

REMARKS ON THE OUTBREAK OF CHOLERA IN BROAD STREET, GOLDEN SQUARE, LONDON, IN 1854.

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IT is commonly supposed, and sometimes asserted even at meetings of Medical Societies, that the Broad Street outbreak of cholera in 1854 was arrested in mid-career by the closing of the pump in that street. That this is a mistake is sufficiently shown by the following table, which, though incomplete, proves that the outbreak had already reached its climax, and had been steadily on the decline for several days before the pump-handle was removed. Had it been possible to make it complete, the table, as I will presently show, would have pointed still more decisively to the same conclusion.

Meanwhile, to indicate the well-defined and concentrated character of the outbreak, I may here state that during the first thirty days of August there had been an average of but one death per day from cholera throughout the parish (St. James's, Piccadilly) in which Broad Street is situated; that the earliest cases on August 31st did not manifest themselves till about noon on that day, and that nearly all the deaths here recorded occurred within an area of about 250 yards radius from the pump as its centre.

Date.	No. of Fatal Attacks.	Deaths.
August 31st	34	4
September 1st	142	72
„ 2nd	128	127
„ 3rd	62	76
„ 4th	55	71
„ 5th	26	45
„ 6th	28	40
„ 7th	22	34
„ 8th (Pump closed)	14	30
„ 9th	6	24
„ 10th	2	18
„ 11th	3	15
„ 12th	1	7
„ 13th	3	13

„	14th	.	.	0	.	.	6
„	15th	.	.	1	.	.	8
„	16th	.	.	3	.	.	6
„	17th	.	.	4	.	.	5
„	18th	.	.	0	.	.	4
„	19th	.	.	1	.	.	4
„	20th	.	.	0	.	.	1
„	21st	.	.	0	.	.	0
„	22nd	.	.	2	.	.	3
„	23rd	.	.	0	.	.	3
„	24th	.	.	1	.	.	0
„	25th	.	.	0	.	.	1
„	26th	.	.	1	.	.	2
„	27th	.	.	0	.	.	0
„	28th	.	.	2	.	.	2
„	29th	.	.	0	.	.	1
„	30th	.	.	0	.	.	0
Date unknown	.	.	.	127	.	.	46
				668			668

The forty-six deaths of unknown date are stated by the Committee of Inquiry to have nearly all occurred during the first week of September; and, as the omission is due to the confusion which prevailed, they most likely occurred on the first two or three days, when the confusion was such as few who were not in the midst of it can imagine. For instance, on the night of September 2nd there were as many as eighty-two bodies in the "dead-house."

Moreover, as the cases in this table are those of resident inhabitants, there is no account here taken of non-resident work-people who, after being attacked within the "area," died at their own homes out of the district. Their number is reckoned by the Committee as about forty, of which twenty-eight belonged to Broad Street alone; and these twenty-eight were all seized before the evening of September 2nd, after which date the factories were closed for a time.

It is certain, then, that the table, if more complete, would have indicated more clearly even than it now does the exceeding virulence of the outbreak during its two or three earlier days, and the rapidity of its decline after the climax was passed; and the column of fatal attacks, incomplete as it is, establishes the fact that the climax was reached within a very few hours of the first manifestation of the outbreak.

Clearly the original cause of the explosion must very soon have lost much of its fatal power. That the Broad Street well-water was this cause I am not now concerned to show. Provisionally assuming it to have been the cause (and prepared, if necessary, to prove it), I will try to define the limits (as to time) of the fatal operation of the water, and perhaps incidentally to throw some light on the period of "incubation."

I had occasion, as a member of the committee, very closely to investigate all the circumstances of the outbreak as connected with the Street (Broad Street) in which the greatest mortality, 10 per cent ($\frac{90}{900}$), of its resident inhabitants occurred; add to this mortality the cases of the twenty-eight non-resident work-people; add again fifty persons who recovered from severe attacks, most of whom I personally examined, and it will be admitted that the results of a close investigation of such a street would probably fairly represent the results which would have been obtained by a similar examination of the whole area. But I did also, in conjunction with Dr. Snow and others, though not with equal minuteness, pursue the inquiry from day to day for weeks together in other streets, and we found that the results, as far as they went, corresponded.

We found then that, whilst it was exceedingly difficult to disconnect any of the earlier cases from the use of the pump-water, we discovered less and less connexion between this water and the disease on each succeeding day after September 3rd; and among the attacks, fatal and not fatal, after September 6th, we could trace no such connexion at all.

Indeed, in Broad Street itself the outbreak completely ran its course in nine and a half days. I succeeded in ascertaining the alleged *hour* of fatal attack in every case in this street; and I know that no attack, fatal or not fatal, occurred in it after September 9th.

It is worth noticing that generally the streets nearest to the pump became the soonest free from the epidemic. "The suddenness of the principal outburst," say the Committee, "as also its rapid subsidence, is chiefly marked in those streets and courts which are nearest to the centre of the cholera area; whilst in the border of this space, and beyond its limits, there is no such abrupt and extreme rise and fall in the number of attacks."

Thus, during the decline of the outbreak, we seem to catch sight of an outside limit to the fatal operation of the water.

