ON THE RELATIONS OF
THE MORTALITY FROM CHOLERA
IN
LONDON,
TO THE
GENERAL MORTALITY AND TEMPERATURE.

BY

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THE following communication has been prepared with a view to prove that there are certain meteorological conditions related to cholera which have not hitherto been noticed; and which, although they do not suffice to account for the outbreak of that scourge, give information which may assist us in our investigations as to its nature and origin. It is limited to a consideration of the two epidemics in London of 1849 and 1854; and since the former has already received much attention at the hands of the most competent authorities, it will be alluded to here only as offering points of comparison and contrast with those of the more recent one of 1854. For the more ready apprehension of the statistical details, two diagrams have been prepared, which exhibit the various relationships on the most cursory examination.

From Diagram No. 1 the following facts may be gained in reference to the cholera epidemic of 1854, considered in relation to the general mortality, and the various questions relating to temperature in that year. The weekly number of cholera deaths in the attack of 1849 are also inserted by way of comparison.

Thus, the *general mortality* was above the average at the beginning and the ending of the year 1854, as well as throughout nearly its whole course. This was especially evident in the spring quarter and the part of the summer quarter which preceded the great development of the epidemic; and it is not a little remarkable that, whilst in the 25th week it suddenly rose up to the extent of 140 cases, in the 26th week it suddenly fell nearly 300 cases, and so reduced continued during the three weeks which ushered in the great attack. It has also varied the experience obtained from epidemics in general, in that it did not, after the cessation of the cholera, subside below the line of the average mortality, but on the contrary, with the exception of three weeks, viz., the 49th, 50th, and 51st, it was considerably above the average, and at the end of the year the excess was no less than 228 cases. The extremes of the year were 984 and 3413 cases in the week.

In reference to *temperature*, it is evident that the attack of cholera occurs at the period of the highest temperature (60° to 65°), and after the temperature has been regularly and progressively increasing from the spring months. The temperature remains at or near to the highest point until about a week before the epidemic has attained its acme, when it declines more rapidly than it ascended, and is reduced to an average of between 45° and 50° before the mortality returns to its ordinary standard. The winter months of the year 1854 had, for the most part, a temperature higher than the average, whilst, on the contrary, the spring months were colder than the average. During the latter half of the year the temperature corresponded very much with the average standard, the most marked exception being the week immediately preceding the acme of the attack,

when it rose nearly 4° above the average, and although it sunk nearly 7° on the following week, it yet remained slightly above the average. Thus at the season of the year when cholera prevails, the winds are hot, the ground dry, and the beds of rivers and stagnant waters exposed by the constant evaporation.

The *daily variations*, or the daily extremes of temperature, are not only great but inconstant in our climate. During the winter half of the year they are clearly less than during the summer half, and are the lowest in the last and the first few weeks of the year, and then seldom exceed 10° . The greatest variation in 1854 was very evident in the first three weeks of the spring quarter (26°) and the greater part of the summer quarter, and was the greatest (31°) in the 36th week, or that of the acme of the cholera attack in both 1849 and 1854. In the first and last quarters of the year the variation was not only at or approaching to the minimum, but the increase or decrease proceeded with some approach to regularity and constancy. The great inconstancy which marked the two middle quarters is well exhibited by the diagram.

The next question in relation to temperature, is that of the difference between the temperature of the air and the dew-point; and this has its importance as being indicative of the relative amount of moisture existing in the atmosphere. The higher the dew-point the less is the difference between that temperature and that of the air, and the greater is the amount of humidity. This question is, therefore, determinable either by representing the two lines of temperature, of the air and of the dew-point, and marking their varying differences, or by using a single line, which shall indicate the difference between them. The latter is the more simple, and has been used in the construction of the diagram; and in proportion as it ascends, so does the degree of humidity diminish. It will be observed that the line exhibits great and sudden variations, and that they in general correspond with the line of *daily variation* of temperature. The greatest

differences are noticed in the spring and summer months, being 8° in the former, and 12° in the latter, and the week (28th) when the line began to suddenly ascend, was that in which the cholera of 1854 commenced its great development. Throughout nearly the whole period of the prevalence, this line ran high, and began to decline in the week when the deaths from cholera were the most numerous. In the autumn months the great degree of humidity is indicated by the low line referred to, and its constancy by the regular course which the line pursues. The lowest point, or that of the greatest humidity of the air, is at the commencement of the year; and so rapidly did it rise in that season, in 1854, that in the 9th week it was nearly as high as at any other period of the year, thus indicating at that period a very great degree of dryness.

