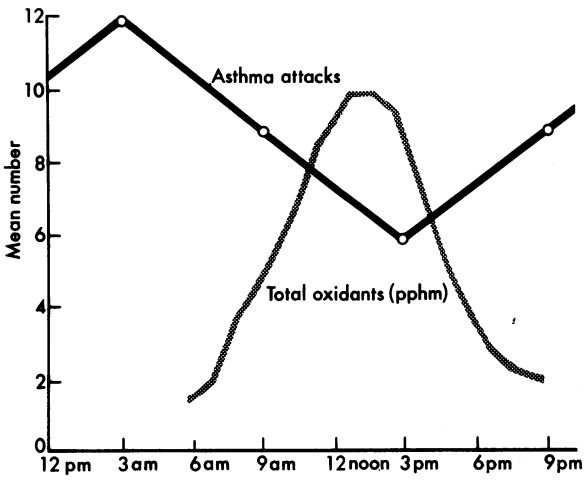
From the data supplied by the patients, all asthmatic attacks were coded for (*a*) time of onset (by 6-hour periods daily), (*b*) severity of attack, (*c*) address where attack began, and (*d*) patient's opinion as to cause of onset. Two criteria were used to determine the severity of an attack. First, the patient estimated whether the attack was mild, moderate, or severe. Second, the amount and type of medication needed to relieve wheezing was used to confirm the patient's opinion. Any episode which began outside the Pasadena area was excluded from the tabulation.

Air pollution and weather data, including total oxidants, particulates, carbon monoxide, temperature, and relative humidity, were supplied by the Los Angeles County Air Pollution Control District. Daily data on damage to plants were collected from a plant exposure-box located in a residential area of Pasadena. Pollen counts were taken as a special adjunct to this study by Dr. Willard Small. Because of technical problems, it was impossible to obtain a continuous record.

Table 1. Characteristics of asthmatic patients in the Pasadena study, September–December 1956

Characteristic	Total	Male	Female
Total	137	69	68
Age (years):			
Under 5	4	1	3
5–14	50	29	21
15–24	15	10	5
25–34	8	4	4
35–44	16	7	9
45–54	17	3	14
55–64	13	6	7
65 and over	14	9	5
Duration of asthma (years):			
Under 1	5	1	4
1	7	4	3
2–4	32	17	15
5–9	33	18	15
10 or more	60	29	31
Residence in Los Angeles basin (years):			
1	2	1	1
2–4	15	7	8
5–9	47	25	22
10 or more	73	36	37

Time of asthmatic attacks and levels of total oxidants, Pasadena study, September–December 1956



Findings

Midnight to 6 a.m. was the peak period for attacks of asthma. The peak in readings for air pollution, as measured by total oxidants, occurred between 10 a.m. and 4 p.m. (see chart).

The total number of attacks experienced during the period did not vary significantly by sex; 69 males had 1,697 attacks and 68 females 1,738 attacks. The average number of attacks during the study period varied with age. The group under 25 years of age had proportionately fewer asthmatic attacks than the group 25 years and over.

A large number of patients in the study had only a few days with asthmatic attacks. Of the 137 patients, 19 had no attacks, and 21 had only one to four attacks during the study. Fifty-two patients had fewer than 10 attacks each. At the other end of the scale, four persons had an attack every day of the study, and two others had attacks on more than 90 days.

For three-fourths of the attacks, the asthmatic patient stated that he did not know the nature of the precipitating factor (table 2). The patients attributed only 165 of their attacks (5 percent) to smog. In fact, they ascribed almost as many attacks to infection as to smog, weather, and temperature changes combined.

The patients characterized most of their attacks as mild; they considered only 5 percent moderate or severe. None of the 165 attacks reported to be precipitated by smog were severe and only 10 of them were moderate. The remainder were mild.

Analysis

The relationship of the daily number of patients who had attacks of asthma to daily levels of total oxidants, particulates, and carbon monoxide in the air was studied. No correlation (product-moment method) between any chemically measured maximum of air pollution and the daily number of patients affected was sufficient to explain a major fraction of the attacks. The coefficient of determination (r^2) between daily attacks and concurrent maximum oxidant readings was 0.14. Thus, in this instance, only 14 percent of the variation in the number of patients having attacks was associated with the variation in oxidant level.

