THE INFLUENCE OF ATMOSPHERIC CONDITIONS ON THE MORTALITY OF INFANTS SUFFERING WITH GASTRO-INTESTINAL DISORDERS

A STUDY OF THE SUMMERS OF 1910, 1911 AND 1912 IN ST. LOUIS *

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Description of Charts: The heavy upright lines in the charts (pp. 321-2-3) represent the total number of deaths from non-surgical disorders and diseases of the gastro-intestinal tract which occurred among infants in the first two years of life in St. Louis on each day of the months May, June, July, August and September of the years 1910, 1911 and 1912 (deaths in the first week of life were not included). Each horizontal space denotes one death. The numerals at the left and right margins refer to degrees of heat and relative humidity and also to average miles per hour of wind velocity.

The heavy horizontal line represents the mean of the daily maximum and minimum temperatures.

The shaded horizontal line represents the mean relative humidity for each day as determined by averaging the relative humidity at 7 a. m. and 7 p. m.

The horizontal line at base of charts represents the average wind velocity per hour for each day.

(Temperature, relative humidity and movement of air were computed from records at the U. S. Weather Bureau at St. Louis. Deaths were compiled from death certificates at the mortuary office of the St. Louis Health Department.)

As for humidity, the charts for St. Louis seem to coincide with studies conducted in other cities, notably those of Willim for Berlin and Breslau; in none could a definite relation between humidity and summer deaths among infants be shown.

The St. Louis charts show that quite often the most intimate relation between heat and deaths may exist during periods of low humidity; an instance of this may be seen in the rise of the death-curve in Chart 1 (1910), which set in about the middle of June, when the humidity was low, and remained low until the death-rate had acquired its usual summer level. This is still more strikingly seen in Chart 2, the excessive heat of 1911 continuing throughout June and July, presenting the highest death-curves of the three summers and being attended by a singularly low relative humidity. (In corroboration, it was interesting to find that curves taken in New York City during the past several summers show also that a low humidity often accompanies a high death-rate in the presence of high temperatures.) Instances illustrating the converse of this proposition are found several times in these St. Louis charts and

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show that the death-rate may be surprisingly low during excessively moist periods, even when the temperatures were high. Elevations of temperature above 71 or 72 F. were, as a rule, soon followed by a rising death-curve regardless of the presence or absence of high relative humidity.

As for the influence of heat on infant deaths from gastro-intestinal disorders, a glance at any charts of this sort will show at once that a strong relation exists; there is an obvious although imperfect parallelism between the temperature-curve and the death-curve. It was chiefly for the purpose of studying this relation that the present work was undertaken.

The nature of the influence of high temperatures on infant deaths, of those infants particularly who are suffering from gastro-intestinal disturbances, is far from clear. A view which has attracted a considerable amount of attention during the past two years is based on the assumption that heat may produce so profound an alteration of metabolism as to be followed within a few hours by death. This so-called "heat-stroke" theory was evolved not from clinical observation, but from the study of mortality charts such as are here presented; they differ from these, however, in the very salient fact that for the most part 2:00 p. m. temperatures or maximum temperatures were used, whereas in the St. Louis charts, mean temperatures for each twenty-four hours were selected.

In the case of adults, heat-stroke is clinically well known, and similar if not identical conditions have been produced experimentally in monkeys by exposing them to the sun (Aron, Philippine Islands); among infants, however, heat-stroke has not been commonly diagnosed, and if the contention made by Liefmann and Lindemann, the originators of this theory, is correct, many deaths which have been ascribed to toxic degenerations of liver or heart or to alimentary intoxications were, to be more accurate, heat-strokes.

In order to study the acute rises in deaths coincident with similarly acute rises in temperature, Liefmann and Lindemann used the terms "death-peaks" and "heat-peaks." In the present study an "heat-peak" was assumed to be the summit or climax of any ascending daily mean temperature, starting at not less than 70 degrees. During the summers 1910, 1911 and 1912 such "heat-peaks" occurred in St. Louis forty-one times; "death-peaks" coincident with these "heat-peaks" occurred in nine, 22 per cent., of instances; or, to place it the other way 'round, coincident with 78 per cent. of the "heat-peaks," the death-curve either remained stationary or dropped.