In order to obtain an average for the estimation of the true value of the line of 1854, I have used the returns of 1847, 1848, 1849, 1851, 1852, and 1853, and the diagram will show a remarkable want of uniformity between it and the line of 1854. Thus, according to this average, the greatest dryness runs through the greater part of the spring and summer quarters, having its maximum (10°) in the 27th week, and increasing and decreasing with considerable regularity though about 3° . It is, however, evident, that dryness of the air prevailed, on the average, for many weeks before the season of the great outbreak of cholera.

It is worthy of note that after the dryness had almost attained its maximum in the 14th, 15th, and 16th weeks of 1854 (9°), it suddenly fell, and continued at a much lower point (5°) through all the succeeding weeks, until the 28th week, when the attack of cholera developed itself. Thus, although cholera is accompanied by the driest state of atmosphere known in this climate, it was, in 1854, preceded for many weeks by an uniform low range of humidity, so low as about 5° below the average. The meteorological conditions which precede an attack of cholera must have great importance in the estimation of those who

believe in the existence of a cholera poison, since in such anterior conditions the poison may be presumed to have been originated and developed. As this view is still entertained by some writers, it may be useful to point out that, in the year referred to, this period was marked by a temperature of about 5° below the average, by less extremes of temperature than the preceding and succeeding periods, and by much greater humidity than is common in our climate at that season. The conditions which attend the epidemics are not of importance on this theory, except so far as affording an opportunity for the propagation and distribution of the poison; but if we consider that an essential predisposition to the attack of cholera is an exhausted nervous system, or a state of that system in which exhaustion is rapidly induced, we must also note the accompanying conditions. These were, in 1854, the highest range of temperature, the greatest daily variation and inconstancy of temperature, and excessive dryness of the air. There are, therefore, three separate sets of conditions which it is imperative to bear in mind. First, the anterior and introductory ones of lower temperature, less variation of temperature, and greater humidity of the atmosphere. Second, the concomitant conditions of high temperature, great daily variation, and excessive dryness of the air. Third, the suddenness and the period of the change when the former set of conditions passed into their opposites. This took place, in the two epidemics, in different weeks of the year, but yet in each *immediately* before their great development, and must, therefore, not be passed over without due consideration.

It is manifest that all these conditions succeeding to each other, but inseparably connected together, are fitted to exercise an exhausting effect upon the sensitive organization of man greater than that which would probably result from the isolated action of any of them.

I have purposely refrained from any continued reference to these conditions in the epidemic of 1849, since they have already been detailed by the best authorities; but as

the foregoing remarks need, for their due appreciation, certain points of contrast with the conditions of 1849, I have prepared Diagram 2, which exhibits the contrast of temperature free from any other lines. At the first glance it will appear that there are great diversities between the two lines of 1849 and 1854 under each of the heads of inquiry, but a little closer examination will show that the peculiarities now detailed in reference to 1854 are in the main supported by the diagram for 1849. The key to the solution of the apparent difficulty is the fact that the development of the epidemic of 1849 preceded that of 1854 by about six weeks, and if this be used, it will be discovered that much less dissimilarity exists upon the diagram than at first sight appears.