To determine whether smog had a delayed effect in producing asthmatic attacks, maximum total oxidant levels were compared with the number of patients having attacks 6, 12, 18, and 24 hours later. In general, the lagged correlations were lower than concurrent correlations. The coefficient of determination between daily attacks and maximum oxidant readings taken 24 hours previously was 0.06. Thus, only 6 percent of the variation in number of persons having attacks was associated with variation in oxidant level occurring 24 hours previously.

Table 2. Precipitating factors and severity in asthmatic attacks, as stated by the patients, Pasadena study, September–December 1956

Subject	Number of attacks	Percent of total
Total	3, 435	100. 0
Precipitating factor:		
Unknown	2, 503	72. 9
Infection	326	9. 5
Temperature change [1]	176	5. 1
Smog [2]	165	4. 8
Exertion	123	3. 6
Allergens	72	2. 1
Emotional factors	70	2. 0
Severity:		
Mild	3, 266	95. 1
Moderate	128	3. 7
Severe	41	1. 2

[1] Includes 13 attacks attributed to weather changes.
[2] One patient with 95 days of attacks attributed 66 attacks to smog.

No significant correlation was found between number of persons affected and levels of carbon monoxide or particulates. Lagging did not increase the correlation. Transformations of the data did not improve the association between the pollutants and asthmatic attacks.

In an attempt to establish more homogeneous subpopulations, the patients were grouped by sex, age, duration of illness, and length of residence in the Los Angeles area. Coefficients of determination were obtained between daily numbers of patients having attacks and maximum total oxidant levels for these subpopulations. In no instance, on either a concurrent or lagged basis, did the coefficient of determination exceed 0.18, the value obtained for patients who had resided in the Los Angeles basin for 10 years or more.

A coefficient of multiple correlation was computed between oxidants on a given day and attacks on the same day and on the next day. Another was computed between attacks on a given day and oxidants on the same day and the preceding day. The order of magnitude of these correlations was still low. All correlations calculated led to the conclusion that there was relatively little association between oxidant levels and attacks of asthma.

Temperature, relative humidity, and water vapor pressure (a calculated measure of humidity independent of temperature) were correlated separately with number of persons having asthmatic attacks on a daily and on a 6-hour basis. Water vapor pressure was calculated by determining the saturation water vapor pressure and multiplying by the relative humidity. Correlations were lower than with oxidants. Lagging did not increase the magnitude of the correlations.

The coefficient of multiple determination (R^2) computed between number of persons having attacks as the dependent variable and total oxidants, temperature, and relative humidity as independent variables was 0.21. Thus, 21 percent of the variation in number of persons having attacks was explained by fitting the regres-

sion curve based on all three environmental measures.

The occurrence of asthmatic attacks and daily levels of oxidants were also compared on an individual patient basis. The mean number of patients having attacks on days with oxidant levels above the median oxidant level (13 pphm) was not significantly greater than the mean number on days with oxidant levels below the median. However, a comparison between the mean number of patients having attacks on days with oxidant levels above the level at which most persons have eye irritation (25 pphm) and the mean number on days with oxidant levels below this level was significant ($P=.05$). One inference which may be drawn from these data is that there may be a threshold level for oxidants above which there is a physiological response.

Since damage to growing plants (annual bluegrass) is used as a biological index of air pollution, agreement between the reactions of asthmatics and of plants was also tested. The number of persons having attacks on days with plant damage was significantly greater than the number on other days ($P=.05$). In one subpopulation, those persons living in the Los Angeles area 10 years or more, the number of patients having attacks on days with plant damage was highly significantly greater ($P=.01$). More detailed breakdowns—cross-classifying patients by sex, residence, and severity of illness—did not give consistent results.

The next step was to see whether some clue might be provided by those who do react. The total group might be masking the positive responses of a few smog reactors. Consequently, the daily response of each member of the study group was compared with the biological index of air pollution, plant damage. Eight persons whose attacks corresponded most often to days having plant damage were thus categorized as smog reactors and studied as a group. It was hoped that this group might have some other common characteristics, but none was evident except that seven of the group were females.