According to Finklestein, Klose and others, a more striking effect of high temperatures may be observed on the day following the summit of the heat-wave. This I found to be the case in 24 per cent. of instances; lastly, the third day was represented by 15 per cent. Further than this

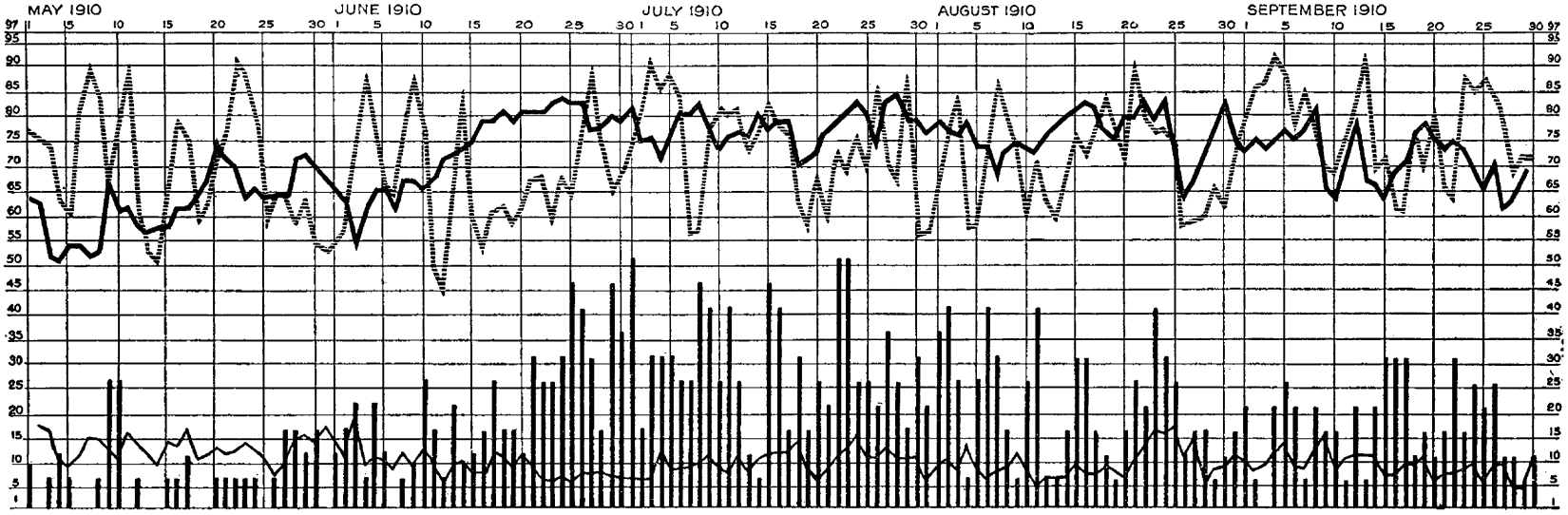

Chart 1

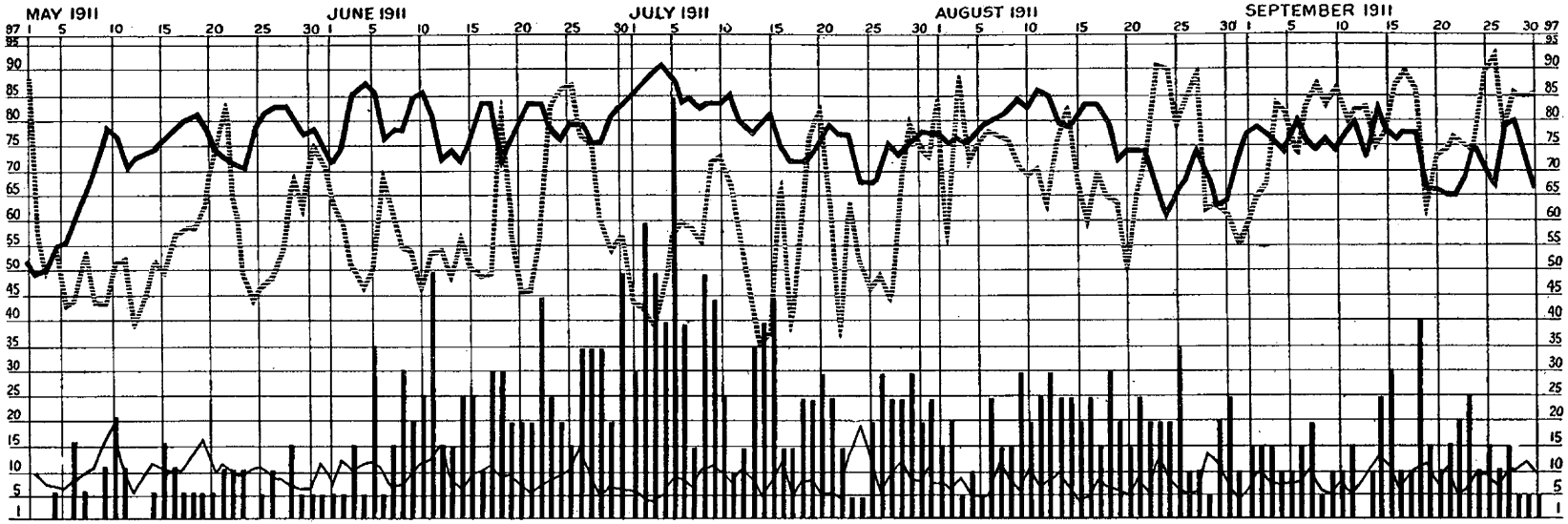

Chart 2

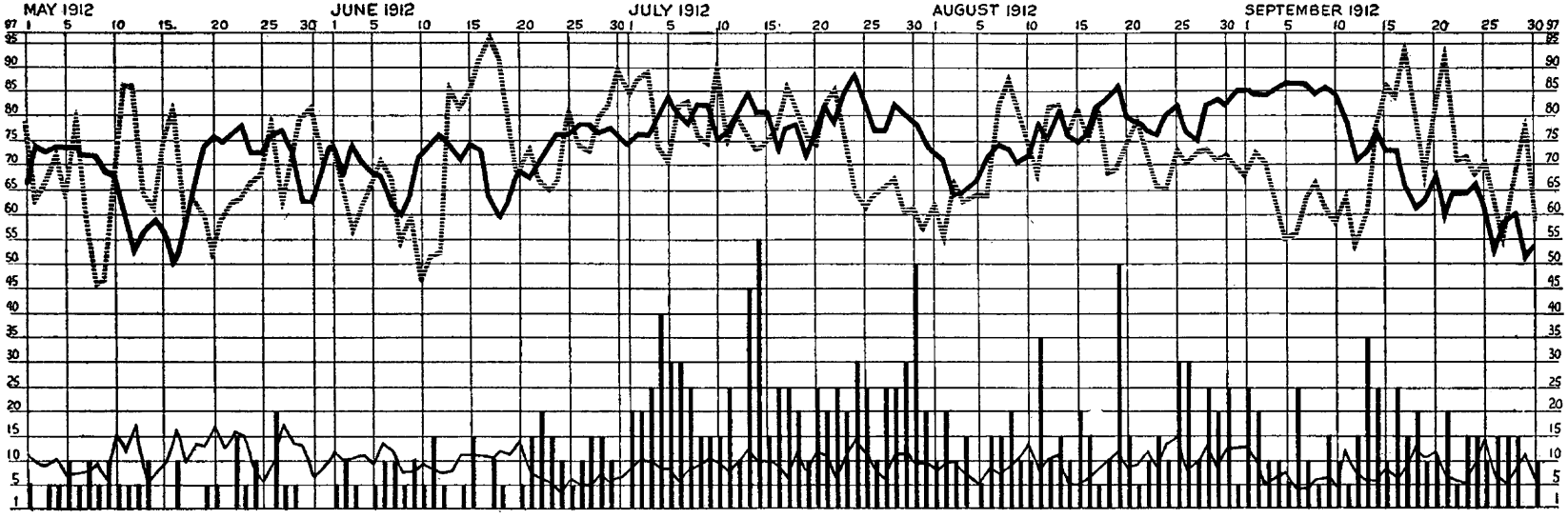

Chart 3

it was not possible to go because of the occurrence of new and conflicting "heat-peaks."