The questions of temperature relating to 1849, as contrasted with those already given for 1854, may be thus briefly stated :

The whole of the year, as well as of each quarter, had a temperature somewhat higher than that of 1854. The two years began at the same degree but ended by a difference of eight degrees, 1849 being then the colder. In the 22d week of 1849 the temperature had become very high, and was then higher than in the 28th week of 1854. In the 28th week the maximum was attained, and this was not only greater than in 1854, but preceded the maximum of the latter year by seven weeks. The highest range of temperature endured in 1849, from the 28th to the 36th week (9 weeks), whilst that of 1854 was from the 30th to the 35th week (6 weeks), and from these periods in both years the temperature rapidly declined. In 1849, therefore, the high temperature commenced earlier, was more elevated, and endured longer than in 1854, but in both years alike the sudden elevation corresponded with the period of the development of cholera, and the decline of the temperature with the recession of the attack.

The daily variation was somewhat less in the early spring of 1849 than in 1854, and at that period the highest point

was five weeks later than in the latter year; but the sudden increase of the variation in the summer quarter preceded that of 1854 by about six weeks, and the acme was attained about nine weeks earlier than in 1854. In both years the period of elevation was that of the development of the epidemic, and about that of the sudden increase of temperature.

The lines indicating the difference between the temperature of the air and the dew-point, in reference to the two years, correspond pretty closely in the first and fourth quarters, but differ in the second and third quarters, and this difference is, as in the preceding instances, very much that of the period when the increase began. In the latter part of the second quarter the degree of humidity was less than at the same period of 1854; but whilst the greatest degree of dryness in 1849 was observed in the 27th and 28th weeks, and continued in an elevated but yet lessening degree until the 38th week (12 weeks), that of 1854 occurred in the 29th, 30th, 33d, 34th, 35th, and 36th weeks, (with an interval of depression in the 31st and 32d weeks), and continued until the 39th week (11 weeks). As in the preceding remarks the period of the marked increase of the dryness was that of the commencing development of the disease, the greatest daily variation and the highest degree of temperature.

Thus the characteristics of the year 1849, in reference to temperature and cholera, very much corresponded with those of 1854; and the two years mutually support each other, if the difference between the period of development of the epidemic in the two years be borne in mind.

In conclusion, we have not at present information on other meteorological points of so precise a nature as those now detailed in reference to temperature; but it yet suffices to enable us to make the general statement, that at the season of the year when cholera has prevailed, there have been a very small fall of rain, large accumulations of electricity in the atmosphere, and a prevalence of south-westerly winds of small motor force. These circumstances,

in addition to those associated with heat, produce that state of the atmosphere which is known by the terms "sultry," "oppressive," and "close," and which has so well-known a tendency to induce exhaustion both of body and mind. To these may further be added certain sequential occurrences, which tend materially to increase their effect. Thus the long continued heat and want of rain cause the springs to cease, and with them a suitable supply of pure, fresh water; the beds of rivers and pools to be exposed to the action of the sun, and with it the exhalation of malarious gases; and, at the same time, the sewers in our towns not being flushed with an abundant supply of water, the filth moves but slowly, and remains long enough to pour out nauseating and narcotising gases at every trap-hole. All these must be familiar to every one; but the latter is best known to the inhabitants of this metropolis, who find it needful, at that season of the year, to avoid an inspiration on approaching a trap-hole, in order to avert the deadly effects of inspiring the fetid gases. It has not uncommonly been noticed that the opening of sewers has been apparently the immediate cause of the appearance of cholera in a district, a circumstance rather to be explained, on the known action of poisonous gases, than on the emission of any organic poison-cell.

But perhaps one of the most potent concomitant influences is that tendency to the decay of animal and vegetable life which so universally abounds at that season of the year. It is probable that too little importance has been attached to this influence, and in order to estimate it, we must consider it both negatively and positively: negatively by the negation of those sanitary powers which are doubtless exercised by both animal and vegetable life at its seasonal origin and activity, as in the spring and early summer; and positively, by the return to gaseous elements of the structures of which both animals and vegetables are composed.

It is well known that in tropical climes the scourge to which we now refer is vastly more virulent in its operations

than in cold or even in temperate regions ; for there the heat is the greatest, the stagnation of the air more perfect, the electricity more extensively accumulates, and, with the vast development of animal and vegetable life, there is at this season a corresponding decay. There sultriness attains its acme, and induces a degree of listlessness and exhaustion which happily is not known in these regions. There, from doubtless the same causes, fevers of the most malignant nature, probably closely allied to cholera, rage at the same season yearly, and drive out, not only men, but birds and the beasts of the forest, to the upland districts.

