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AIR POLLUTION AND ITS RELATION TO PULMONARY DISEASE

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A review of the literature covering the past 50 years leads to the conclusion that there is a high degree of correlation between community air pollution and mortality and morbidity attributable to pulmonary disease. Generally air pollution affects those most who are least able to stand stress, that is, the over 65 years of age group, the under 1 year of age group, and the sick, especially those already afflicted with pulmonary illnesses. The air pollution incidents occurring in New York City from November 16–17 to November 22, 1953 and from October 15–17, 1957 in which excess deaths occurred are discussed in some detail.

It was, and in some respects still is, common to hear that there is no evidence that air pollution has any serious effects on health generally and on pulmonary disease specifically. It is almost 100 years ago, if one considers the »modern« scientific and medical literature that references (1, 2) began to appear relating air pollution to harmful effects on health. Some 60 years ago a few, among them *Ascher* (3) and *Mills* (4) influenced by *Ascher*, insisted that smoke tends to produce and aggravate pulmonary disease. *Ascher* in 1907 (5) noted that the increase in mortality attributable to acute pulmonary disease was greater in industrial than in agricultural districts. Over a period of 25 years this increase he said amounted to 100% for infants and in these districts the increase was most pronounced in those areas having the greater amount of smoke.

As long ago as 1895 *Cohen* (6) a British Chemistry Professor pointed out that a comparison of the health data for urban and rural areas indicated that life expectancy of urban dwellers was reduced for all age groups. *Cohoe* in 1911 (7) in the U. S. noted the higher incidence of death from pulmonary diseases in smoky areas as compared with smoke-free rural areas.

It is clear that many years ago a number of observers had commented on the harmful effects of air pollution on the health of human beings and particularly the higher incidence of pulmonary disease in areas with polluted air. Why then the reluctance to accept this as a fact and the

continual seeking of refuge behind a barricade of statistics in order to prevent the public and even relatively well informed people from learning this? Take for instance this statement from a California Report (7A) and compare it with the conclusions of *Mills* (8) based on virtually the same data.

»Selected respiratory deaths for all ages and cardiac deaths occurring in people 65 and over continue to be examined in relation to the available air pollution measurements and meteorological conditions. To date, no obvious association between periods of air pollution and deaths has been shown. Again, there is an association between air temperature and deaths.«

In a report (9) issued in July 1962 it was stated, »Detailed examination of mortality data by the staff and consultants of the State Health Department has turned up no proof that air pollution has caused deaths in California. Also, in no smog episode has acute illness directly related to smog been observed.«

Mills (8), however, concluded that there were almost 400 smog-correlated deaths a year in Los Angeles County in 1955, 1956, and 1957 and a direct relationship between maximum temperature and ozone (oxidant) concentration. This relationship existed for all temperatures from 46 to 104° F. The excess deaths he concluded could not be attributed to high temperature, except if it was greater than 96° F, because of low humidity.

The prior work of *Mills* has been severely criticized for failure to take into account other factors than air pollution but the virtually total absolution granted to smog by the California Health authorities seems to be equally suspect.

SOURCES AND MAGNITUDE

The principal cause of air pollution in a City like New York is the burning of fuel for heat, light, power, and movement of mass transportation. There are three factors that are involved in the intensity of pollution; these are: population density, the meteorology of the region, and the topography of the region. The amount of fuel consumed is then the capacity factor and the density of population, the meteorogical conditions or air stagnation on any given day and the topography form the intensity factor.

The amount of pollutants emitted to the atmosphere is proportional to the amount of fuel used. The amount of any given pollutant is an index of that pollutant source. For instance, sulfur dioxide is an indicator of fuel used for heat and power. Carbon monoxide is a measure of the amount of gasoline used, mainly by passenger vehicles.

There are two principal types of air pollution. These are generally characterized as (1) reducing but which I prefer to term acidic and (2) oxidizing. The first of these has as principal pollutants sulfur oxides,

mainly sulfur dioxide, suspended particulate matter, and smoke and the second of these has as principal contaminants organic compounds (usually termed hydrocarbons), nitrogen oxides, and ozone or oxidants.

