

Report on a public local inquiry into an outbreak of typhoid fever at Croydon in October and November 1937.

Contributors

Great Britain. Ministry of Health.

Publication/Creation

London : H.M.S.O., 19.

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MINISTRY OF HEALTH

REPORT
ON A PUBLIC LOCAL INQUIRY
INTO AN OUTBREAK OF
TYPHOID FEVER AT
CROYDON

In October and November
1937

*Presented by the Minister of Health to Parliament
by Command of His Majesty
February, 1938*

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MINUTE OF APPOINTMENT.

PUBLIC HEALTH ACT, 1936.

LOCAL GOVERNMENT ACT, 1933.

The Minister of Health, in exercise of the powers conferred upon him by Section 318 of the Public Health Act, 1936, and Section 290 of the Local Government Act, 1933, and of all other powers enabling him in that behalf, hereby appoints *Harold Lawson Murphy*, Esquire, K.C., to hold a local inquiry into the causes leading up to the outbreak of typhoid fever in the County Borough of Croydon in October and November, 1937, and the steps taken to deal with that outbreak;

And the Minister of Health further appoints *Harold John Frederick Gourley*, Esquire, M.Inst.C.E., and Sir *Humphry Davy Rolleston*, Bart., G.C.V.O., K.C.B., M.D., F.R.C.P., to sit with the said Harold Lawson Murphy at the said Inquiry as assessors.

Given under the Official Seal of the Minister of Health
this 22nd day of November, 1937.

GEORGE CHRYSTAL,
Secretary,
Ministry of Health.

(L.S.)

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ERRATA

REPORT ON A PUBLIC LOCAL INQUIRY INTO AN OUTBREAK OF TYPHOID FEVER
AT CROYDON IN OCTOBER AND NOVEMBER, 1937. CMD. 5664.

Page 5, fourth paragraph, line 7: " 80,000 gallons per day " should read
" 80,000 gallons per hour."

Page 10, lines 12 and 13, " chlorination at the Russell Hill and Addington
Wells " should read " chlorination at the Russell Hill Reservoir and Addington
Well."

REPORT ON A PUBLIC LOCAL INQUIRY INTO AN OUTBREAK OF TYPHOID FEVER AT CROYDON IN OCTOBER AND NOVEMBER 1937

To the Rt. Hon. Sir KINGSLEY WOOD, P.C., M.P.,
Minister of Health.

SIR,

Upon the 22nd of November, 1937, I was appointed by you to hold a Local Inquiry into the causes leading up to the outbreak of typhoid fever in the County Borough of Croydon in October and November, 1937, and the steps taken to deal with that outbreak.

On the same day Sir Humphry Davy Rolleston, Bt., G.C.V.O., K.C.B., M.D., F.R.C.P., and Harold John Frederick Gourley, Esquire, M.Inst.C.E., were appointed to sit with me at the said Inquiry as Assessors. I accordingly held the Inquiry in public at the Town Hall, Croydon, and, after a preliminary meeting to discuss representation and procedure, I heard evidence and the addresses of Counsel during 16 days between the 21st December, 1937, and the 12th January, 1938. In addition I and my Assessors visited various sites in the Borough and immediately outside it which, it seemed possible, might have some bearing on the subject of the Inquiry.

As a result I have the honour to report as follows:—

The immediate cause of the outbreak was a portion of the public water supply becoming infected by the typhoid bacillus. The infected portion was that derived from a chalk well at Addington. How that well became infected is a question that cannot be answered with absolute certainty, but all the circumstances and probabilities point so strongly in one direction that I feel justified in coming to a definite conclusion on the subject. That conclusion is that the well was infected by the fact that at the end of September and during October, 1937, men, one of whom was an active carrier of typhoid, were working in the well and that during large parts of such period water from the well, unfiltered and unchlorinated, was being pumped to supply.

I will proceed to develop the reasons for these conclusions at greater length.

Apart from certain areas deriving their supply from the Metropolitan Water Board the Borough of Croydon depends for its water supply on five wells, two of which—Addington and Stroud Green—supply what is called the high level area and three—Surrey Street, Waddon and Selhurst—the low level area.

The normal yield of the Corporation's wells is 6,066,000 gallons a day, of which the Addington Well gives 1,000,000 gallons. There is a statutory limitation on the amount that can be pumped from this well. All these wells extend into and derive their supply from the Upper Chalk. Amongst the storage reservoirs supplied from them is one at Addington which, apart from an adjoining elevated tank, represents the high level storage and which, at the material time, though receiving some water from the Stroud Green Well, was primarily filled from the Addington Well the water from which passed through a 21-inch rising main to be delivered above top water level so that water could not be drawn back for supply from that main.

The area of the Borough is 12,617 acres of which some 3,700 acres were on the high level supply. The population "at risk" on the high level supply was estimated during the Inquiry as being between 36,000 and 40,000 out of a total of approximately 250,000 persons in the Borough.

