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Typhoid Fever

Especially in reference to
its aetiology as illustrated by various epidemics
occurring in Yabak - Newport, Mon within recent
years.

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1.

The continued fever which bears the name of Enteric or Typhoid has come into considerable prominence during the last few years with regard to its aetiology and treatment - and more especially its diagnosis.

It consists in an increased tissue change, caused by the entrance into the system of a definite Bacillus which produces certain characteristic symptoms chiefly in the intestinal tract. Eberth-Gaffky's Bacillus is now recognized as the specific organism of the disease. To prove that any definite Bacillus is the cause of any particular series of symptoms and morbid changes it is necessary to:

1. Isolate the Bacillus in every case.
2. Grow the Bacillus in a suitable medium outside the human body.
3. Produce the original series of symptoms & morbid changes in an animal by the introduction of the Bacillus into that animal.

Each of these steps is very difficult in the case of Enteric Fever. 1. Eberth first pointed out rod-like bodies with rounded ends in certain cases of Typhoid fever & then Gaffky demonstrated their existence in almost every

case he examined in sections of the intestine through Peyer's patches & in sections of the Spleen and Mesenteric Glands. 2. Although he was not able to cultivate them from every case still in a large number of cases he was able to cultivate them from the stools, portions of gut, mesenteric glands and Spleen and to show that they were not present in the blood.

3. The final step, the most important has been found to be the most difficult to attain. Klein in Stevenson & Murphy's Treatise on Hygiene & Public Health Vol II page 168 (published 1893) states that "Typhoid fever has not been communicated by any experimenter to the lower animals"

It was found that the introduction of the Bacilli into various animals such as monkeys, white mice &c produced very violent symptoms but all pointing to acute Septicaemia. In the British Medical Journal March 12th 1898 it is noted that E. Frankel & Simmonds as the result of intraperitoneal injections of the Bacillus Typhosus in rabbits & mice, succeeded in producing a disease marked by hypertrophy of the Spleen, mesenteric glands

& Peyer's patches. In this case however it was possible that the symptoms were caused not by the growth & multiplication of the Bacillus but by toxic substances in the organisms originally injected.

The experiments of P. Reuling (Ann de l'Inst-Pasteur no 11 nov^r 25th 1897) have however removed any doubts that may have existed as to the possibility of communicating Intercia from to animals. His method of procedure was to feed rabbits or rats upon Cabbage or lettuce leaves soaked in water containing a culture of Bacillus Typhosus. The feeding was not in any case prolonged beyond ten days & was stopped at the first appearance of symptoms of disease. Unless the diet was ample & given continuously it was found that no effect was produced. Of eight rabbits experimented upon four were unaffected, although the B. Typhosus was found in the faeces during the whole period of feeding. Their blood did not give Widal's reaction. The fifth rabbit suffered from a febrile attack of eleven days duration but recovered. Here again no Widal reaction could

be obtained. The three remaining rabbits suffered from what may be regarded as a typical attack of Enteric fever, rise of temperature, malaise & diarrhoea being prominent symptoms. The blood in all three cases was shown to have an agglutinating action on cultures of the Eberth-Gaffky bacillus. Post-mortem examination showed congestion of the small intestine, proliferation & ulceration of Peyer's patches, with enlargement of the spleen & mesenteric glands. Cultures of the Typhoid Bacillus were made from various organs of the body. The same method of feeding gave similar results with white rats & in one case a pure culture of the Typhoid Bacillus was obtained from the blood of the heart. The proof that the Eberth-Gaffky Bacillus is the specific cause of Enteric fever is thus complete.

For its full development the Bacillus requires. I. Suitable medium which may be (a) Decomposing animal matter

(b) Water

(c) Milk

(d) Various specially prepared materials

II Moisture as considered in reference

- to (a) Action of the ground water
- (b) Flooding of low lying lands along river banks

III Temperature which may be

- (a) General
- (b) Local

I Suitable Mediums -

(a) Decomposing animal matter. -

It is connection with the media in which the Bacillus will grow and increase in virulence that the greatest importance has to be attached as on this depends chiefly the measures to be taken to eradicate the disease. It is ~~owing to its~~ partiality for filth that enables it to produce epidemics of Typhoid fever wherever the drainage system is incomplete thus the drainage of a large area may become infected by the stools of one single case with the result of producing Typhoid in persons living in houses into which the exhalations of the contaminated drain can penetrate through inefficient traps &c.