All the known acute air pollution incidents, that is, the Meuse Valley (1930), Donora (1948), New York (1953), and London (especially 1952) have been associated with the »acidic« or »reducing« type of air pollution and one can include in this category the Poza Rica (Mexico) incident of 1950 which involved the escape of hydrogen sulfide from a petroleum refinery.

Just a few words about the magnitude of air pollution. More than 350 million tons of coal are used in he U. S. per annum and public utilities use about 170 million tons. There are about 70 million motor vehicles in the U. S. using 60 billion gallons of gasoline, diesel oil and LPG (Lignefied petroleum gas). In New York City, about 35 million tons coal-equivalent are used in New York City including about 13 million tons of coal, 3.5 billion gallons of fuel oil, 1.5 billion gallons of gasoline, 2.5 million tons of refuse and garbage.

Some idea of the amount of pollutants given off can be gathered from the facts that some 1.5 million tons of sulfur dioxide are given off to New York City air during a year (1/12 of the total domestic U. S. emission) and that since virtually all the gasoline sold in New York City is leaded some 7 million pounds of lead are emitted by motor vehicles to New York City air and streets each year (10).

DEFINITIONS RELATING TO PULMONARY DISEASE

Current studies show that the following diseases: (1) nonspecific infectious upper respiratory disease, (2) chronic bronchitis, (3) chronic constrictive ventilatory disease, (4) pulmonary emphysema, (5) bronchial asthma, and (6) lung cancer can be correlated with air pollution (11).

If you will permit me I will recall for you definitions relating to the middle four of these for one must remember that standardized definitions do not exist (12). In England, a patient is considered to have *chronic bronchitis* (13) when there is clinical evidence of a progressive affection of the bronchial tree with cough, expectoration, and dyspnea, the course of which is emphasized by exacerbations of the symptoms attributable to infection or to chemical or physical agents. More succintly it is defined as a disease characterized by a productive cough on most days for at least 3 months in a year for at least 2 consecutive years (14).

Chronic constrictive ventilatory disease is the term applied to a long continued nonspecific, respiratory condition in which the ventilatory defect of increased resistance appears to govern the clinical picture generally even though other symptoms or signs may also be present (11). This illness is called a variety of other names such as »chronic nonspecific respiratory disease,« » obstructive pulmonary,« and »obstructive

ventilatory disease,« and also »obstructive lung disease« (12) and »obstructive airway disease (15). Such diffuse obstructive pulmonary syndromes are measured by determining the maximum expiratory flowrate.

Pulmonary emphysema may be considered a physical breakdown of the lungs. The air sacs rupture and small air passageways collapse. Because these ruptured sacs retain air, it becomes more difficult for the person affected to breathe.

Asthma is a disease characterized by recurrent attacks of dyspnea attributable to a temporary change in the bronchial tubes or to a reflex spasm of the diaphragm. In most cases it is due to an allergic reaction.

BRITISH EXPERIENCE

Chronic bronchitis is a major disease in England. More than 10% of all deaths are assigned to this cause (16). It is the second major cause of death in men in the age group 40 to 55. As noted in the introduction, among the earliest citations to a relationship between urban air pollution and deaths from respiratory disease were those made in England. The »classic« example of an air pollution disaster is the London episode of December 5–10, 1952. More than 2,000 persons died in excess of the normal mortality. Original reports gave the number as 4000 excess deaths (17). In the succeeding 12 weeks an additional 8,000 deaths over the normal death number occurred (18). Many of these deaths were due to respiratory illnesses. Thus the deaths from pneumonia were four times higher and from bronchitis nine times higher than normal (see Table 1). The increase in mortality affected all age groups but those over 45 were affected most. The mortality for the new-born was doubled and for those infants aged one to 12 months the mortality more than doubled (17) (see Table 2). Between December 1 and 21, 1952, 22,201 people sought medical

Table 1

*Deaths from bronchitis and from pneumonia by age, London administrative county: weeks ended Dec. 6, 13, and 20, 1952**