Temperature (Average)

Whole year	1849	1854
1st Quarter	43.98	43.08
2nd do	42.1	40.8
3rd do	42.3	41.7
4th do	41.3	43.8

Questions of Temperature
in reference to the Cholera in London,
in 1849 and 1854.

CONTRASTED.

Week	Year	Temperature 1849 and 1854.	Amount above or below the Average.	Daily Variation.	Difference between Temperature of Air and Dew-Point.	Week	Year	Temperature 1849 and 1854.	Amount above or below the Average.	Daily Variation.	Difference between Temperature of Air and Dew-Point.
1	1854	30.2	-5.6	10.	1.6	27	1854	56.9	-5.1	17.7	5.3
2	1849	30.7	+6.6	7.4	3.4	28	1849	62.7	+1.2	27.4	14.1
3	1854	37.5	+2.3	8.4	3.1	29	1854	56.4	-5.5	17.3	1.6
4	1849	39.3	+3.8	11.7	3.4	30	1849	66.8	+5.4	28.9	14.6
5	1854	42.2	+5.8	10.3	2.	31	1854	63.2	+1.3	24.9	9.8
6	1849	46.6	+9.7	12.	3.3	32	1849	60.5	-1.3	22.1	9.4
7	1854	42.2	+5.2	13.5	3.6	33	1854	64.9	+2.9	27.8	11.4
8	1849	45.8	+8.5	10.5	6.5	34	1849	58.9	-2.2	27.6	6.1
9	1854	42.	+4.3	14.7	2.7	35	1854	58.5	-3.7	15.1	3.1
10	1849	40.6	+4.8	12.1	3.5	36	1849	59.5	-1.9	19.9	9.1
11	1854	42.	+3.7	11.	5.6	37	1854	60.1	-1.7	19.6	6.2
12	1849	45.	+11.9	9.3	4.3	38	1849	66.4	+4.9	26.2	11.2
13	1854	35.1	-3.7	13.3	5.6	39	1854	59.9	-1.2	22.4	8.7
14	1849	40.7	+4.	17.6	4.5	40	1849	60.3	-1.1	17.6	9.3
15	1854	40.9	+1.5	14.6	7.1	41	1854	61.2	+1.1	22.5	9.1
16	1849	45.4	+5.8	12.8	5.	42	1849	62.9	+2.6	18.9	9.3
17	1854	41.	+1.1	13.	9.2	43	1854	65.1	+5.9	26.8	9.6
18	1849	42.4	+2.7	16.3	6.7	44	1849	64.	+3.7	16.	7.5
19	1854	43.8	+3.7	18.3	4.2	45	1854	59.2	+1.1	30.9	9.1
20	1849	43.	+3.9	15.9	6.8	46	1849	64.	+5.3	20.1	9.3
21	1854	47.2	+5.7	20.4	7.7	47	1854	60.7	+3.8	23.9	6.9