With the exception of a few isolated outlying cases all the primary cases of typhoid were, during the material time, within the area of the high level supply. In the few exceptional cases the patients had opportunities of drinking high level supply water. For instance, one outlying case on the low level supply was found to be a member of a football club where there was a tap on the high level supply.

On 3rd November, 1937, after the notification of a number of cases, and after it had become apparent that it was high level supply water that was the common element so far as the possible source of infection was concerned, samples of the water from the Addington Well and the Stroud Green Well were submitted for examination by the Ministry of Health's Bacteriologist. On 4th November, 1937, it was ascertained as a result of tests that the Stroud Green water was quite satisfactory but that the water from the Addington Well was heavily polluted although, for reasons which will appear later, it was not possible to isolate the typhoid bacillus. On the same day the supply from the Addington Well was cut off and it appears certain that no primary case was infected after that date. Indeed it seems highly probable that infection ceased not later than 1st November, when an adequate measure of chlorination was applied to the well (a matter I will deal with when I come to the second subject matter of my reference) and when the carrier to whom I have referred had stopped working in the well.

I would add that the existence of any other possible cause common to the large number of cases of primary infection was eliminated.

These facts pointed to the Addington Well, and that alone, as the source of the epidemic and there was complete unanimity upon this point amongst the scientific experts who assisted me with their evidence.

There remains, on this part of my reference, the question of how the water from the Addington Well became infected. I will state the ascertained facts and reserve my comments until later.

The Addington Well was constructed in 1888. It is 10 ft. in diameter, lined with brickwork to a depth of 68 ft. and extends to a total depth of 205 ft. There are two systems of adits—that is to say long galleries or headings driven into the chalk from the well itself with a view to augmenting the resources available. The upper system is driven at 151 ft. below the level of the room where the pumping engines are installed and has a total length of 672 yds.; the lower is at 162 ft. below the engine room floor (327 ft. O.D.) and has a total length of 150 yds. These adits have an east and west direction, though those to the east yielded substantially all the water obtained. The work carried out during the material period, 24th September to 28th October, 1937, comprised the driving of a short horizontal heading from a lower adit to a cavity which existed under and connected with an upper adit, the building of brick stoppings in the eastern adits about 15 ft. from the shaft and the insertion of control valves in those stoppings. The object in view was to control the inflow into the well and thus enable repairs to the pumping plant to be carried out.

It was necessary in order to keep down the water level while this work was being carried out to use both of the two available pumps. The output of each of these two pumps was 78,000 gallons per hour, and until the work referred to commenced the water passed through rapid pressure filters (which would more properly be described as "strainers" since no coagulant was used) with a capacity of 80,000 gallons per day. With two pumps at work it was impossible to pass the whole output through the filters or, owing to the layout, to pass the output of one pump only when two pumps were at work.

Prior to July, 1936, a chlorinating apparatus was available in the filter house though it was only used at intervals. As a consequence of unsatisfactory samples an ammoniator was added at that date and 0.05 p.p.m. (parts of chlorine to a million parts of water) were used regularly with an increased dosage up to 0.15 p.p.m. when the quality of the water deteriorated. I may remark here that it was stated in evidence, which I accept, that as a precautionary dosage 0.05 p.p.m. was inadequate and in the particular circumstances of this well 0.15 to 0.2 p.p.m. was necessary.

From the commencement of the work on 24th September, 1937, until 15th October the water, whilst work was in progress, was pumped to waste and to supply during the remaining time, but from 16th October until 3rd November it was pumped continuously to supply. The mechanical arrangements of the filter and the chlorinating plant were such that when the filters were not in use neither was the chlorinating apparatus.

I proceed to give a general description of the way the work was carried on.

The men, 18 in all, worked in two shifts of four hours but varying the individual hours so that while some came up for their mid-day meal others continued the work. Night shifts did not commence until 16th October and the ascertained carrier was throughout on the day shifts. They were let down and drawn up from the well in couples in what is termed a "skip," which is, in fact, a foreshortened barrel. In the same barrel, from time to time, the chalk excavated from the adit was hoisted to the surface.

It is material to state that during previous work in the well in January, 1937, a fatal accident had occurred owing to the breaking of the skip's attachments and the consequent fall of a workman to the bottom of the main well shaft. Owing to a natural disinclination thus created to work in the well it was in response to a call for volunteers that workmen were found in September, 1937. It is right to say that there seems to have been no lack of volunteers but they were not drawn from the regular water-works staff but mainly from men normally engaged in work on sewers.