Age (years)	Bronchitis			Pneumonia (at ages over 4 weeks)		
	Dec. 6	Dec. 13	Dec. 20	Dec. 6	Dec. 13	Dec. 20
Under 1	2	6	1	5	9	7
1–44	—	11	4	2	4	6
45–64	21	193	95	11	31	16
65 and over	53	494	296	27	124	96
All ages	76	704	396	45	168	125

* After W. P. D. Logan, Lancet, 1 (1953) 36

Table 2

*Deaths registered in London administrative county, by age: weeks ended Dec. 6 and 13, 1952**

	All ages	Under 4 weeks	4 wks. – 1 yr	AGE 1–14	15–44	45–64	65–74	75 and over
Dec. 6	945	16	12	10	61	237	254	355
Dec 13	2484	28	26	13	99	652	717	949
Ratio of week ended Dec. 13 to week ended Dec. 6	2.6	1.8	2.2	1.3	1.6	2.8	2.8	2.7

* After W. P. D. Logan, Lancet, 1 (1953) 336

treatment for symptoms referrable to the upper respiratory tract (19). On December 9, 1952 492 applications were received of which 390 cases were accepted by Emergency Bed Service in London. The increase in sickness was almost entirely due to respiratory disease (20) and as in the 1951–52 episode (21) the increase was due almost exclusively to those over 45 and under 5. The morbidity and mortality data of this episode indicate that those least able to bear additional stress were affected most severely (10).

There was a remarkable correlation between the intensity of pollution as measured both by sulfur dioxide concentration and suspended particulate matter as shown in Table 3. The maximum concentration of total suspended particulate matter was 4460 micrograms per cubic meter and 1.34 ppm of sulfur dioxide (22). For comparison the former value is 22 times the average New York City concentration of suspended particulate matter and 6 times the yearly average of sulfur dioxide in New York and 4 times the winter average.

One must not think that the 1952 incident in London was in isolated one for others of somewhat less severity occurred in December 9–11, 1873; in January 26–29, 1880; in December 28–30, 1892; in November 26 – December 1, 1948; and again in 1956, 1958, 1960, and December 1962.

One must also not conclude that such air pollution incidents are limited to London.

In February 1928 Manchester had 13 days of fog and the death rate rose to 34.4/1000 as compared with the »normal« annual rate of 13.2/1000. Other instances have occurred in Liverpool, Birmingham, Leeds, and Glasgow and in other cities in Great Britain. It has been shown, as another example, that similar trends are apparent for the sulfur dioxide concentration, the number of days showing weather temperature inversions and the number of deaths attributed to bronchitis in Sheffield in 1955 (23).

Table 3

*Deaths in greater London and constituent areas by date of occurrence, Dec. 1–15, 1952 (excluding any deaths occurring within these dates but not registered by Dec. 20). Atmospheric pollution readings at Kew observatory, Richmond (South-West London)**

Area	Deaths on December														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Greater London	259	301	321	288	406	581	894	910	792	543	528	484	501	449	425
London A. C.	112	140	143	120	196	294	513	518	430	274	255	236	256	222	213
Outer ring	147	161	178	168	210	287	381	392	362	269	273	248	245	227	212
Atmospheric pollution (mg per c. m.) max. reading	0.30	0.95	0.30	0.95	2.55	2.55	1.70	1.95	1.45	0.30	0.30	0.45	0.45	0.95	0.30

* After W. P. D. Logan: Lancet, 1 (1953) 336.

There are few papers dealing with the effect of air pollution on the very young. One of these namely the London incident of 1952 has already been mentioned. *Moncrieff* (24) pointed out that when there is an irritating atmosphere, namely, one that is smoky, foggy, dusty, too dry or too cold, there is a rise in admissions of small babies with »acute suffocative bronchitis.« He described these children as being dyspneic and choking and a stomach wash (which he regarded as an essential treatment) produced a filthy mixture of fog particles and mucus which probably represented swallowed sputum.