This was well shown in the case of two epidemics of Typhoid in the County

Borough of Newport, Mon in 1891 & 1892.

The Seaport town of Newport lies on the river Ask; part of the town being on the flat land along the banks & part on the higher land on either side at some little distance from the river. The town being, in its infancy, confined to one bank of the river & having recently increased rapidly has, as all such towns have to do, taken into itself various outlying sanitary areas. One of such areas occupied the other bank of the river & its corresponding high ground beyond this area called Maudee was absorbed in 1886 & in it the sanitary arrangements were far from perfect. In it also there are numerous wells, at the foot of the high ground and attached to private houses. These wells have always been a source of danger being very liable to the entrance of surface water & in the want of efficient drainage to the entrance of sewage. Thus there have at various times been sporadic cases of Typhoid which could be traced to the use of the water of one of these wells contaminated at least with sewage. The summer of 1891 was wet

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I told with the result - that there was a number of the wells contaminated, more than the average number of cases of Typhoid occurred in the Autumn & the sewers of all that part of the town became contaminated with the result - that cases occurred in houses where there were no wells but where the house drain connections were at fault - the cases from the wells were in the low-lying part of the district - while the majority of the cases from entrance of sewer gases were in houses on the high lying ground. The late Dr. Davies, Medical Officer of Health, at that time, reported to the Sanitary Authority that "in 1891 there had been 10 deaths & 61 notifications of Typhoid in the Borough". "The considerable number of cases of Typhoid fever reported is in a great measure explained by a limited outbreak of this disorder which was confined to a certain district in Maudslayi which on investigation was traceable to defective house drain connections which allowed the entry of sewer gas into the houses & probably also in some instances to the use of polluted water."

By Octob^r 27th/91 he was able to report - that with reference to the outbreak of Typhoid fever which had taken place chiefly in the upper part of Maumee all possible precautions had been taken to prevent the spread of the disease & that he had found the owners of houses most ready to adopt any suggestions for structural amendments with the result that it had now abated. During the two succeeding quarters two & four deaths from Typhoid were respectively noted but during the quarter ending March /92 there were no deaths from this disease. In his report of Octob^r 27th/91 he notices that - "the deaths from diarrhoea among children have been few which has always been the case in cold, wet summers as it has been shown that it requires a certain rise of temperature in the soil before this complaint makes any head." all through this small epidemic the attention of the Sanitary authorities was chiefly directed to closure of the polluted wells & to house to house inspection of drains. The wells were closed for drinking purposes but some were not filled or sealed up but left for use in stables &c. The drains found defective

were of course remedied & during the winter frosts the disease died out completely. It was not till the 3^d September /92 that Dr. Davies reported "a very serious outbreak of Typhoid at Maudes" after a very hot & dry summer. It was noticed that a majority of the cases now occurred on the high lying ground & thus suggested the idea that the sewer gases rising to the higher level were the chief factors ~~was~~ ⁱⁿ the dissemination of the disease. Thus on September 3^d "it was also considered that the sewers in several of the streets where Typhoid had occurred required to be ventilated by the construction of gratings" on the 25th October he reported that since his last report there had been 9 deaths & being in Maudes "Since the ventilation of the sewers has been carried into effect - there has been no death - on the high ground & only one fresh case of the fever notified. This fact tends to corroborate the theory as to the origin of the outbreak in insufficient ventilation of the street sewers which through defective house connections allowed sewer gas which happened to be charged at the time with the specific poison to enter the houses in the locality which became infected"