The provision for workmen requiring to relieve themselves while in the adit was this. An ordinary stable bucket was let down and kept in the adit. When, according to the evidence, it became half-full it was placed on, and bedded into, one of the loads of chalk going to the surface. This, of course, involved the skip being drawn into the adit from the main shaft; the chalk and bucket being placed in it; and its being released (though it may be with care) into the main shaft prior to being pulled up to the surface. The actual work the men were doing was lighted by hurricane lamps. In what part of the adit the bucket was kept did not clearly appear. I am satisfied that the men were warned that if their bowels were moved they should come to the surface where there was adequate lavatory accommodation. I am also satisfied that in this long dark gallery where water was flowing there were ample opportunities, if a man were so minded, for the deposit of faeces and that there can have been no desire to multiply the daily journeys, up and down, in the skip. The typhoid carrier to whom I have already referred and who was, by common consent, described at the Inquiry as "Case A", worked in the well with certain recurring

intervals from 28th September to 26th October. It should be said of him at once that he was a man who had served in the war, had contracted typhoid in the war, and, through no fault of his own and in ignorance of the fact himself, remained a carrier of the bacillus.

The period of incubation in the case of typhoid is variable and uncertain. It follows that the date of infection must always be conjectural. From the evidence I have heard given by eminent medical witnesses, I should say that the period of incubation in water-borne epidemics is not likely to be less than 14 days, that 21 days would be fairly common, and that the incubation period may be even longer. In fact, in this epidemic the one incubation period which was ascertainable with comparative certainty was 23 days. But, whatever period be taken, the dates of the onset of symptoms point to the original infection having taken place while the work was proceeding in the well and while the carrier was there. I have been supplied with charts, and I gratefully acknowledge the assistance I have derived from them, correlating the dates of the carrier's presence in the well with the dates of notification of the disease, the dates of the onset of symptoms so far as ascertainable, and the dates of infection, taking different periods of incubation. They all enforce the same conclusion. That conclusion is supported by the views on probabilities expressed by every medical gentleman who appeared before me and who was aware that the presence of a carrier in the well at the material time had been ascertained.

Although I have stated what is my definite conclusion as to the infection of the well, since it is one that cannot be arrived at with absolute certainty, I think it proper to deal with certain other possible sources of infection to which my attention was called. As these included farms where pigs and other livestock were bred it may be desirable if I make one or two preliminary observations upon the typhoid bacillus in connection with such suggested sources of infection. Among the animal world it would appear that it is only in the human intestine that the typhoid bacillus lives. Removed from that environment and apart from certain special articles of food, such as milk or shell fish, its life is short. Five days was given me as an estimate of its length of life in a domestic water supply. Some writers on the subject place it a good deal lower. There is apparently no known case of a pig or other animal being an intestinal carrier of the bacillus. The short life of the bacillus once evacuated from the human intestine explains why, in addition to the invariable difficulty which exists, for various reasons, in isolating the typhoid bacillus from public water supplies, the carrier having ceased work in the well on 26th October the bacillus could not be isolated after 3rd November. It also throws doubt upon the utility of looking for a possible source

in some unknown and unascertained human carrier at places far distant from the well when at the material time there was an ascertained carrier in the well itself. On the other hand, the state of the area from which the Addington Well derives its water is a matter of importance for it is chalk soil covered above a certain elevation by more or less permeable clay-with-flints. It appears to have been widely thought in the past that chalk provided a mode of natural filtration. This idea is now abandoned and it is recognised that owing to the wide fissures in the chalk it is possible for water to flow through it almost completely unfiltered. Experiments carried out about 1900 showed that brine and also known bacteria washed into a swallow hole or depression in the grounds of the Warlingham Mental Hospital found their way into the Addington Well, two miles to the north, within 48 to 72 hours thus indicating at least one master fissure in that direction.

The gathering ground of the Addington Well is pear-shaped extending southward from the well $3\frac{1}{2}$ miles, rising to an elevation of 700 feet O.D., and having an area not less than $3\frac{1}{2}$ square miles, though it may be as much as $4\frac{1}{2}$ square miles. I have visited with my Assessors all the places in this area to which our attention was called. If one was driven to seek for a source of infection in this area one would look either at the farm known as Fisher's Farm or at the site of a latrine used by workmen while building a school closely adjoining the well itself. It is right to say that both of these possible dangers have been removed. The drainage from the farm has been connected with the public sewer and the latrine has been cleared out after ceasing to be in use. For the purpose of the Inquiry a careful investigation was undertaken into the medical history of those occupying houses (and more especially houses relying upon cesspits) and farms upon the gathering ground. The result was that over a considerable time no case of typhoid had been notified or known in this area. In these circumstances I think it is safe to conclude that though the gathering ground undoubtedly contained potential sources of danger the actual infection of the well was not derived from it.

Having stated the facts which have led me to the conclusion that the cause of the infection of the well was the work that was carried on between September and November, 1937, involving the presence of a carrier in the well while water was being pumped to supply, I now proceed to make certain observations upon those facts. The work was not urgent. It is true that one of the pumping engines was badly in need of repair but the work had been postponed for some time so as to commence in September which was considered a convenient period having regard to the normal water level. It was quite possible, although at considerable inconvenience no

doubt, to shut off the supply from the well while work was taking place. That is what has actually been done since 4th November, 1937. It was quite possible, as has since been done, to install a chlorinator at the Addington Reservoir. Neither course was adopted at the time.