AMERICAN EXPERIENCE

There has been a real struggle in the United States to present proof of causal relationship between mortality and morbidity, particularly with respect to pulmonary disease, and air pollution. This struggle virtually reminds one of a trial in a court or for that matter of a TV trial, the major difference being that instead of producing evidence, that is the presentation of clues, a host of statistics are marshalled for presentation.

You have undoubtedly been aware of the incident at Donora and Webster, Pa., that occurred October 26–30, 1948. During this period the weather was foggy and raw, the wind velocity was low and there was a period of very stable weather. About 43% of the combined population of these towns, that is some 6,000 persons out of 13,000 were affected by the smog and were ill. The principal symptoms were first those affecting the respiratory tract and second those affecting the gastro-intestinal tract. The severity of the illness was not influenced by sex, race, occupation, length of residence in the area, or amount of physical exertion at the time of the incident. There was a direct relationship between the severity of the symptoms and increasing age. More than 60% of those over 60 years of age reported that they were affected to some extent by the smog and half of this group were severely affected. Twenty persons died in this incident, 17 on the third day; the ages of those who died ranged from 52 to 84 years with an average of 65 years (25).

Two additional impressive facts emerge from the initial and subsequent Donora studies. First, in Donora-Webster there were 340 out of the 13,000 (2.6%) who had bronchial asthma and 88% of these were made ill by the smog whereas only 43% of the general population were made ill. In addition, while only 10% of the general population had severe effects, 57% of the known asthmatics had severe reactions (11). Second it was found in a survey conducted ten years after this incident that the mortality of those who had reported that they were made ill at the time of the smog was greater during the ten year period than was the mortality of the group that said it was not affected (26).

The smogs of Los Angeles, in particular, and California in general are notorious and as I have mentioned in a prior section there have

been strong denials that there is any effect on the mortality of the residents in California or Los Angeles. In one respect, however, these denials have been tempered by caution.

In a study of 137 bronchial asthma patients in the Los Angeles area in 1956 that was carried on for 98 days, it was found that the peak period for the number of attacks occured from 12 midnight to 6 a. m. The maximum oxidant readings, however, occur in the 10 a. m. to 4 p. m. period. This particular report (7) stressed the difference in time but the original report pointed out that the average number of persons affected was significantly more when the daily oxidant value was high enough to cause the customary smog eye irritation than when the oxidant value was below the irritation inducing level (27).

There has been a marked increase in interest in the United States concerning the relationship of air pollution to pulmonary disease in the past five years. It will not be possible in this paper to cover all of these reports. For example, *Bower* (12) reported that a large number of people in the U. S. are subject to obstructive lung diseases of various degrees of severity. The crude death rate in the U. S. for chronic bronchitis, emphysema, and asthma combined has shown a steady increase since 1948. Death rates for persons past middle age have shown a considerable increase between 1945, 1950, and 1955.

Dohan and co-workers (28) have noted that there is a high correlation between the mean concentration of suspended particulate sulfate in city air and the incidence rates (mean of 3 years) of respiratory disease lasting for more than 7 days in women working in 5 cities. *Farber* and *Wilson* (29) stress that there is a relationship between chronic respiratory diseases and air pollution as well as lung cancer and air pollution. A group of investigators studying towns, one having more air pollution than the other (Seward and New Florence, Pa.) made an interim finding (30) that there was a statistically significant difference in the average airway resistance and airway resistance times volume between the two communities for each for persons over 30 years of age.

In the period from 1954 to 1959, deaths from bronchitis, emphysema and malignant tumors increased (+433.7, +158, and +36.1% change respectively) whereas those from asthma and tuberculosis decreased (—18.8 and —29.3), the total increase for respiratory diseases being 18.7% (31) (see Table 4).

So far we have spoken about what happened over in Europe and in Pennsylvania and in California. Can it happen in New York City? It has and it can.