"Seven polluted wells in the same district have been closed. Foul drinking water however I am satisfied played but a subordinate part in the propagation of the fever as no more than 18 out of the whole 100 cases can in any way be attributed to the use of bad water. The poison of the fever in by far the majority of instances entered the system by the lungs & not through the stomach in other words it was inhaled not swallowed" although fresh cases did not arise some of those already notified died during the next quarter for on the 24th January/93 he reported 9 deaths & in Mambree. In his report for the year 1892 he states there were 17 & notifications of Typhoid with 20 deaths & thus writes of the epidemic. "The sudden outbreak of Typhoid fever on the East-(Mambree) side of the river began during the very hot weather in August & continued with more or less intensity for the next three months. There were 130 cases in all 22 in August - 74 in September 26 in October 7 in November & 1 in December (this in population of less than 6000) It originated in my opinion in want of Ventilation of the street sewers & defective house connections

permitted sewer air to enter freely into houses in the infected locality. A few of the cases were also traceable to the use of water from polluted wells (These wells were tested for sewage not for *Shuttleworth's Bacillus*). The steps taken by the Sanitary Committee to cope with the epidemic were house to house inspection to find out defects - the free use of bromocretants & in the absence of any hospital provision the engagement of nurses to attend the sick at their own homes. The Ventilation of the sewers was at once taken in hand & a number of fresh Ventilators put in. Ten polluted wells were closed. This epidemic gradually died out - still during the quarter ending March /93 there were 3 deaths.

Strangely enough a localized outbreak occurred in the Autumn of /93 on the opposite side of the river to the Maunabo District - but still on the flat - causing 6 deaths. This small outbreak was abruptly closed by at once putting in numerous Ventilators in the sewers. On the Maunabo side the streets run in terraces along the side of the rising ground so that the gas rising to its highest level.

accumulated in long stretches of sewer pipes the houses with defect drains acting as extractors. In the case of the small outbreak in 1913 in the street where the cases broke out it was found that the sewer ran into a cul-de-sac past the houses from the main sewer & there was no ventilation at the cul de sac. The theory has been advanced that the Bacillus can originate de novo from sewer emanations, putrefying animal matter, usually exposed mud &c. some even supposing that the germ producing the fever is a product of decomposition - But in the great majority of cases the direct infection of the patient by emanations from a known case of Typhoid carried by contaminated water, milk, food, sewer gas or directly, directly by the personal emanations of a Typhoid patient has been proved & the extreme probability of the germ remaining quiescent in the soil for sometime & then becoming virulent - though some accidental cases would tend to show that the Bacillus does not originate de novo.

The germicidal action of fresh air & sunlight was well shown in these epidemics.

While the gratings were being put into the sewers in the main streets to act as Ventilators there was a great outcry & numerous complaints were made as to the obnoxious smells arising from the gratings. One or two cases stated that they were sure that they had caught the infection while crossing the road over one of the gratings & inhaling the poisonous gases but in these cases the drains at their private residences or places of business were invariably found to be defective so that there was a much more likely source of infection. One thing is certain that during the whole epidemic only one man among the number employed in opening the infected sewers & drains & putting in Ventilators became ill with Typhoid & there is every possibility that he may have been infected through his hands not being thoroughly cleansed after being in contact with the filth & thus contaminating either his food or drink. A very large number of gratings were put in opening into the main streets & yet none of those passing over them & living in other parts of the town became infected thus showing that fresh air & sunlight have a diluting effect & a germicidal action and that

it requires long exposure to the germ laden gas & thus a large number of germs to enter the system before the Bacillus is able to produce Typhoid. The Bacillus has not yet been discovered in sewer gas & it may be that the Bacillus Typhosus is present often in the intestinal tract in a modified form & that inhalation of sewer gas assists its evolution into Bacillus Typhosus. In which way sewer gas acts either as a vehicle or a stimulating agent in the process of evolution there is no doubt that the entrance of sewer gas into dwellings has resulted in Typhoid.

It should be noted that the Maidenhead district drinking water supply is the same as that for the whole Borough and there was never any suspicion with regard to it.

(b) Water

The fact that water may form a medium in which the Bacillus can actually grow and increase in virulence is extremely important as it is owing to this fact that the water supply of a town may become infected with a comparatively minute quantity of Typhoid germs & produce a most violent &

widespread epidemic. It has been proved that the *Bacillus Typhosus* can grow in even sterilised water but in a feeble way & it will ultimately die out in this medium but in water to which even a small amount of animal matter has access it will grow readily. The fact that it can remain alive in water chemically pure & pure to all the usual tests for sewage is the important point.