Although all the patients were under management by their physicians, it was not usually possible to determine whether or not individual asthmatic attacks were allergic in nature. The study depended entirely on the patient's account of his attack as recorded in his diary. This diary method obviously has severe limitations.

In view of the complexities of relating air pollution effects to the human biological system, there is need for much more work before the conclusions of studies such as this can be evaluated properly. We recommend that future studies in this area of asthmatic response to air contamination place greater emphasis upon clinical and laboratory evaluation.

Summary

During the autumn months of 1956, a study was undertaken in Pasadena, Calif., to ascertain the effect of community air pollution (smog) on persons having bronchial asthma.

One hundred and thirty-seven asthma patients under the care of five physicians maintained a daily record of each of their asthma attacks for 98 days. Total atmospheric oxidants, particulates, and carbon monoxide, relative humidity and temperature, and plant damage were measured concurrently.

The study indicated the peak period for attacks was midnight to 6 a.m., but the maximum oxidant levels were recorded between 10 a.m. and 4 p.m. Asthmatic attacks occurred with equal frequency among males and females.

Low positive correlations were found between chemical measures of air pollution and number of persons having attacks. Low correlations were also noted for temperature, relative humidity, and water vapor pressure.

A significantly greater number of persons had attacks on days with high enough oxidant values to cause eye irritation (25 pphm) than on other days as well as on days with plant damage.

Of the study group, it was decided to characterize eight as smog reactors because their attacks corresponded most often to days showing plant damage. These patients showed no other common characteristic, although seven of the group were females.

Environmental Health Training Program, 1961–62

All short-term technical courses in environmental health presented by the Public Health Service's Divisions of Occupational Health, Radiological Health, Engineering Services, Air Pollution, and Water Supply and Pollution Control from July 1961 through June 1962 are listed below. Additional information and application forms may be obtained from either the Chief, Training Program, Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio, or the appropriate regional office of the Department of Health, Education, and Welfare.

The facility or laboratory where each course is given is indicated by the following code:

DOH—Occupational Health Research and Training Facility, Cincinnati, Ohio.
SEC—Sanitary Engineering Center, Cincinnati, Ohio.
Rock—Radiological Health Laboratory, Rockville, Md.
Mont—Southeastern Radiological Health Laboratory, Montgomery, Ala.
Vegas—Southwestern Radiological Health Laboratory, Las Vegas, Nev.

1961

July 10–21: Advanced training for engineers and scientists from foreign countries (47S), SEC.
July 10–Sept. 8: Engineering aspects of radiological health (94R), SEC.
July 24–28: Recent developments in water bacteriology (4W), SEC.
Sept. 11–22: Basic radiological health (6R), Vegas.
Sept. 12–14: Milk pasteurization controls and tests (95M), SEC.
Sept. 20–22: Sampling and identification of aeroallergens (86A), SEC.
Sept. 25–29: Engineering management of nuclear emergencies (83R), Vegas.
Oct. 2–13: Community air pollution (53A), SEC.
Oct. 9–13: Determination of antibiotic and pesticide residues in dairy products (72M), SEC.
Oct. 9–20: Basic radiological health (6R), SEC.
Oct. 9–20: Industrial hygiene engineering (101O), DOH.
Oct. 9–20: Industrial hygiene chemistry (102O), DOH.
Oct. 16–27: Plankton identification and control (19W), SEC.
Oct. 23–27: Ion-exchange techniques for fluorides and mercury (103O), DOH.
Oct. 23–Nov. 3: Control of particulate and gaseous pollutants (85A), SEC.
Oct. 23–Nov. 3: Occupational radiation protection (15R), SEC.
Oct. 23–Nov. 3: Basic radiological health (6R), Rock.
Nov. 6–10: Radioactive pollutants in water (20WR), SEC.
Nov. 6–10: Medical X-ray protection (61R), Rock.
Nov. 13–17: Radionuclides in water (65WR), SEC.
Nov. 28–30: Training for occupational health nurse consultants (104O), DOH.
Dec. 4–15: Chemical analyses for water quality (3W), SEC.
Dec. 11–15: Medical and biological aspects of air pollution (68A), SEC.