I conducted an intensive investigation (32) of the November 1953 smaze incident rewriting and revising the data in the light of the new data which accumulated as the years passed. In 1957, I made a next to final major revision but this was never published. Since an altered version (33) of my original work was published in 1962, it is no longer

Table 4

Deaths from specific chronic respiratory diseases, United States, 1959

Cause of Death	Deaths 1959	Per cent distribution	Per cent change 1954–1959
Deaths from all causes	1,656,814	100.0	+ 11.9
Asthma	4,984	0.3	— 18.8
Bronchitis	2,705	0.2	+ 43.7
Emphysema	7,728	0.5	+158.0
Malignant neoplasms of respiratory system	38,185	2.3	+ 36.1
Trachea, bronchus and lung specified as primary	17,163	1.0	+ 54.1
Tuberculosis of respiratory system	10,627	0.6	— 29.3

Source: National Vital Statistics Division, Washington, D. C.

necessary to withhold the original data. The fact that there were excees deaths attributable to air pollution in this incident can be stated with 95% confidence.

From November 16–17th through the 22nd, 1953 an intense weather inversion formed and persisted over the Metropolitan New York Area. This caused a build-up of air pollution that reached a maximum on November 20th. The sulfur dioxide concentration reached a value of 0.86 part per million at 9 : 30 a. m. on that date and the total suspended particulate matter for that 24 hour period from noon November 19 to noon November 20 at Greenpoint, Brooklyn, was 33.45 tons per cubic mile. An analysis of the total deaths for the period from November 16 through November 24 for a number of years shows that deaths per day for this period in 1953 averaged 244 as compared with an average of 225 for the years 1951, 1952, 1954, and 1955. A statistical evaluation of the difference between the two means indicates that the probability that such an event could occur by chance is about one time in 100 instances, hence the correlation between the high air pollution and high deaths in the November 16–22, 1953 period is good. The pollution affected the age groups under 1 year and over 65 years the most. This is shown in Tables 5 and 6.

The manipulations of the statisticians in the revised version made the effect on those under 1 year of age somewhat less certain but both versions stress the effect on the older age groups. A further investigation (34) of this incident with respect to pediatric and adult clinic visits disclosed an increase in upper respiratory illnesses and cardiac visits at the four hospitals studied and these were significant at three of the 4 hospitals.

Table 5
City of New York deaths by day
November 16–24, 1951–1955
averages

Age Group Years	Average Deaths 1951–55	Average Deaths 1953	Difference 1953 – Average
Under 1	103	113	10
1– 4	23	18	—
5–14	14	9	—
15–24	20	14	—
25–44	148	163	15
45–64	694	726	32
65 and over	1028	1151	123
All ages	2029	2194	165

Table 6
City of New York deaths by day
November 1951 to 1956
65 years and over

Day	1951	1952	Avg. 1951–2	1953	1954	1955	1956	Avg. 1954–6
16	116	111	114	136	111	116	109	112
17	105	114	110	134	103	134	102	113
18	106	109	108	103	122	105	108	112
19	101	100	101	102	129	116	118	121
20	116	117	117	148	117	110	124	117
21	111	112	112	134	132	105	100	112
22	114	108	111	127	116	128	105	116
23	117	109	113	140	118	136	112	122
24	128	105	117	127	109	104	110	108
Total	1014	985	1003	1151	1057	1054	988	1033
Average for Period	113	109	111	128	117	117	110	115

I would not want one to think that this is the only such incident occurring in New York City. As in the case of London, New York City is plagued from time to time by intense weather inversions and in a number of these there have been serious health effects. I made an in-depth study (35) of another such incident in 1957 and 1958, namely a study of the air pollution incident of October 1957.

In October 1957, there was a marked increase in the number of deaths in the City of New York. This increase was attributed to Asiatic flu.

In the period October 15th through the 17th there was an intense weather inversion in the Metropolitan New York area. This inversion caused a build-up of air pollution in the City. There was a definite increase in the number of deaths over and above those attributable to the influenza epidemic during this period of high atmospheric pollution. The average number of deaths for October for the years 1951 through 1956 was 216. The average number of deaths for October, 1957, was 277. The number of deaths rose to a maximum of 343 on October 16. The average for the three day period of intense air pollution was 319. Thus for the three day period there was an excess of 122 deaths. This is shown in Tables 7 and 8.