The most complete & instructive evidence (Stearns & Murphy's *Treatise on Hygiene & Public Health* - Vol II p 167) as to the contamination of drinking water by Typhoid stools & whole sale infection by such drinking water was brought forward by Dr Thome Thome in elucidating the now famous epidemic of Typhoid fever in & about Caterham. His report for 1878 published in the Volume of the Medical Officer of the L.C.C. contains the full account - on this most instructive & now classical piece of epidemiological work. It was proved that one of the employees at the Caterham works of the Kent Water Co. while actually affected with Typhoid fever managed to contaminate water his stools the water at the original wells of the Company

& this contaminated drinking water, in its distribution about Caterham, Regent & other places produced in the consumers Typhoid fever. More recently the terrific outbreak at Maidstone again in Kent in 197 was shown to be due to contamination of certain springs most probably by hop-pickers. The water of these springs passed into the main drinking supply of Maidstone.

The cases in which the water has of itself contained an appreciable amount of sewage other than Typhoid before its infection & then produced epidemics are numerous. Reicke in a communication to the Hamburg Surgeons Society (Public Health Vol 1x No 2 Nov^r 1896) showed that the recurring epidemics of Typhoid in Hamburg were due to the drinking water chiefly. This water was taken from the river which was always much contaminated with sewage. He noted short & explosive outbreaks in February & March when the frost interfered with the filter beds. The mortality from Typhoid before 1848 was very high. In 1848-9 the system of sewers &c was completed with a great im-

improvement - soon though the run was becoming more & more polluted. In 1893 the filter beds were established with a very marked improvement - & he notes that an inefficient - filtering at once told on the Typhoid rate. He specially notes one instance - on August 8th - 11th / 93 there was severe outbreak of vomiting & diarrhoea amongst the workmen at a wharf on the Elbe who were supplied with river water filtered through a Bishops patent filter. Shortly before the outbreak the filter had been cleaned & consequently did not work well. Some two or three weeks later 19 out of 110 showed symptoms of Typhoid.

In Newport there has been no contamination at any time of the water supply but there have been numerous cases as before mentioned due to persons using some of the old wells under exceptional circumstances such as hard frosts &c - These wells being deep & not liable to be frozen even in the severest winters.

Contaminated water has been shown to be a source of danger in an indirect way

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viz when taken into the stomach in the form
of ice cream &c & when it is used for the
cleaning of utensils used to hold articles
of diet - such as milk &c also when articles
of diet - such as water cress & other green
vegetables have been soaked in it - also
when various shellfish, mussels, oysters &c
have lived & grown in it. In fact so strong
has the feeling been with regard to outbreaks
due to eating shellfish especially oysters taken
from sewage contaminated water that
legislation interference has been asked for.

(c.) Milk

The fact that
milk can form a medium for the growth of
the typhoid germ has been recognized for
a long time. ~~But~~ Milk may become infected
in various ways - usually by the use of con-
taminated water in the cleaning of the
utensils ^{containing} it or by the germ being carried
by the air from a dried mass of infected
animal matter. It may be that milk
stored in a room to which sewer gas from
an infected drain has access may be
able to absorb that which in the gases

can produce Typhoid but - I have not been able to find a record of any case caused in this way. Ballard has shown (Stevenson & Humphrey Treatise on Hygiene & Public Health Vol II p 167 that - in ^{the} dissemination of the Virus of Typhoid Fever as in the Solington Epidemic milk plays an important role (Tables Transactions of the International Medical Congress London 1881)

In Newport in 1897 a small outbreak occurred which was found to be limited to persons supplied with milk by a dairyman living in a village a short distance out of the town. Various cases were found to have in this village but these at first seemed to have no connection with this said dairy as they did not obtain their milk supply there, not only so but the person from whom the village residents obtained their milk was on anything but good terms with the aforesaid dairyman but on inquiry it was found that at this particular time the person supplying the village residents had run short of milk for all her customers & had obtained some milk from the dairyman

through a blind party. It was then shown that there was a well on the premises of the dairyman polluted to a marked degree with sewage matter both from the cow houses & private houses. The dairyman denied that he or his servants ever used this water to wash the milk vessels but the fact remains that whenever the well was closed no more cases occurred & the outbreak was limited to less than a dozen. This number only being attacked out of all the dairyman's customers might be due only to one or so of the milk vessels being washed with the infected water.