22	1849	45.9	+4.1	12.	6.5	48	1849	56.5	-3.2	16.2	7.6
23	1854	40.1	-2.1	16.1	5.1	49	1854	57.1	+1.5	18.8	6.2
24	1849	40.	-3.6	12.5	5.1	50	1849	55.7	-1.2	18.8	10.4
25	1854	47.3	+4.	23.1	7.9	51	1854	55.2	+1.	27.5	8.
26	1849	40.2	-3.9	8.8	5.3	52	1849	58.4	+5.4	16.7	5.1
27	1854	49.9	+5.7	26.4	7.5	53	1854	53.6	+1.	20.3	5.5
28	1849	45.7	+6.	17.7	6.2	54	1849	51.2	-1.8	12.3	4.6
29	1854	48.	+2.7	26.4	7.7	55	1854	50.9	+1.	17.7	3.6
30	1849	41.8	-2.7	13.7	3.1	56	1849	46.7	+4.7	17.	7.4
31	1854	52.6	+5.8	24.9	8.1	57	1854	46.5	-3.	12.5	4.2
32	1849	37.1	-9.4	14.	5.5	58	1849	52.4	+3.6	16.7	7.2
33	1854	43.	-5.8	16.2	5.8	59	1854	44.9	-3.1	17.9	5.8
34	1849	45.9	-3.7	15.7	5.5	60	1849	55.	+9.6	11.6	4.
35	1854	48.9	-2.5	18.	4.1	61	1854	49.7	+3.4	18.6	5.
36	1849	55.2	+3.2	23.5	8.3	62	1849	50.3	+4.1	16.3	5.8
37	1854	49.7	-2.2	19.9	4.5	63	1854	42.2	-2.5	14.6	3.6
38	1849	45.5	-6.7	15.	6.3	64	1849	50.2	+4.1	11.3	5.9
39	1854	51.9	-9.	24.8	7.3	65	1854	37.5	-2.1	12.6	3.4
40	1849	54.9	+2.6	16.2	7.2	66	1849	45.2	+1.	13.1	4.2
41	1854	46.9	-3.3	16.1	4.6	67	1854	36.5	-5.3	10.	2.8
42	1849	56.9	+1.9	14.	7.2	68	1849	43.3	-2.	10.	3.7
43	1854	52.3	-4.1	19.5	3.9	69	1854	38.4	-3.4	11.1	4.1
44	1849	60.3	+1.3	15.5	7.	70	1849	34.5	-9.	10.1	3.2
45	1854	52.3	-5.5	17.7	6.4	71	1854	42.2	+1.	11.4	4.5
46	1849	59.7	+7.	19.5	8.4	72	1849	42.2	+1.4	11.8	3.1
47	1854	55.1	-3.9	16.8	4.6	73	1854	42.8	+2.6	11.8	4.3
48	1849	53.5	-7.1	21.	9.6	74	1849	40.	+6.	9.4	2.6
49	1854	58.7	-1.5	22.4	6.	75	1854	40.5	+1.6	11.2	3.2
50	1849	59.2	-1.4	23.3	11.7	76	1849	42.3	+2.5	7.2	1.5
51	1854	57.9	-3.5	19.9	5.5	77	1854	39.8	+2.3	9.9	3.1
52	1849	60.2	+3.	18.5	10.9	78	1849	33.1	-5.1	9.6	5.3