1962

Jan. 8–19: Medical aspects of radiological health (50R), Rock.
Jan. 8–19: Industrial hygiene engineering (101O), DOH.
Jan. 8–19: Industrial hygiene chemistry (102O), DOH.
Jan. 15–26: Basic radiological health (6R), SEC.
Jan. 22–Feb. 2: Bio-oxidation of industrial wastes (73W), SEC.
Jan. 22–Feb. 2: Microscopic analysis of atmospheric particulates (71A), SEC.
Jan. 29–Feb. 2: Radioactive pollutants in air (39AR), SEC.
Feb. 5–9: Recent developments in water bacteriology (4W), SEC.
Feb. 5–9: Radioactive pollutants in water (20WR), SEC.
Feb. 12–16: Radionuclides in water (65WR), SEC.
Feb. 12–16: Laboratory examination of milk (2M), SEC.
Feb. 19–23: Laboratory examination of foods (9M), SEC.
Feb. 26–Mar. 9: Water quality management (1W), SEC.
Feb. 26–Mar. 9: Basic radiological health, (6R), Vegas.
Mar. 5–9: Analysis of atmospheric inorganics (54A), SEC.
Mar. 12–16: Methods and practices for State milk laboratory survey officers (70M), SEC.
Mar. 12–23: Analysis of atmospheric organics (55A), SEC.
Mar. 12–23: Sanitary engineering aspects of nuclear energy (35R), SEC.
Mar. 19–23: Radiological health for nurses (78R), Rock.
Apr. 2–6: Meteorological aspects of air pollution (90A), SEC.

Continued→

Apr. 9–13: Fundamentals of data processing (97S), SEC.
Apr. 16–20: Shellfish sanitation (44M), SEC.
Apr. 16–20: Radioactive pollutants in water (20WR), Mont.
Apr. 23–May 4: Community air pollution (53A), SEC.
Apr. 23–May 4: Basic radiological health (6R), SEC.
Apr. 23–May 4: Organic industrial wastes characterization (57W), SEC.
Apr. 23–May 4: Industrial hygiene engineering (101O), DOH.
Apr. 23–May 4: Industrial hygiene chemistry (102O), DOH.
May 7–11: Inorganic industrial wastes characterization (10W), SEC.
May 7–11: Heat stress and its control (105O), DOH.
May 7–16: Reactor safety and hazards evaluation (36R), SEC.
May 7–18: Solvent analysis techniques (106O), DOH.
May 7–18: Basic radiological health (6R), Rock.
May 14–25: Radionuclides in foods (59MR), SEC.
May 14–25: Atmospheric survey (84A), SEC.
May 21–25: Medical X-ray protection (61R), Rock.
May 28–June 1: Source sampling for atmospheric pollutants (89A), SEC.
June 4–15: Advanced training for sanitary engineer reserve officers, SEC. (Titles of three courses to be announced.)
June 11–15: Medical management of nuclear emergencies (92R), Vegas.
June 18–29: Aquatic biology for engineers (12W), SEC.

Courses in Care of Premature Infants

In the fall of 1961, the Institutes for Physicians and Nurses in the Care of Premature Infants at the New York Hospital-Cornell Medical Center, under the sponsorship of the New York State Department of Health and the Children's Bureau, will begin the 13th year of operation. These institutes are designed to meet the needs of physicians and nurses in charge of hospital premature nurseries and special premature centers, and of medical and nursing directors and consultants in State and local premature programs. The attendance at each institute is limited to six physician-nurse teams. The program for physicians is of 2 weeks' duration and that for nurses of 4 weeks' duration. Participants pay no tuition fee and stipends are provided to help cover expenses during attendance at the institute. Institutes for the 1961–62 year are definitely scheduled to start on the following dates: September 18, 1961; November 6, 1961; January 8, 1962; March 19, 1962; May 16, 1962. Early application for these institutes is essential since plans are contingent on the number of applications received.

Additional information may be obtained by writing Box 143, Institutes in the Care of Premature Infants, New York Hospital, 525 East 68th Street, New York 21, N.Y.