There was both misunderstanding and lack of communication between the responsible officers of the Corporation in connection with the work. Dr. Holden, the Medical Officer of Health, was never informed that the work was being carried out at all. He was in complete ignorance of it until after the outbreak had taken place. It is true that Dr. Holden's duties did not include any direct responsibilities with regard to water but he was sent monthly analyses of the water taken from certain of the wells and reservoirs. He had frequently made careful comments upon these analyses and had advised on the question of chlorination. I cannot help thinking that if Dr. Holden had been informed that men were working in the well and that simultaneously filtration and chlorination had ceased his advice would have been sufficient to put an end to such a state of affairs. His ignorance of the fact that chlorination had ceased may seem the less surprising when I go on to say that Mr. Boast, the Borough Engineer, who was the person directly responsible for the water supply, was also in ignorance of it. At a meeting preliminary to the work being commenced between Mr. Boast, Mr. Brandram-Jones the assistant water engineer and Mr. Ellis the mechanical engineering foreman in the Waterworks Department, it was brought home to Mr. Boast's mind that the proposed work would involve by-passing to a considerable extent the filtration plant. I am not satisfied that he then understood that it would involve a total by-passing of the filtration plant even when the water was being pumped to supply. He certainly never understood that it would involve elimination of the chlorinating plant. It was common ground between all three witnesses as to this interview that no mention of the chlorinating plant was made at all. This seems very surprising, for the filtration plant used as it was without a coagulant did little more than remove turbidity. The chlorinator, on the other hand, was worked with an ammoniator and even with the very small dosage that was being adopted, and without the stepping up of that dosage which took place from time to time when the analyses seemed unsatisfactory, might conceivably have been effective to deal at least with the typhoid bacillus. Evidence was given that the typhoid bacillus is killed by a smaller dose than that necessary for the destruction of the colon bacillus. It would seem that Mr. Brandram-Jones overestimated the value of the filtration plant and under-estimated that of the chlorinator. He attributed virtues to the filtration plant which it did not possess and regarded (with some reason) the very small dosage applied

to the chlorinator as one merely intended to keep it, so to speak, ticking over, so that it should be ready for stepping up from time to time when it was required. He therefore mentioned the cutting out of the filtration plant but omitted to point out that this involved as a necessary consequence the cutting out of the chlorinator. Mr. Boast was not sufficiently acquainted with the layout of the pipes to be aware that the one proceeding followed the other. On 31st October, 1937, after the outbreak had definitely begun he inquired on the telephone from Mr. Brandram-Jones (who had left Croydon on 16th October to take up a post elsewhere) what orders he had left as to chlorination at the Russell Hill and Addington Wells and learned for the first time that the latter was not being chlorinated at all and had not been chlorinated for a considerable time. What is extremely difficult to understand is how (even in the absence of any communication with the Medical Officer of Health) it occurred to none of these gentlemen that the fact of men working in the well during a period when water was being pumped to supply afforded strong grounds for the stepping-up of the dosage of chlorination in contrast to its elimination. If Mr. Boast had mentioned the desirability of increasing the dosage of chlorine he would at once have been informed that the by-passing of the filters involved the by-passing of the chlorinator. If it had occurred to Mr. Brandram-Jones, who regarded the existing dosage as merely nominal, that an increase in the dosage of chlorination was desirable while the work was proceeding he would, of course, have been the first to point out to Mr. Boast that the work was involving the total cessation of chlorination.

In this surprising and regrettable state of affairs the work commenced. The men selected for the work, as I have already pointed out, were not men of the regular waterworks staff and admittedly not familiar with the high standard of care in connection with water that would be possessed by members of that staff. I have been told that they were carefully selected for physical fitness out of a very large number of volunteers. I am unable to accept this evidence. I have seen seven of the men at very close quarters and I cannot understand how some of them could have been accepted on their appearance as physically fit. Case A, in particular, could not, in my opinion, have conveyed the impression of a healthy man. The important point is that there was no examination at all, however cursory, by the only class of person who would have been qualified to express any opinion of value upon the subject, namely a member of the medical profession. It was present to the minds of Mr. Boast and his assistant that the state of the men's health was a matter of importance yet neither the Medical Officer of Health nor any assistant of his was asked to examine them. Indeed, as I have already pointed out, the Medical Officer of Health's

department (situated in the same building as that of the Borough Engineer) was left in entire ignorance of the work being carried out at all. No one would expect that as a preliminary to this class of work there should be bacteriological tests made of the faeces and urine. When, however, there is no urgency about the work, a Widal blood test would appear to be a not unreasonable precaution.

I should observe, since I have dealt with the arrangement for urination while the men were working in the well that this appears to have been completely unknown to Mr. Boast although it would also appear that it had been the practice in Croydon during such work for many years.