But how much earlier than the 6th, by reason of the incubation time, we are to fix this limit it is of course hard to say. For instance, a friend of mine, the Scripture reader of St. Luke's Church, told me that on the evening of September 2nd he quite exceptionally drank about half a pint of the pump water from the ladle. On the September 4th he began to suffer slightly, and on the 6th severely, from diarrhoea; on which latter day I found him in bed very ill indeed. Now if he had died, and without telling me any of these circumstances, I should certainly have supposed that he was seized on the 6th, as I had seen him at his work every day, and never heard him complain of illness. And as for his drinking of the pump water, if there had been any reason to suspect it at all, I might have thought that he took it later than September 2nd. The value of this case consists in his drinking of this water having been clearly ascertained to be an exceptional act on his part.

From the cases of persons described as having been *habitual* drinkers of this water we can of course learn little to define the exact period of incubation in each case (unless they happened to be seized very early in the outbreak, when by reason of the known duration of the special pollution of the well, of which I will speak presently, we may get at some approximation to the truth); for, especially as this water had to be sent for, even an habitual drinker of it may have omitted to drink it for a day or two, taking the Company's water instead; and so we cannot certainly fix the day on which he first encountered its fatal influence.

Few habitual drinkers of the pump water, to my knowledge, escaped with impunity. Few survivors were able to assure me that they so drank it regularly during the week ending September 2nd. But on and after that day several persons, who had not been in the habit of drinking it, began doing so, at least occasionally, from a notion (due to the enormous quantity of it taken by some patients who revived from collapse) that it was "good for cholera." More of *these* drinkers than of habitual drinkers of the pump-water escaped with impunity, I myself being among the number, as I drank some of it at 11 p.m. on September 3rd, though not from any idea of its beneficial qualities.

Judging from the case of the Scripture reader, we may, perhaps, assign a longer period of incubation to the cases of those who suffered, or even died, among the later than among the earlier drinkers of the Broad Street water.

The proximate cause of the outbreak, as is well known, is

alleged to have been the pollution of the well by the discharges of an infant suffering from diarrhœa, which discharges, diluted with water, began to be poured on August 28th into a cesspool, the communication of which with the well was clearly ascertained. They continued all day on August 29th, and ceased on the 30th, having thus lasted about forty-eight hours.

We have then an interval of four days between the *probable* date of the first pollution of the well and the beginning of the outbreak. But what time must be allowed for the discharges to percolate from the cesspool to the well, and also to become injurious, of course I cannot tell. I only know that we must not ask for any time later than August 30th as the starting-point of the mischief, because one man who exceptionally drank it at noon on that day was seized with cholera, according to his widow's account of the matter, at 9 a.m. on September 1st.

Assuming her to have been right as to the hour of attack, indeed whether right or wrong, we have for incubation time in one case at most forty-four hours. And she was most likely right, because the unanimous testimony of the medical men who were in the thick of the outbreak was to the effect that for the first two or three days there was an almost total absence of "premonitory symptoms."

Still even this interval of forty-four hours is longer than the interval in the few other cases where we can unmistakably isolate the act of the drinking. They are only three in number, and all belong to the 1st of September, on which day, for instance, a gentleman who came up from Brighton in the morning drank the Broad Street water at luncheon in Poland Street, and was seized with cholera in the evening of the following day. We get here about thirty hours for the interval. Another interval under similar circumstances was about twenty-four hours; and another not more than twelve hours.

From these data, considered by themselves, it might be very unsafe to pronounce any opinion as to the day on which the water reached its maximum of special pollution or rather of injurious influence. But, taken in connexion with the general facts of the outbreak and other evidence respecting the effects of the water, they help at least to the conclusion, that the water was not very injurious before August 30th or after September 2nd, on which latter day indeed it seems likely that it was rapidly on its way towards purification.

That the water should so quickly purify itself is not

astonishing when we bear in mind (1) that the discharges ceased on August 30th, (2) that the body of water at any one time in such a well is inconsiderable, and (3) that it was consumed (and therefore replenished) at a most extraordinary rate during the first few days of the outbreak by reason of the almost incredible quantity of it drunk by the patients, in some cases as much as seventeen quarts a-day.

It may be seen from the table that, notwithstanding the rapidity of the decline of the outbreak on September 3rd, the rate of decline flagged on subsequent days, so much so as to seem at one time almost to stand still.

This used formerly to perplex me, and I sought an explanation of the phenomenon in the hypothesis of a subsequent pollution of the well by the discharges of other patients (three in number) in the same house on the earlier days of the outbreak, especially as I was told by surviving relatives that the discharges of these patients were carried to the cesspool. But they afterwards confessed to me that they had thrown them out of the windows into the back-yard, the temptation to do so arising from their rooms being at the back of the upper floors. The above-mentioned infant having lain ill in the front kitchen, in this case the cess-pool (being in the front area) was the handiest place of deposit.

Here I must not omit to mention that if the removal of the pump-handle had nothing to do with checking the outbreak which had already run its course, it had probably everything to do with preventing a new outbreak; for the father of the infant, who slept in the same kitchen, was attacked with cholera on the very day (Sept. 8th) on which the pump-handle was removed. There can be no doubt that his discharges found their way into the cesspool, and thence into the well. But, thanks to Dr. Snow, the handle was then gone.

The slackened rate of decline after September 3rd does not, in the present state of knowledge upon the mode of propagation of cholera, need any explanation. I now only wonder that with such a start from the agency of the pump, and with so much material thus supplied for the continuance of the outbreak by other means of communication, it had so little power to sustain itself for any length of time after its original promoter had begun to suspend its fatal operation.