Table 7

City of New York deaths by day

Date	October 1957	October 1951–1956
13	268	211
14	295	228
15	309	218
16	343	215
17	307	216
18	291	216
19	279	212
20	268	213
21	256	214
22	289	214
23	255	215
24	266	221

In 1958, I made an investigation of deaths of the under 1 year of age group, of deaths of the over 65 years of age group, and of deaths attributed to bronchitis and pneumonia and attempted to correlate these deaths with high air pollution as expressed by a factor which I termed a chemical air pollution index (36). These data are presented in Tables 9, 10 and 11. Inspection of these data shows there is little correlation between the maximum number of deaths on any given day of high pollution in most months of 1957 but that in many instances the number of deaths for each category on the days of high pollution exceeded the average number of deaths for the corresponding month.

It is necessary to mention two other aspects of the relation of air pollution to pulmonary disease. These are (1) the asthma diseases noted in New Orleans (37) and Yokahama or air pollution asthma (38) and

Table 8

City of New York deaths by day
October 1957

Date	Deaths Under 1 Yr.	Deaths Over 65	Deaths from Pneumonia and Bronchitis	Deaths from Asthma, Respiratory Tuberculosis and Lung Cancer	Total Deaths from Respective Ailments	Total Deaths	% of Deaths Due to Respiratory Ailments
15	16	168	29	18	47	309	15.2
16	8	190	28	9	37	343	10.8
17	17	171	21	14	35	307	11.4
18	20	147	30	19	49	291	16.8
19	13	139	24	11	35	279	12.5
20	10	132	17	13	30	268	11.2
21	8	140	22	11	33	256	12.9
22	16	154	20	14	34	289	11.8
23	10	142	12	11	23	255	9.0
24	13	139	28	13	41	266	15.4

Table 9

Days of highest pollution (City of New York)

1957	Date	Pollution*	Deaths (Under One Year)		
			On Date Specified	Max. for Month.	Avg. for Month
Jan.	21	13.84	14		
	22	9.81	8	18	12
	10	9.80	14		
	13	9.05	8		
Feb.	25	8.45	15		
	4	7.38	15	21	12
	26	7.25	11		
Mar.	14	7.20	13	17	11
Apr.	26	7.25	9	19	11
May	13	8.25	15	16	11
	9	7.30	11		
June	27	6.35	10	19	12
	26	5.15	7		
July	26	5.45	7	17	10
Aug.	29	4.73	11	17	10
Sept.	30	8.99	12	16	11
Oct.	16	17.95	8		
	17	9.41	17	20	14
	15	7.29	16		
	23	7.12	10		
Nov.	13	16.45	6	17	11
	19	5.31	12		
Dec.	16	7.49	10		
	24	7.22	15	24	12
	30	6.99	14		

* Above 1.0 is a day of relatively high pollution.

(2) pulmonary disease attributable to metals in the ambient air. The most spectacular of the latter are beryllium disease (39), and the effect of manganese (40) on epidemics of pneumonia. One other aspect that requires mention is that the alveolar membrane is an important reactor to antigens which air pollution supplies (41). It is beyond the scope of this paper to discuss these.

Table 10

Days of highest pollution (City of New York)

1957	Date	Pollution	Death (Over 65 Years)		
			On Date Specified	Max. for Month	Avg. for Month
Jan.	21	13.884	143		
	22	9.81	145	161	139
	10	9.80	144		
	13	9.05	123		
Feb.	25	8.45	152		
	4	7.38	140	170	130
	26	7.25	127		
Mar.	14	7.20	112	147	122
Apr.	26	7.25	136	146	126
May	13	8.25	111	146	118
	9	7.30	128		
June	27	6.35	112	263	129
	26	5.15	112		
July	26	5.45	118	178	115
Aug.	29	4.73	96	124	101
Sept.	30	8.99	129	134	115
Oct.	16	17.95	190		
	17	9.41	171	190	145
	15	7.29	168		
	23	7.12	142		
Nov.	13	16.45	157	157	132
	19	5.31	152		
Dec.	16	7.49	139		
	24	7.22	129	174	138
	30	6.99	141		