Mr. Boast was under the impression that he had given directions to the effect that the men, whether they required to defecate or urinate, should be brought to the surface. If he did so (which was a matter of dispute) it would seem that his words were "use the lavatory" which might not have conveyed the meaning he intended to those, like Mr. Brandram-Jones and Mr. Ellis, acquainted with the practice of bringing men to the surface for the one purpose and not the other. I do not attach overmuch importance to this for I think that there was much force in an observation made by Mr. Ellis that if there was insistence upon the men coming to the surface whenever they desired to urinate and no provision made for that purpose where the work was being carried on the danger of misconduct would be greatly increased. This is quite a different matter from the question whether the provision for urination in the well gave any guarantee of safety. In my opinion it did not. The most elementary care would seem to dictate at least the use of a vessel which could be closed before being thrust out into the well shaft and hauled to the surface. This is, perhaps, an appropriate point to refer to the fact that Case A was definitely ascertained to be a faecal carrier and that a number of tests failed to detect any trace of the bacillus in his urine. There is the less materiality in this, since the scientific evidence established that a very large proportion, probably more than one-half, of faecal carriers are, at least intermittently, urinary carriers and that, as the detection of the bacillus in the urine is a more difficult matter than in the faeces, a negative result from even a large number of tests is not conclusive. While I have stated at the outset that all the probabilities point to the source of the infection of the well as being the work that took place in September and October, 1937, treating the gathering ground as a potential, but in this case improbable, source of infection I am bound to say that singularly little attention appears to have been paid by the water department to that potential source prior to the outbreak.

It is regrettable that a contractor's workmen engaged on Corporation work were allowed to dig and use a latrine almost directly above one of the well adits. The only explanation I

received of this was, firstly, that the latrine was obscured from the view of persons at the well buildings by a hedge and, secondly, that the work was being undertaken for the Education Department. I cannot regard either explanation as satisfactory. It seems unfortunate also that the existence of Fisher's Farm in which there were privies draining only into the soil and with an obvious tendency to flow downwards through the chalk in the direction of the not distant well should have been ignored. Of these, and of other undesirable features of the gathering ground, Mr. Boast frankly confessed himself to have been quite ignorant before the outbreak. I should say at once that Mr. Boast's duties as Borough Engineer covered so wide a range of matters as to make it impossible for him to give detailed personal attention to the highly important subject of water supply. He was responsible for highways, lighting, drainage, housing and many other matters. It may well be a matter for consideration whether in a borough of the dimensions of Croydon with its own water supply that supply should not be under the direction of a fully qualified water engineer reporting to a water committee and keeping in close touch with the Medical Officer of Health.

This concludes the observations I desire to make upon the facts relating to the causes leading up to the outbreak. I will now deal with the second subject matter of my reference, namely, the steps taken to deal with the outbreak.

Consideration of such steps may be naturally divided into two periods, the one before and the other after 4th November, 1937, when the source of the infection had been ascertained and when the supply of water from the Addington Well had been definitely stopped. The first period is a short one. On the 20th October, 1937, notification of a typhoid case was received. It is evident, and generally agreed now, that this case was unconnected with the outbreak which commenced so soon afterwards. The lady who was the sufferer had been on a holiday to France, she had eaten oysters there and both her own doctor and others who investigated the case were, and remained, of the opinion that she had contracted typhoid abroad. I mention the case because its occurrence, unattributable to any ascertainable local cause, undoubtedly rendered it less easy when the first few cases of those material to this Inquiry were notified, to visualise the oncoming of a local epidemic.

On 27th October the first case arising out of the outbreak was notified and on 28th October another case was notified. On 30th October two further cases were notified. On the same day Dr. Holden, the Medical Officer of Health, received a letter from a Mr. C. H. Rimington calling his attention to two further cases and stating, with considerable prescience, that even in these early cases other possible causes could be eliminated and that "the only common thing appears to be water".