Federal Publications

Manual for the Microscopical Diagnosis of Malaria in Man. *PHS Publication No. 796; 1960; 80 pages; 50 cents.*

Microscopical detection of malaria parasites in stained-blood films is treated in detail in this completely revised manual, the first edition of which was printed in 1942.

Although malaria is no longer a problem in the United States, this country has a vital interest in the World Health Organization global program, the goal of which is worldwide eradication of malaria. The ability to diagnose the disease microscopically will continue to be of importance in this as in other countries as long as malaria exists anywhere in the world.

The manual contains 16 plates, more than half in color, depicting many stages of malarial parasites.

The Scientist in the Public Health Service. *PHS Publication No. 41; revised 1961; 29 pages; 20 cents.*

This recruitment brochure describes scientific programs in the Public Health Service and the professional people engaged in them. It is intended for young graduate chemists, physicists, microbiologists, mycologists, and specialists in other categories.

While the descriptions of the programs are general, several examples of typical scientific projects are given. Benefits, pay scales, and other civil service and commissioned corps recruitment data are presented.

Division of General Medical Sciences. *PHS Publication No. 757; 1961; 23 pages; 15 cents.*

This booklet outlines the division's grant programs for research in the sciences basic to medicine and biology, in public health, and in certain clinical sciences and its grant programs for research training and fellowships in the basic biomedical sciences. The division administers the General Clinical Research Center program and directs the NIH Center for Aging Research.

Fields of principal research emphasis by the division are discussed, such as developmental biology and chemistry of life processes, and different areas being given attention in the research training and fellowship programs, such as genetics, biophysics, and biomedical engineering.

Study sections, training committees, and the National Advisory Health Council are described in relation to the conduct of the division's programs.

Hope. The anchor of life. *Department of Health, Education, and Welfare Publication (unnumbered); 1960; 36 pages and supplement, 19 pages.*

A history and description of the organizations and programs within the Department of Health, Education, and Welfare, this booklet tells how the Department affects people in every community. It is intended to answer the most frequent inquiries about the Department's activities.

The Department's seven basic objectives are listed, and the Public Health Service, the Office of Education, the Food and Drug Administration, the Office of Vocational Rehabilitation, the Social Security Administration, and their major components are discussed.

Several pressing health and social problems or needs are briefly stated and résumés of projects to alleviate them are given. Supporting statistics are presented in the supplement.

Environmental Health Planning Guide. *PHS Publication No. 823; 1961; 58 pages.*

This publication is designed to assist official and nonofficial, professional, and lay community groups in evaluating present health-related services and facilities within a community from the standpoint of planning for future environmental sanitation needs.

Three chapters of the guide describe necessary preparation for the study, including financing and basic study needs; collection of data on sanitation services, health agency operations, planning agency, public sewerage and water, refuse collection and disposal, air pollution and housing; and utilization of data in developing conclusions and recommendations, preparation of a report, and putting recommendations into action.

The guide also includes typical map illustrations and a typical report format.

The Dentist in the Public Health Service. *PHS Publication No. 475; revised 1961; 6 pages.*

Designed as a recruitment brochure, this publication is aimed primarily at dental students, but is also of interest to practicing dentists.

It points out that dentists in the Public Health Service have an opportunity to engage in clinical dentistry, basic laboratory research, epidemiology, chronic disease studies, applied field research, radiological health, public health administration, and in other activities closely related to dentistry.

Listed are benefits enjoyed by career dentists in the Service, including complete medical care, annual and sick leave, opportunities for further training, and retirement benefits.

This edition supersedes the 1956 revision.

This section carries announcements of new publications prepared by the Public Health Service and of selected publications prepared with Federal support.

Unless otherwise indicated, publications for which prices are quoted are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Orders should be accompanied by cash, check, or money order and should fully identify the publication. Public Health Service publications which do not carry price quotations, as well as single sample copies of those for which prices are shown, can be obtained without charge from the Public Inquiries Branch, Office of Information, Public Health Service, Washington 25, D.C.

The Public Health Service does not supply publications other than its own.