(d) Various specially prepared materials such as glycerine, Bouillon, Agar blood serum, boiled potato &c. have been found to be specially favorable for the growth of the Bacillus. Into these of course the Bacillus has to be placed by human agency & in them it grows in a definite form thus allowing of the use of these media in its differentiation from other Bacilli found in the same habitat.

II Moisture

(a) The action of ground water

It has long been observed that various diseases but more specially Typhoid fever increased & diminished with certain changes in the height of the subsoil water.

There are two views held in this connection

(1) "The outbreaks of enteric fever occurred when the ground water was lowest and especially when after having risen to an unusual height it had rapidly fallen"

(Park's Practical Hygiene p. 8) This is the view of Pettenkofer & Buhl but they also hold that "it is necessary to have impurity of the soil from animal impregnation, heat of soil & the entrance of a specific germ".

(2) A uniformly low ground water is most healthy - a uniformly high ground water is preferable to one that is fluctuating specially if the limits be wide. Baldwin Latham agrees with this & holds that the most unhealthy time is when percolation commences after the lowest ground water period.

Croydon - fewest in June maximum in January

Paris - " " June " from Aug. to Nov^r

Newport - 1906 " " June " " Sept to Oct^r

Peterkofers view would entail that good drainage of the subsoil would increase the amount of suture but this has not been found to take place. In connection with this "it must however be borne in mind that it is not the ground water itself that is the cause of disease but the impurities in the soil which the varying level of the ground water helps to set in action".

(b) Action of localised Saturation of tracts of land either from overflow of river banks or along tidal rivers where high tides overflow parts of the land. Newport is liable to the latter in a marked degree: The lower lying parts of the town being liable in the event of exceptionally high tides to be flooded & have their drains blocked. The lower parts of the town are so markedly more liable to Typhoid that 86 per cent of the cases notified in 1896 were from the low lying districts.

III Temperature

(a) A general high temperature is necessary. The Bacillus can survive a low temperature but seems to lose its power of growth. — Epidemics invariably occur in Summer or Autumn.

(6) Local High Temperature.

This is one of the causes of the almost-Endemic nature of the Typhoid on the low lying ground in Newport. The houses on this land are either built - below very high tide level or on ballast - obtained from a variety of sources & some of it - certainly contaminated with - sewage material. When houses are built - on such land & insufficient - means have been taken such as the absence of cement-ground floors &c to prevent - the heat of the house drawing up the moisture from the underlying ground they are invariably found to prove unhealthy.

It is thus seen that the Bacillus is possessed of considerable vitality. It can live & probably grow in such a poor medium as water & it can resist - considerable variations of temperature specially cold, also the action of various other Bacilli in putrefaction processes & also the action of the gastric juices. It is owing to this great - power of resistance that - it has been held by some, including I think - himself that the Bacillus is capable of forming spores

In potato cultures bright-terminal globules can frequently be seen which Gaffky interpreted as spores but which observers have noted as never being present - in cultures in other media - thus Buchier has been able to show that they only represent involution products. Klein in Sherman & Murphy's Treatise on Hygiene & Public Health - Vol II p. 169 states that - "The Typhoid Bacillus never survives a temperature of 60°C for five minutes & in this respect behaves in a manner totally different from spore bearing Bacilli." "The drying of a thin layer of a culture of this Bacillus no matter what age the culture & no matter what the medium & whether grown on surface or in the depth kills the microbe." Dilution of the gases from contaminated sewers with fresh air & the action of sunlight markedly diminishes their virulence.