I should say at once that the conduct of Mr. Rimington (who most unfortunately lost his own son in the course of the outbreak) seems to me to have been that of a very public-spirited citizen and that his emphasis on the question of water was not only justified in the event but may have been of considerable value. The 30th October, 1937, was a Saturday. On Sunday, 31st October, a meeting of local ratepayers, organized by Mr. Rimington, took place at the house of one of them, a Mr. Green. Mr. Green himself subsequently became a sufferer from the malady but fortunately recovered and was able to give evidence before me. At this meeting Dr. Holden and Mr. Boast were present. I have referred in connection with the first subject matter of the Inquiry to the odd lack of communication between the waterworks department and that of the Medical Officer of Health in connection with what was being done at the Addington Well. There is an equally surprising parallel in the opposite direction. Mr. Boast, the gentleman in sole control of the water undertaking, was unaware until 31st October when he received a telephone message to that effect from a private citizen, Mr. Rimington, that any cases of typhoid had occurred in the Borough at all. This undoubtedly arose from Dr. Holden having formed the view that the possibility of water being the cause of the cases which had been notified was comparatively remote. There was some dispute as to what precise expression was used by Dr. Holden at the meeting on 31st October with regard to water being the cause of the infection. Dr. Holden's own statement as to what he may have said was "that I could not suspect water until I had eliminated other factors". There was a good deal of evidence from gentlemen present at the meeting that Dr. Holden used the word "inconceivable" in connection with water as a possible cause but Dr. Holden's own recollection as to what he may have said is quite sufficient to show the tendency of his mind at the time. There are a number of explanations of this. He had had the sporadic case on 20th October; since then he had had only four notifications apart from the two mentioned in Mr. Rimington's letter. He was in complete ignorance, through no fault of his own, of the work that had been carried out in the Addington Well and of the fact that chlorination there had stopped. There was nothing at the time to make him visualise the extent of the coming epidemic although there was sufficient to make him uneasy. Sporadic cases of typhoid, though happily increasingly rare, are still common in the experience of a Medical Officer of Health whose area comprises a population of a quarter of a million. Up to July, 1937, from the beginning of the year, there had been ten notifications of enteric fever in the Borough, nine of which were cases of paratyphoid, the less virulent form of the disease which is very commonly derived from articles of food contaminated by a carrier. Dr. Holden had, no doubt, in his

mind the last substantial outbreak of typhoid in the country which was, in fact, found to be caused by milk, albeit the primary cause was the infection of the milk by water, though not from a public water supply. At the same time I think it is proper to point out that Dr. Holden was under the impression that water was comparatively rare as a cause of recent outbreaks of typhoid. That impression was wrong. I had the advantage of hearing the evidence of Dr. Suckling, an expert of very great qualifications and outstanding as an authority upon water supplies. He is the joint author of the standard work upon the subject which was freely used and referred to by all parties at the Inquiry. Dr. Suckling's opinion, expressed in his own words, was "I think that water occupies the pre-eminent position with regard to the spread of typhoid fever" and again "my view is that the majority of the epidemics of typhoid fever have been due to the infection of water rather than food". It is obvious that when typhoid occurs all possible sources of infection should be tested as soon as possible. It would seem, however, on the evidence I have heard, that even before it is possible to draw a line between the sporadic and the epidemical, water should be immediately suspected and if there is any priority in the course of examination for possible causes it should be given to water.

Returning to the events of 31st October, 1937, it was on that date that Mr. Boast, now apprised for the first time of the existence of typhoid in the Borough, telephoned to Mr. Brandram-Jones at the place where he was then engaged and received from him the surprising information that chlorination at the Addington Well had ceased for a considerable period. Dr. Holden and Mr. Boast discussed the matter and as a result, on the morning of Monday, 1st November, an adequate dosage of chlorination (0.18 p.p.m.) was applied to the Addington Well. As I have already stated the facts point to infection having ceased from this date even if it had not ceased at a slightly earlier date, the carrier having left the well on 26th October.

On the same day, 1st November, 1937, there were two further notifications and Dr. Holden took the very wise course of communicating with the Ministry of Health. On the next day there was one further notification and Dr. Holden again communicated with the Ministry definitely asking for the assistance of one of their Medical Staff. As a result Dr. Ernest T. Conybeare of the Ministry of Health, who throughout was in close touch with Dr. Hutchinson, his immediate superior at the Ministry, arrived in Croydon early on the morning of 3rd November and attended daily at the Borough for a considerable time. Dr. Conybeare's mind moved instantly to water as a possible source of the infection and one of his first inquiries was whether the residences from which cases had been reported were all on the same water

supply. On that date Dr. Holden appears to have been unaware that eight out of the nine cases notified up to date were on the high level supply. In response to Dr. Conybeare's request Mr. Boast produced a map showing the water system of the Borough from which it became tolerably clear that the common vehicle of the infection was water from the high level supply. Dr. Holden said in evidence that he asked for a map of this kind to be prepared but unfortunately the date of this request did not appear. In any event I cannot understand the necessity for any special preparation of such a map. It is remarkable that there should not have been readily available in the Borough Engineer's office some map which would enable him or his assistants quickly to determine whether a particular house was on the high level supply or the low level supply. Armed with such a map on Sunday, 31st October, Dr. Holden and Mr. Boast might have satisfied themselves of the fact that the first six cases notified were on the high level supply. It is an undoubted fact that the pipeline system in Croydon is extremely complicated but it is hard to believe that its ramifications cannot readily be traced in the Borough Engineer's office.

As a result of Dr. Conybeare's visit the separate samples from the Stroud Green and Addington Wells were submitted to the Ministry and on the following day as a result of the report upon them, as I have already stated, the supply from the Addington Well was cut off.

