A CONTRIBUTION TO THE STUDY OF METEOROLOGIC STATES ETIOLOGICALLY RELATED TO INFLUENZA EPIDEMICS.

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MODERN authorities do not lay any particular stress on the relationship of atmospheric and telluric conditions to the spread and virulence of influenza; the fact nevertheless remains, that the most severe and widespread epidemics occur in winter. The preponderance of these epidemics in this season is best shown by comparing the percentages. December, January and February are credited with about 36 per cent. of the total epidemics; while June, July and August show only 15 per cent. Then again, the epidemics in winter are much more universal and are accompanied by more complications and sequelæ.

Meteorologic states must, therefore, have some relation to influenza. But the study of this relationship is such an intricate and perplexing problem that the mind is apt to become bewildered. Yet in the light of our present knowledge of the etiology, it does seem impossible to select those atmospheric conditions which rationally may be factors. Only recently Anders (*Philadelphia Medical Journal*, August 19) attempts to discover by a careful study of meteorologic data this relationship, but arrives at no conclusions. His suggestion that a moist soil

may be a good breeding place for the influenza bacilli is opposed by the characteristics, as to growth and activity, of that particular organism.

Meteorologic conditions may have a causative relation by influencing the cultivation and growth of the influenza bacillus, or by the augmentation of individual susceptibility. Each of these methods requires consideration.

The atmospheric state must be studied: first, as it exists naturally; and second, as it is modified in dwelling places. The former has been studied more or less and the conclusions are indefinite and contradictory. Thus high barometric pressure, dryness of the air, and fog have been associated with one epidemic, and have been absent in others. Let us study the usual conditions in buildings during or preceding an epidemic.

This atmospheric condition varies according to external and internal states in temperature and humidity. The temperature variations even in our extreme weather are not great. The extremes may be put between 60 and 80 degrees. Certainly, one would look in vain to find in this a factor. But in order to obtain this temperature the air in our dwellings is made stagnant; that is, very little communication is held with the external air.

During our severe winter days the atmosphere in our buildings and residences is more or less stationary, and free circulation with the telluric atmosphere is almost entirely prevented. Now this is an extraordinary difference between severe winter and summer conditions. Let us see if it can be connected in any way with the spread of influenza.

The influenza bacillus has certain peculiarities which makes it very susceptible to surrounding conditions. According to Pfeiffer the bacilli rapidly perish in water, and are exceedingly sensitive to drying. Then, too, they do not develop at a low temperature, and no growth occurs below 70° or 75° F. The contagion is not conveyed by the outside atmosphere, but by particles of moist secretion thrown into the air by the coughing and sneezing of an influenza patient. Finkler has sufficiently upset the miasmatic origin of the disease ("Twentieth Century Practice"), and with the knowledge of the specific micro-organism and its peculiarities, the miasmatic nature of the influenza contagion is almost absurd.

Those conditions of the air which retain the bacilli active and allow a concentration of the number of germs are favorable to the virulence of the contagion.

It is obvious that this atmospheric state does not occur in summer, with the dry air and the free atmospheric circulation through our dwellings; but in winter, when all the doors and windows of our buildings are closed and the air is moist and warm within them, the condition is favorable for the infection of individuals.

The dissemination and spread of the disease is carried on by individuals sick with the disease and fomites, as Finkler has brilliantly demonstrated. The spread of the epidemic follows the excursions of commerce. The original origin may be obscure, but whenever a virulent type of micro-organism commences to attack individuals its spread may be closely watched. The short incubation period and the universal mingling of thousands of individuals

daily in our business centers is sufficient to explain the rapidity of its dissemination without resorting to mystic miasmata. This spreading is very much favored by the stagnation of the air in our dwellings. The department stores, theaters, office buildings, schools and other public places become the supply stations for the rapid importation of the disease into our homes.

In December of 1898 the epidemic raged in the Eastern States, and became epidemic here in January, 1899. The germ, no doubt, was carried here by some travelers. It was slowly distributed at first, but soon a sufficient number were attacked to cause an almost universal dissemination. For example, a drummer gives the disease to two or three employees in a store; in a few days they are attacked, but so frequently men, and women too, continue their work. The store in which they work is warm and the entrance closed by double doors. These employees cough and sneeze, and fill the room more or less with the contagion. The customers arrive and breathe the hot, contaminated air and carry the disease home. In summer there exists a free circulation, and the coughed particles are quickly dispersed throughout the atmosphere, and the bacilli are desiccated.

At the theaters half a dozen individuals may cough sufficiently to fill the stagnant air with bacilli, and hundreds are thus infected in one evening. At the schools, also, one pupil is capable of infecting almost the whole school in a few hours of coughing and sneezing. And in all places it is the warm, stagnant, moist air which becomes the predisposing atmospheric condition.

When the number of cases is large and many of our shoppers, clerks and salesmen are attacked, the storehouse must necessarily become teeming with germs, and in this concentration very few individuals can resist the onslaught. On a heavy shopping day the whole city may thus become infected.

The atmospheric conditions during the last epidemic, January and February, 1899, in St. Louis, were favorable for the propagation of the contagion in the manner outlined. During December a few isolated cases occurred in various parts of the city, but the maximum number of new infections took place in the early part of January. On the fifth day of this month the temperature fell from a daily mean of 41 degrees to 22 degrees. But what is more important, the daily maximum fell from 57 degrees—a temperature which still allows considerable ventilation—to 27 degrees. From the 5th to the 12th day of the month the daily maximum did not rise above 42 degrees, and the daily mean was much lower. During this time the greatest number of infections took place. The next period for dissemination occurred in the latter part of January, when the daily mean fell below 20 degrees, and the daily maximum below 30 degrees. It will be readily seen that such temperatures are not conducive to ventilation. Snow and wet weather preceded these cold periods. Such days limit the amount of daily intercourse, shopping, business, and theaters. But following these wet days a rush of activity in all public buildings is the custom and the contagion spreads rapidly during the cold days.