It has been proved that the Bacillus can remain quiescent in the ground for many months at least. Professor Delepine has been able to isolate the Bacillus in an "infected area" that is in the soil of a district where Typhoid fever is prevalent & where it has shown

a tendency to produce sporadic cases from time to time even when all attempts are made to stamp it out permanently by securing good sanitary arrangements & disinfection. Dr. J. Robertson M. O. H. Sheffield in the British Medical Journal of January 8th 1908 has shown that although he was not able to isolate the Bacillus in the soil taken from an "infected area" yet by experiments made he was able to note a marked increase in the number of the Bacilli placed by him in

the soil of a field. He noted that the Bacilli which were not "fed" by bouillon gradually died out but that the colonies "fed" increased & were present soon after a rather severe winter. He writes "they (the experiments) prove that the typhoid organism is capable of growing very rapidly in certain soils a leaking or defective drain is constantly feeding with organic matters the surrounding soil. If cases of typhoid fever are attributed to this drain & the leak repaired it is possible that a similar action will take place to that which occurred in the soils which were not manured."

The Bacillus would seem to be widely distributed

& to be present in almost all soil in a greater or lesser degree, a conclusion to which the following seem to point-

1. The occurrence of the disease in all climates
 2. In sparsely populated as well as thickly populated districts
 3. The marked influence of the rise & fall of ground water on the prevalence of the disease all over the world
 4. The rapid production of the disease whenever accidental circumstances arise causing increased food supply to the Bacillus or providing it with the necessary moisture & heat for its growth.
 5. The cases that have been noted where some old drain or cesspool has been opened with the result of producing Typhoid in some person engaged in the operation soon though there has certainly been no recent infection of the drain or cesspool with Typhoid stools.
- There may thus be a constantly varying amount of Bacilli in the soil - dying out in the one place for the want of proper food, moisture or heat; increasing rapidly in another on the accidental admission of suitable nutriment - & thus increase through the action of some vehicle producing an epidemic which in its turn produces new contaminated areas.

Predisposing causes

Enteric fever occurs in all countries but seems to be more prevalent in temperate than in tropical climates. It attacks all races impartially. It has been noted by some observers that it is rare among the adults of the native races of India & by some has been described as a race immunity while others state that it is merely an acquired immunity as the children are brought up under such conditions as to make it highly probable that many of them have a mild attack even in comparative infancy & thus acquire an immunity. In the British Medical Journal Aug: 7th 1897 Surgeon Major Freyer has published the result of certain tests applied to children in India tending to show that the native is not born immune but has an attack frequently very early in life. Freyer thus explains the increased prevalence of enteric in English soldiers in India stating that in the old days the soldiers went out to India from homes not much better in a sanitary sense than the homes of the natives. He was, in fact, immune to enteric long before his arrival in India but that nowadays with

the great improvement in Sanitary matters in this country he goes out to India to meet it at every turn & thus fall a victim.

Season The Registrar General's returns show that the highest mortality is in October & November in London. In 1896 in Newport 75 per cent of the notifications were in September & October.

Sex has no marked effect - although there is not the same marked preponderance of male cases that one finds in other diseases where males are more exposed to risk of infection.

Age. 52 per cent of the cases occur in adolescence. It is very rare in children & in persons over 45 yrs of age at least in this country. Some authorities among others Prof. Sir Trauger Stewart consider that Infantile intermittent fever is usually typhoid which has slight peculiarities & in which the rash so frequently seen in adult cases is absent. Whether this is really so will soon be definitely known by the application of Widal's test to all doubtful cases.

Occupation has no effect. It might be supposed that workers on Sewage farms, Sanitary officials, Labourers employed in Ventilating Drains

Nurses &c would be more susceptible but this has not been found to be the case. In the epidemic referred to in Newport - only one man caught the infection. During the two years the Infectious Hospital has been open in Newport - only one nurse has suffered from Typhoid. In both these cases the possibility of direct infection through some slight carelessness in personal cleanliness could not be dismissed.