Events after 4th November can be dealt with shortly, for the primary source of infection had then definitely ceased to operate. It was only from water in mains and cisterns originally supplied from the Addington Well that any infection could possibly be derived. It is to be remembered that from 1st November a measure of chlorination sufficient to destroy the typhoid bacillus had been in operation at the Addington Well and that in the normally occupied house deriving its water from that source the cistern would, at the utmost, contain a day's supply and generally a good deal less. It is also important to bear in mind the short life of the bacillus except in environments quite different to a household water supply. This question of household cisterns at one time bulked largely in the minds of my Assessors and myself as a possible explanation of some of the later cases. We obtained a plan showing the 19 latest cases to be notified, other than proved secondary cases, accompanied by details of the water arrangements in the residences concerned, showing especially the content of the cisterns and the taps that might possibly be used for drinking purposes and which were on the cistern. We had especially in mind the fact that in some of the older houses the cisterns might be large. The plan showed that most of the houses concerned had small storage capacity varying from 17 to 26 gallons. The two houses with the largest storage, one of 71 gallons and the other of 56 gallons, had no tap

connected with the storage tank. No less than 6 out of the 19 had no storage tank at all and depended entirely upon the main. Having regard to these facts I have been driven to the conclusion that the continuance of any polluted water in the cisterns and storage tanks after 4th November, 1937, played no part in the epidemic. I do not, however, intend to minimize the general importance of this matter more especially with regard to houses that might be temporarily unoccupied. On the 11th November Dr. Suckling arrived in Croydon to give the authorities the benefit of his assistance in dealing with the epidemic and one of his first recommendations was that water stored in unoccupied houses should be run off and on the same day a statement was issued to the Press advising people who might return to houses that had been unoccupied for some time and where there were cold water storage tanks first to run off the stored water. It seems to me, on the evidence, that this is a very desirable precaution and should be recommended at the very earliest possible moment after the water supply is ascertained to be the probable source of infection.

I come now to a matter of criticism which is to some extent general in relation to both of the periods which I have been considering. On 1st November Dr. Holden, by letter, notified all the registered medical practitioners in the Borough of the fact that certain typhoid cases had occurred in South Croydon. No details were given other than a general warning to keep the possibility of typhoid in their mind. It would be doing an injustice to the local medical practitioners to assume that, with this warning before them, they would not seriously consider the possibility of typhoid in any case of fever that they were called in to treat. That they would do so was stated in evidence which I accept, and indeed it seems obvious. On the other hand, there was uncontroverted evidence from the highest source before me that the clinical symptoms of typhoid vary in particular outbreaks and that the early symptoms can readily be mistaken for those attributable to other causes. The early manifestations sometimes seem to be not unlike those of influenza and they can be, and have been, mistaken for those of appendicitis. In addition, the remarkable diminution of typhoid in this century has deprived medical practitioners of any common acquaintance with the disease. These facts seem to me strongly to enforce the view expressed by Sir William Willcox, who took the trouble of attending the Inquiry on the 6th January, 1938, to give the assistance of his valuable evidence, and to express the view that in all large areas there should be some committee representing all the local practitioners which, upon the occurrence of any outbreak, would be in constant and close touch with the Medical Officer of Health and would provide the means of pooling and distributing all the information available from time to time as to symptoms

and possible causes. For instance, in the present case, it would have been of assistance to the general body of practitioners for the purposes of diagnosis to know as soon as possible that water had been identified as the source of the disease. It is desirable to make two things clear. Firstly, Sir William Willcox was not directing any special criticism at the Corporation's medical services for lack of some such committee as this. On the contrary he emphasized the fact that the absence of such a body was general throughout the country except in very few cases. Secondly, nothing in the evidence of Sir William Willcox detracted from the fact that after the outbreak had taken place the sole responsibility for dealing with it rested with the Medical Officer of Health and that he could not at the time of such a crisis be expected to act as Chairman of a committee. The view expressed by Sir William Willcox was a plea for some means of creating closer contact and more ready communication between the Medical Officer of Health and the general body of practitioners, and part of the value of the suggestion seems to me that it might tend rather to easing than increasing the work of the Medical Officer of Health during the course of an epidemic. I would observe too that a very large number of cases in this epidemic occurred on the very borders of the Borough and that it was obviously desirable that contact and communication should be established between the Medical Officer of Health and a slightly larger number of doctors than those with addresses in the Borough Directory. Before leaving the evidence of Sir William Willcox I desire to say this in order to avoid confusion. Sir William Willcox came to the Inquiry to give evidence on a particular and important subject. I personally asked him before his evidence was concluded whether he could assist us with his opinion upon the source of infection in the Addington Well. It subsequently appeared that Sir William Willcox was unaware at the time of the presence of an ascertained carrier in the well. This was natural enough, for when he gave his evidence, the evidence proving the existence of a carrier had not yet been tendered. He consequently expressed the view that the probable source of infection was in the gathering ground. The other medical gentlemen who were present during the Inquiry and who gave evidence gave that evidence on the assumption that there was at the material time a proved carrier in the well although the establishment of this fact was left to a later stage in the evidence when the Ministry of Health's Bacteriologist was called. I think I am entitled to say, as a result of an inquiry subsequently made, that if Sir William Willcox had been aware of the fact that at the material dates there had been a typhoid carrier in the well (of which he was unaware through no fault of his own) his opinion as to the cause of the infection would not have differed from that of his medical colleagues.