Because of these low figures it was sought to determine the behavior of the death-curve in relation to accessions of heat to points above 70 F., that is, the behavior of the death-curve was noted whenever the mean temperature reached 70, 75, 80, 85 and 90 F. This method revealed ninety-six instances in the three summers, and it was found that, corresponding with the day of the heat accession, the deaths went up in 27 per cent. of instances, that on the day after the accession it rose in 34 per cent. of instances and on the third day in 20 per cent. of instances. It is noteworthy, moreover, that the elevations of the death-curve on extremely hot days was less frequently noted than on those days when the temperature was not so high, as is seen in the following summary:

BEHAVIOR OF DEATH-CURVE IN RELATION TO ACCESSIONS OF MEAN TEMPERATURE TO 70, 75, 80 AND 85 F., SUMMARY OF NINETY-SIX INSTANCES IN 1910, 1911 AND 1912:

AT 70 DEGREES: In eighteen instances of accession to 70, the death-curve rose on the first day, four times; second day, seven times; third day, three times. In four of these eighteen instances the death-curve fell on the day the mean temperature reached 70 F.

AT 75 DEGREES: In thirty instances of accession to 75, the death-curve rose on the first day, eleven times; second day, eight times; third day, four times. In five of these thirty instances the death-curve fell on the day the mean temperature reached 75 F., and in two instances it remained stationary.

AT 80 DEGREES: In thirty instances of accession to 80, the death-curve rose on the first day, eight times; second day, thirteen times; third day, eight times. In six of these thirty-six instances the death-curve fell on the day the mean temperature reached 80 F., and in one instance it remained stationary.

AT 85 DEGREES: In twelve instances of accession to 85, the death-curve rose on the first day, three times; second day, four times; third day, four times. In one of these twelve instances the death-curve fell on the day the mean temperature reached 85 F.

In ninety-six instances the death-curve dropped or remained stationary in twenty instances; the rise of the death-curve on the day of the accession of heat was more frequent at 75 F., than at 80 F., or 85 F.

In studying the relation of heat to deaths, the originators of the heat-stroke theory found this relation to be most evident in the early summer months. Some of the German charts show this very nicely, but the charts for St. Louis do not show so great an intimacy between heat and deaths in the early months as they do in the later months of the summer; for example, in 1910, the first death-rise in May is not accompanied by a coincident rise in temperature, and a fall in temperature precedes the death-rise of May 27-30. Again, the rising death-curves of early June accompany a really low temperature, but were preceded by moderate heat a week earlier. The fastigium of heat of middle and late June is followed rather than attended by the rising deaths, and such relations may also be seen, although to a less definite degree, elsewhere in

the chart for this year. In the 1911 chart it may be noted that the deaths follow rather than accompany the excessive heat of June and July, although it had already been so extremely hot for so long a time that the curves become confused. Lastly, the rise in deaths in late September accompany a lowered temperature curve, but follow a higher preceding one. In 1912, the deaths of late June are apparently more closely related to the heat of middle June than to that of late June, and this is again seen in the rise of late September in the presence of very low temperatures, following, however, the very high temperatures earlier in the month. It would appear that the death-curve exhibits a sequential rather than an accompanying rise to the heat-curve, the hot days often passing without leaving an immediate impress in deaths.

As for the relation of wind velocity to infant mortality in summer, the subject may be dismissed at this time with a word — no relation could be made out. This does not mean that a relation does not exist, since to the contrary, it has been shown that movement of air is capable of prolonging the lives of animals exposed to the sun; but the charts do not show this.

CONCLUSIONS

A definite relation between atmospheric heat and deaths among infants suffering with gastro-intestinal disturbance exists; at what degree of heat lethal effects are seen does not appear in these charts.

A. So-called "heat-peaks" or short-lasting but excessive temperatures doubtless emphasize, but they do not dominate the summer infant death-rate; whether many of these deaths are the direct result of "heat-stroke," although easily supposable, has not been shown.

B. Continuous heat shows a stronger relation, although not necessarily an immediate relation, to deaths of infants suffering with gastro-intestinal disorders, which, as infants are now housed and fed, is very fairly constant.

I wish to thank Mr. Montrose Hayes, Chief of Weather Bureau at St. Louis, for assistance in compiling material for the charts.

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