Insufficient-Ventilation, want of Sunlight & overcrowding all predispose as can readily be understood in the case of a germ due to a Bacillus that delights in filth. This shows the importance of cleanliness in the houses as the Bacillus may actually grow in the dirt between the boards of a floor or wall & suddenly take on a virulent action under some special circumstances

General ill health may predispose but not markedly

Immunity The fact of having had one attack does not necessarily imply that it is impossible for that person to have another

but there seems to be some immunity
 for a time at least. It is rare to have
 a second attack. Since Vidal brought for-
 ward his serum test this immunity has
 come more prominently forward. It has
 been found that the serum of persons who
 have had Typhoid does not lose its agglutina-
 -tion power for a long time. Of course it
 is more difficult to prove that persons
 whose serum gives the reaction although
 they are at the time in perfect health
 must at one time or another have suffered
 from Typhoid fever. Freyer & other observers
 in India have tested this & they find that
 many children from 2 yrs & upwards give
 the reaction & their deduction is that the
 native children are subject to Typhoid
 at a very early age & practically remain
 immune for a life time. If that is so
 it would seem as if Vidal's test would be
 of little use in India to distinguish an
 attack from any other disease as the
 patient would give the reaction of im-
 -munity in any case. This does not
 seem to hold in this country.

Clinical History

In whatever way the Bacilli enter the system whether by ingestion or inhalation they require

1. To enter in sufficient number
2. To enter a system that will allow them to live.

These two requirements are so intermingled that it is impossible in any case to say which one it was that must have been wanting. It is well known that every person drinking contaminated water or milk or breathing the same sewer gas does not necessarily become a victim to the disease. In many cases the second requirement seems to be the important one. Thus in the severe winter of 1894 I attended Mr. B. who lived with her husband in apartments in this town. During that winter the water pipes all over the town became frozen in various parts. In this particular house they could obtain no drinking water from the ordinary water supply pipes. The householders obtained water from neighbours while Mr. B. who was a stranger did not like to ask but obtained her supply from a pump attached

to a well in a stable at the back of the house
 Both she & her husband drank this water
 but she only took Typhoid fever. The water
 of the well was found to be contaminated
 with sewage in an extreme degree as the
 liquid filth of the stable could easily pass
 down the pump. In the case of the milk
 epidemic already noted many customers
 must have drunk the contaminated milk
 without any bad result. It has been held
 by some that a person whose intestinal
 tract is at all times overloaded & who is
 therefore habitually in a state of auto-intox-
 ication is more liable to infection. There
 is no doubt that the ingestion or inhalation
 of Typhoid germs may produce certain
 symptoms such as diarrhoea & other
 gastric disorders without passing on to
 the actual production of Typhoid. It is
 well known that an epidemic of Typhoid
 is frequently preceded by an outbreak of
 diarrhoea as was noted in the recent
 severe epidemic at Maidstone in Kent.
 This diarrhoea & other gastric disorders may
 be due to the Bacillus itself or it is possible

to suppose that the Bacillus can produce something such as a ptomaine which can act as an irritant without having the power to produce the typical ulcers or the alteration in the serum necessary to give the typical agglutination reaction as in Widal's test. It may thus be that cases of Infantile Diarrhoea & Summer Diarrhoea are due to the entrance of the Bacilli in an attenuated form or few in number into systems able to cope with them or to the entrance of a product of the Bacilli. — In whatever way the individual may have caught the infection there follows a very definite train of symptoms. The germs remain in his system practically quiescent — or at least — without producing any marked symptoms beyond a slight impairment of appetite & a feeling of general malaise & debility, for a certain time called the period of incubation varying from 5 days (Stevenson & Murphy's *Treatise on Hygiene & Public Health* Vol II p. 318) to even 30 days. The average period being from 14 to 21 days. He may then complain of

slight frontal headache & restless sleep. These
 symptoms become much more marked as
 the patient enters the period of invasion.
 Up to this time he has in all probability
 been able to go about & attend to his work
 but now he becomes weak, unable to take
 his food - suffers from severe headache &
 sleeplessness & in the great majority of cases
 diarrhoea sets in but this symptom is
 sometimes absent throughout the whole
 course of the attack. The patient feels
 cold & chilly & may have distinct rigors.
 There is now abdominal pain referred
 generally to the right iliac region but some-
 times to the umbilicus. The abdomen is
 usually distended & one may on pressure
 elicit a gurgle in the right iliac fossa.
 The tongue is furred, red & irritable looking
 at the edges, with the papillae very prominent.
 There is a tendency to vomiting. The diarrhoea
 is frequently marked the number of stools
 varying from 3 or 4 to 16 or 20 in the 24 hours.
 They are very liquid & often very offensive
 & from their colour & consistence have been
 termed "peasoup evacuations". Uniform