Relations of Cholera

WITH

1. General Mortality, London, 1854.
2. Average Mortality D^o. (Registrar General.)
3. Temperature 1854, also the Average Temperature and Variation, D^o. Difference between that of the Air and the Dew point in 1854, and the Average.
4. Cholera 1849 and 1854.

Weeks 1854.

Week	MORTALITY.		TEMPERATURE.					CHOLERA.		RAIN.
	General Mortality 1854.	Average General Mortality.	Temperature 1854.	Temperature, Daily Variation.	Difference between Dew- Point and Tempe- rature of Air.	Average of Years 1847, 1848, 1849, 1851, 1852, 1853.	Cholera, 1849.	Cholera, 1854.	Rain, 1854, Inches.	
1	1444	1388	30.2	10.	1.6	4.3	61	2	1.21	
2	1492	1262	37.5	8.4	3.1	4.5	94	2	.16	
3	1195	1262	42.2	10.3	2.0	5.	62	1	.04	
4	1178	1195	42.2	13.5	3.6	5.4	45		.13	
5	1204	1200	42.0	14.7	2.7	4.4	37	1	.56	
6	1178	1202	42.	11.	5.6	4.3	55	1	.25	
7	1154	1194	35.1	13.3	5.6	4.5	49		.21	
8	1334	1243	40.9	14.6	7.1	5.5	40		.10	
9	1135	1086	44.	13.	9.2	6.3	35			
10	1343	1191	43.8	18.3	4.2	6.3	15		.03	
11	1188	1234	47.2	20.4	7.7	5.9	9		.13	
12	1200	1236	40.1	16.1	5.1	6.9	10		.17	
13	1489	1322	47.3	23.1	7.9	6.5	4		.03	
14	1149	1228	49.9	26.4	7.5	6.9	5			
15	1087	1114	48.	26.4	7.7	5.9	2	2	.03	
16	1193	1110	52.6	24.9	8.1	6.5	1	2	.30	
17	1211	1070	43.	16.2	5.8	6.3	1		.19	
18	1263	1046	48.9	18.	4.1	8.3	3		.40	
19	1093	1041	49.7	19.9	4.5	8.3	4		1.31	
20	1188	1053	51.9	24.8	7.3	8.3	1	2	.04	
21	1143	1016	46.9	16.1	4.6	8.1	5		.87	
22	1090	1007	52.3	19.5	3.9	8.	9	2	.91	
23	1110	1004	52.3	17.7	6.4	9.3	22	1		
24	1085	981	55.1	16.8	4.6	7.8	42	1	.38	
25	1153	990	58.7	22.4	6.	7.9	49	1	.05	
26	1290	1089	57.9	19.9	5.5	8.6	124		.52	
27	984	1046	56.9	17.7	5.3	9.5	152	1	.53	
28	1045	1030	56.4	17.3	4.6	10.	339	5	.87	
29	1008	1118	63.2	24.9	9.8	8.8	678	26		
30	1219	1179	64.9	27.8	10.4	7.5	783	133	.04	
31	1456	1196	58.5	15.1	3.4	8.2	926	399	2.72	
32	1832	1221	60.1	19.6	6.2	9.5	823	644	.01	
33	1833	1224	59.9	22.4	8.7	7.5	1230	729	.15	
34	2039	1225	61.2	22.5	9.4	7.1	1272	847	.13	
35	2515	1248	65.1	26.8	9.6	7.1	1663	1287		
36	3413	1248	59.2	30.9	9.1	7.8	2026	2050		
37	2836		60.7	23.9	6.9	6.9	1682	1549	.45	
38	2504		57.1	18.8	6.2	7.1	839	1284	.25	
39	2216		55.2	27.5	8.	5.3	434	754		
40	1532		53.6	20.3	5.5	5.8	288	411	.45	
41	1394	1000	50.9	17.7	3.6	5.5	110	249	.06	
42	1321	1036	46.5	12.5	4.2	4.6	41	163	.48	
43	1228	1047	44.9	17.9	5.8	4.3	25	66	.62	
44	1252	1081	49.7	18.6	5.	4.6	11	31		
45	1160	1112	42.2	14.6	3.6	4.3	6	23	.08	
46	1309		37.5	12.6	3.4	4.1	8	12	.62	
47	1262	1123	36.5	10.	2.8	4.5	2	8	.22	
48	1350	1203	38.4	11.1	4.4	3.5	1	7	.48	
49	1331	1367	42.2	11.4	4.5	3.6	1	4	.21	
50	1300	1374	42.8	11.5	4.3	3.6		2	.07	
51	1291	1374	40.5	11.2	3.2	4.1	1		.71	
52	1508	1280	39.8	9.9	3.9	4.1			.44

At the period of the year when cholera prevails—

1. The temperature has progressively increased for months, and has attained its acme, so that the ground, water, and air, are hotter than at any other period of the year.

As it declines so does cholera:

2. The daily variation is very changeable, but is the highest in the week when the cholera was the highest, both in 1849 and 1854.
3. The dryness of the air has long been very considerable, and then, although great, is beginning to decline.
4. The rains do not prevail, so that the ground is dry, the rivers low, the beds of stagnant waters exposed, the drains unflushed and emitting foul air.
5. The winds are light and south-westerly, so that the temperature is maintained, and exhalations not removed.
6. The electricity is collected in the air.

All have a tendency to exhaust or to oppress animal and vegetable vitality. All these circumstances have greater influence in hot climates, and in low and enclosed situations, where exhalations abound, and cannot be removed.