The following are cases of infection from actual observation:

A lady from the country visited her daughter in the early part of January. On the 6th day of the month she and her daughter went shopping; on the evening of the 9th the daughter had marked symptoms of influenza, while the mother revealed the symptoms the following day. No other exposure existed.

Here is an illustration of the infection at a theater: A lady and her two children attended the matinee about January 7th. Three days later, almost simultaneously, both children showed characteristic signs. The husband, working daily in store-houses, is very apt to bring the disease home.

A family consisting of husband and wife and two daughters were attacked January 8th. It was shown that the husband had the disease for a few days previous.

In another family the husband suffered from a mild grippal pharyngitis and a few days later his three children showed evident signs of grippe.

These cases could be multiplied. It is exceedingly common for the father to infect his home.

Another common source is the pupil at school. The following are illustrations:

A family composed of father, mother and three children were infected by the boy that attended school. He was attacked January 8th. Following him the other members of the family were successively infected.

In another family composed of mother and three children, January 10th the school-boy presented some typical symptoms. He was sneezing and a mild cough developed. A few days later the other two children showed typical symptoms.

As showing that the concentration of the poison apparently has a marked effect, the following is instructive:

The patient was myself. I had visited and revisited patients during January and February, but always remained in the room only a few minutes. In the latter part of February one day I visited a colored family consisting of three women and seven children, nearly all of whom had influenza. The air was stifling hot and not a little ventilation had been permitted by the mother for days, for fear of giving the inmates cold. I remained in this room about one hour examining all the inmates. Three days later I succumbed to a severe form of the disease.

Besides the condition above considered, the relative humidity in buildings has some bearing. A dry air would rapidly desiccate the infective particles and thus soon render them harmless, while in an air saturated with moisture the particles would remain moist for hours, clinging to the numerous dust particles in a room. In all buildings where many people congregate the air soon becomes charged with vapor from expiration and evaporation; consequently the crowded buildings again become favorable places for bacterial supply. In residences, however, the method of heating influences the amount of humidity and saturation is more uncommon. The dryest rooms are those heated by the hot-air furnace. When outside air at a temperature of zero is raised to 65 degrees, even if almost saturated outside, it will contain a relative humidity of only 8 per cent. in the building. This exceedingly dry air is more or less fatal to the bacillus of influenza. Moreover, the currents of air pro-

duced by the hot air entering convey the desiccated germs from the room. It follows that a building heated in this way will not become a hotbed of infection.

Buildings heated by the steam or hot-water radiators have little ventilation and the air within them becomes slowly saturated with moisture. It will be seen that atmospheric conditions in our dwelling places depend on many modifying influences.

The hot, moist, and stagnant air filled with carbon dioxid has an anesthetic effect on the mucous membrane of the respiratory tract which increases the susceptibility of the person; and it is still an open question whether the cold atmosphere or the hot stifling foul air becomes the most potent predisposing factor in respiratory disease.

Closely connected with the influenza epidemic are several varieties of micro-organisms, particularly the streptococcus pyogenes and diplococcus lanceolatus. In poorly ventilated rooms these may also become proportionately augmented in number. They are found in the dust which permeates the air, and in direct proportion to the stagnation become dangerous. This has been particularly observed in the Bethesda Foundling Home, in which diseases of the respiratory organs become more or less frequent, according to the deficiency of ventilation. When all the windows must be closed in order to maintain the proper temperature bronchitis, pharyngitis, and pneumonia are common. It has been found very effective at these times to thoroughly fumigate the nurseries. In this way the complications of influenza have been enormously reduced in virulence and number. This

fact has been repeatedly demonstrated, so that little or no doubt can exist of its effective action.

Electrical influence, it may be stated, also varies outside and inside. We know that positive electricity is greatest in amount during high barometric pressure, and strongest in winter. So it is only incidental to other conditions mentioned. In buildings there is usually an absence of positive electricity; at least none exists in the air; but during the cold days in those buildings in which the air becomes very dry strong electrical influences are usual. A person walking across a dry carpet, by friction of his shoes on the carpet becomes charged with positive electricity. Sparks fly every time he touches or comes very near an electric conductor. But it is questionable that this electricity has any potency in an epidemic.

The study of cold as a predisposing cause by increasing the susceptibility must not be ignored. But its value as such a factor is dwindling more and more as our studies in pathology advance. In the last influenza epidemic it was a significant fact that those persons who spent much of their time outdoors had a milder attack than those who remained indoors constantly. Persons received a severe infection of this disease who had not left the warm house for weeks. And it really seemed beneficial for a patient —at least in the milder attacks—to breathe cold air. Nevertheless, one cannot deny that a sudden exposure causing a general depression of cellular activity may aid in precipitating an attack.

The conclusion of this study is as follows: Influenza is a contagious disease transmitted by infected particles in the air, and its transmission is fully expli-

cable on the grounds of non-ventilated rooms and the great variety of human intercourse. The meteorologic states favoring the extension of an epidemic are those that insure stagnant and foul air in public buildings.