CONCLUSION

Any unbiased review of the literature over the past 50 years, unobfuscated by statistical analysis, must lead one to the conclusion that there is a high correlation between community air pollution and mortality and morbidity attributable to pulmonary disease. Generally air pollution affects those most who are least able to stand stress, namely, the over 65 years of age group, the under 1 year of age group, and the

Table 11

Days of highest pollution (City of New York)

1957	Date	Pollution	Deaths (pneumonia and bronchitis)		
			On Date Specified	Max. for Month	Avg. for Month
Jan.	21	13.84	10		
	22	9.81	11	15	11
	10	9.80	15		
	13	9.05	12		
Feb.	25	8.45	4		
	4	7.38	20	20	11
	26	7.25	5		
Mar.	14	7.20	8	16	9
Apr.	26	7.25	8	15	9
May	13	8.25	6	14	8
	9	7.30	7		
June	27	6.35	13	18	9
	26	5.15	8		
July	26	5.45	3	13	7
Aug.	29	4.73	6	12	6
Sept.	30	8.99	11	11	7
Oct.	16	17.95	28		
	17	9.41	21	34	20
	15	7.29	29		
	23	7.12	12		
Nov.	13	16.45	9	20	12
	19	5.31	11		
Dec.	16	7.49	16		
	24	7.22	14	21	13
	30	6.99	12		

ill especially those who have pulmonary illnesses. Though we need desperately more intensive investigation of the relation between air pollution and pulmonary disease, that is how air pollution causes these diseases, not if it causes them, we need even more desperately active measures to control and mitigate the amount of pollutants that foul the air we must breathe.

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Sadržaj

VEZA IZMEĐU ONEČIŠĆENJA ATMOSFERE I PLUĆNIH OBOLJENJA

Glavni uzrok onečišćenja zraka u gradu kao što je New York je izgaranje goriva za dobivanje topline, električne struje i svjetla, te teretni transport. Postoje tri faktora koji utječu na jačinu onečišćenja zraka. To su 1) gustoća naseljenosti, 2) meteorologija i 3) topografija područja. Količina potrošenog goriva je, dakle, faktor kapaciteta, a gustoća naseljenosti, meteorološki uvjeti ili stagnacija zraka pojedinog dana zajedno s topografijom sačinjavaju faktor intenziteta.

Težina onečišćenja otpuštenog u atmosferu je proporcionalna težini upotrijebljenog goriva, a težina nekog određenog onečišćenja je indeks tog izvora onečišćenja. Tako je količina sumpornog dioksida u zraku proporcionalna gorivu utrošenom za dobivanje topline i električne energije. Količina ugljičnog monoksida u zraku je mjera za količinu upotrijebljenog benzina (uglavnom putnička vozila).

Postoje dva glavna tipa onečišćenja atmosfere, obično okarakterizirana kao 1) *reducirajući*, koji radije nazivam *kiselim* i 2) *oksidirajući*. U prvi se kao glavna onečišćenja ubrajaju sumporni oksidi – pretežno sumporni dioksid, aerosoli i dim, a drugi sadržava kao glavne zagađivače organske spojeve (pod općenitim nazivom »ugljikovodici«), dušikove okside i ozon ili oksidanse.

Svi poznati akutni ili veći slučajevi onečišćenja atmosfere, kao oni u Meuse Valley (1930), Donori (1948), Londonu (1952, 1962), New Yorku (1953), smatraju se »reducirajućim« ili »kiselim« tipom onečišćenja.

Sadašnja istraživanja pokazuju da se u vezu s onečišćenjem zraka mogu dovesti ove bolesti: 1) nespecifične zarazne bolesti gornjih respiratornih organa, 2) kronični bronhitis, 3) kronična konstriktivna bolest plućne ventilacije (kronična nespecifična respi-

ratorna bolest, opstruktivna bolest pluća), 4) plućni emfizem, 5) bronhijalna asthma i 6) rak pluća.