I pass now to a more pleasant part of my task and to facts which materially lighten it. The Inquiry included a great deal of forcible, searching and severe criticism of Corporation officers. It was never suggested, however, that once a case of typhoid was reported it was not promptly, carefully and skilfully dealt with. Nobody has had anything but praise to say of the hospital arrangements, the nursing and the medical attendance. I have largely dealt with the conditions that caused the outbreak and with the detection of the source of infection. These matters must not be allowed to obscure the fact that the main task of the Medical Officer of Health throughout the epidemic was the provision of accommodation for the sufferers and the treatment necessary to keep down the death-roll as far as possible. The burden in that respect cast upon Dr. Holden was, as it must inevitably be in a case of this sort, an enormous one and nobody suggests that he did not discharge it adequately and well. Counsel appearing on behalf of certain local medical bodies put forward, with considerable skill and moderation, an appeal for greater co-ordination between the Medical Health Department and general practitioners, but expressing the views of his clients, described Dr. Holden as "a loyal, able and industrious servant of the Corporation as well as a truthful and careful witness." With that expression of opinion I concur. It appears to me that the only legitimate criticism that can be directed at Dr. Holden in this case is a slight delay in his realization that "water" was or might be the cause of the epidemic. I do not think that until after the 29th of October he had any reason for directing his mind to water. The two cases notified up to that date, like the earlier case on 20th October, might well have been regarded as sporadic. On the 30th October he had two more notifications and the indication of two further cases making six in all. I think by then his mind might well have turned to water but it is clear from the evidence as to what took place on 31st October that he remained until then reluctant to consider water as a probability. As I have already said, it was on the morning of 1st November that effective chlorination took place at the Addington Well although Dr. Holden admitted that this was done as a precaution and not because the well was then suspected. From these facts it will be obvious that any criticism of delay in attacking the Addington Well supply must be based upon a period not exceeding two days and I must repeat that Dr. Holden until the 31st October was ignorant of the fact that chlorination had ceased at the well. If separate samples of the well water were taken on the 30th October, as they were in fact on 3rd November, the result would have been known at the earliest on 31st October and could, at best, have meant the speeding up of chlorination by some hours. The dates of the various cases render it unlikely that any infection was caused by this short delay and if I had to come to a conclusion upon the matter I should say that it was not.

Nothing in my report must be taken as suggesting that there is something dangerous about the Addington Well. The epidemic arose from an avoidable and external cause and not from anything inherent in the well itself. In fact the infection was due to an unfortunate and rare coincidence of three factors—(a) constructive changes taking place in the well, (b) one of the workmen being a typhoid carrier and (c) the process of chlorination being in abeyance. With due attention to the gathering ground and suitable chlorination there is no reason why the Addington Well should not provide a perfectly healthy drinking water. The evidence, however, makes me think that analyses of the water from these chalk wells should not be at such long intervals as a month.

There is one official of the Corporation whom I have not previously mentioned in the course of this report, Mr. Taberner, the Town Clerk. Mr. Taberner took up his duties for the first time on 1st November, 1937, and immediately found himself involved in the extremely complex and difficult work resulting from this epidemic. All parties represented at the Inquiry publicly expressed their gratitude to Mr. Taberner for the assistance he had rendered them in supplying any information or documents that they desired to have. Indeed I desire to say that the attitude of the Corporation to the Inquiry under the Mayor (who also assumed office after the outbreak had started) and Mr. Taberner was a model of what that of a public authority should be when anything connected with its administrative duties is being investigated. I am completely satisfied that every witness and every document that could usefully assist me and that was in the control of the Corporation was put before me by Sir Walter Monckton on the Corporation's behalf.

Finally I am glad to say that while my responsibility for the conclusions I have expressed, and the grounds for stating them, are entirely my own, my Assessors are in general agreement with them. I have received the most invaluable, painstaking and loyal assistance from Sir Humphry Rolleston and Mr. Gourley throughout.

I have the honour to be,

Sir,

Your obedient Servant,

HAROLD L. MURPHY.

8th February, 1938.

THE
OFFICE OF THE
SHERIFF
OF THE COUNTY OF
SHERBORN
HANTS.

NOTICE
TO THE
CREDITORS
OF THE
ESTATE OF
THE LATE
JOHN
WILLIAM
MURPHY
DECEASED
OF THE
COUNTY OF
SHERBORN
HANTS.

THOMAS
MURPHY
SOLICITOR
AT LAW
SHERBORN
HANTS.

1895