Prikazani su neki podaci o »smogu« u Velikoj Britaniji. Ukratko je iznijet slučaj u Donori u listopadu 1948. godine. Značajno je da onečišćenje atmosfere ima dugotrajan učinak, jer su ispitivanja izvršena 10 godina nakon slučaja u Donori pokazala da je u desetgodišnjem periodu smrtnost onih koji su oboljeli za vrijeme smoga bila veća od smrtnosti onih koji nisu bili bolesni. Neka druga iskustva stečena u Americi također su kratko iznijeta.

Autor je izvršio opširno istraživanje slučaja onečišćenja zraka u New York Cityju u studenomu 1953.

U razdoblju od 16–17. studenoga došlo je do jake inverzije nad metropolitanskim područjem New Yorka, koja je potrajala do 22. studenoga 1953. i uzrokovala gomilanje onečišćenja atmosfere koje je doseglo maksimum 20. studenoga. U pola deset ujutro tog dana koncentracija sumpornog dioksida dosegla je 0,86 ppm, dok je koncentracija ukupnih aerosola za taj 24-satni period od podneva 19. do podneva 20. studenoga u Greenpointu u Brooklynu iznosila 3,45 tona na kubičnu milju.

Analiza ukupnog broja smrtnih slučajeva u razdoblju od 16. do 24. studenoga za nekoliko godina pokazuje da je prosječni broj smrtnih slučajeva u jednom danu u tom periodu u 1953. iznosio 244, dok je prosjek u 1951, 1952, 1954. i 1955. bio 225. Statistička ocjena razlike između ova dva prosjeka pokazuje da je vjerojatnost jedan prema stotinu da do ovakve pojave dolazi slučajno, pa je korelacija između jakog onečišćenja atmosfere i velike smrtnosti u razdoblju od 16–22. studenoga 1953. dobra. Onečišćenje je pogodilo dobne skupine ispod jedne i iznad 65 godina starosti. Dalja ispitivanja ovog slučaja, provedena u 4 klinike za djecu i odrasle, otkrila su u sve 4 bolnice porast učestalosti bolesti gornjih respiratornih organa i srca, koji je bio statistički značajan u 3 bolnice.

U listopadu 1957. u New Yorku je zabilježen značajan porast broja smrtnih slučajeva. Ovaj porast je pripisan azijskoj gripi. U razdoblju od 15–17. listopada došlo je do jake inverzije u metropolitanskom području New Yorka, koja je uzrokovala nagomilavanje onečišćenja atmosfere nad gradom. Broj umrlih je očito prerastao broj smrtnih slučajeva koji se mogu pripisati epidemiji gripe za vrijeme ovog onečišćenja atmosfere. Prosječni broj umrlih u listopadu u godinama 1951–1956. iznosio je 216, dok je prosječni broj smrtnih slučajeva u listopadu 1957. bio 277. Broj smrtnih slučajeva dosegao je 16. listopada maksimum od 343. Prosjek za trodnevni period jakog onečišćenja bio je 319, tako da su u ovom periodu bila 122 smrtna slučaja iznad prosjeka za taj mjesec.

Godine 1958. istraživao sam smrtnost djece ispod 1 godine starosti, odraslih iznad 65 godina starosti i smrtnost pripisanu bronhitisu i upali pluća, pa sam pokušao dovesti te smrti u vezu s jakim onečišćenjem atmosfere izraženim faktorom koji sam nazvao indeksom kemijskog onečišćenja atmosfere. Ovi podaci pokazuju da postoji mala korelacija između maksimalnog broja smrtnih slučajeva u dane jakog onečišćenja i indeksa onečišćenja u većini mjeseca 1957, ali da je u mnogo slučajeva broj umrlih u svakoj od spomenutih grupa na dane jakog onečišćenja bio veći od prosječnog broja smrtnih slučajeva u odgovarajućem mjesecu.

Pregled literature za prošlih 50 godina navodi nas na zaključak da postoji veliki stupanj korelacije između onečišćenja atmosfere i smrtnosti i oboljenja od plućnih bolesti. Onečišćenje, uglavnom, pogađa one koji su najmanje otporni, tj. starije od 65 godina, mlađe od 1 godine i bolesne, osobito one koji već boluju od plućnih bolesti.

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