Throughout - when first-passed, they separate
 on standing into an upper watery layer,
 of a yellowish or brownish colour containing
 albumen & salts in solution, the latter in-
 cluding Chloride of lime & Carbonate of ammonia;
 & a lower layer or deposit, consisting of the
 remains of food, Epithelium & mucus corpuscles
 blood, small yellow flocculi, shreds of slough
 & crystals of triple phosphates" (Roberts. Theory &
 Practice of Medicine page 128) The blood at this
 stage is due to rupture of some of the minute
 vessels in Peyers patches which are acutely
 congested. The shreds of slough are only found
 in some of the evacuations & not in the earliest.
 The urine contains urea & uric acid in excess
 & a diminished amount of Chloride of Sodium.
 In the early stages in a few cases one may
 notice a slight red rash with some throat-
 irritation which soon disappears. The pupils
 are as a rule dilated & equal & there is
 frequently marked deafness. The pulse
 steadily rises sometimes to 100 or 120 in the
 minute but is somewhat weak & soft. The
 temperature also rises in a marked and
 characteristic manner - there is a rise of

2° between morning & evening temperatures
 & a drop of 1° or 1.5° between evening and
 morning. This clinical symptom is most
 important - as though there are certainly
 cases of undoubted typhoid which do not
 show this characteristic chart - yet it is so
 frequently present - as to be of the utmost
 value in diagnosis. Patients have frequently
 advanced to this stage before they apply
 for advice especially among the working classes
 I have noted that those cases seen late &
 where the patient has gone on working
 up to this stage often become quickly very
 seriously ill & that the mortality is distinctly
 higher in these cases than in those cases
 where the early symptoms have caused the
 patient to apply for advice. All these
 symptoms become marked in the second
week of the period of invasion. The diarrhoea
 is still marked & the stools contain blood in
 larger amount - but this is now due to ulcer-
 ation taking place in Peyer's patches & is
 therefore a much more serious symptom
 It may be absent altogether or occur in
 large amount - seriously affecting the chances

of the patient's recovery. at this time a rash appears chiefly on the abdomen sometimes also on the trunk but very rarely on the face. It is very rarely absent in adults but may be so in children. When it occurs it consists of rose coloured, lenticular elevated spots scattered over the abdomen varying in number from 15 or 20 to a fairly well marked rash. These spots disappear on pressure & come out in crops each lasting 2 to 4 days. The nervous symptoms now become more marked the patient becoming very delirious specially at night. This delirium is increased with the rise of temperature which may now reach 105° or even 106° at night although in the majority of cases the highest temperature does not exceed 104° .

In children there is frequently an amelioration with ultimate recovery from this period but in adults the most critical period is now entered on.

In the third week of the period of invasion all the symptoms are at their height and any one of them may become so severe as to endanger life. The delirium is apt to pass

into somnolence & the patient lies taking little or no heed of his surroundings. He may pass urine & stools involuntarily. The abdomen is not so tender but is usually much distended. The urine is scanty, high coloured & may contain albumen in fairly large amount. The pulse is very rapid & weak & shows signs of cardiac weakness. By this time of course he has become extremely emaciated & the muscles may show (Roberts, Theory & Practice of Medicine, p. 129) the peculiar swelling, on being gently tapped with the end of the finger, called myoedema which is due to muscular degeneration. The tongue is dry & cracked & scales have collected on the teeth &c & there is often great difficulty in feeding him. It must be understood that the period of invasion is not always divided into three periods of seven days. Each of the periods may vary specially the last so much so indeed that although the average duration of the period of invasion is 21 days it may continue on to 60 days before the period of convalescence is entered.

There is then a gradual amelioration of all the symptoms, a gradual fall of temperature indicated by a more marked morning remission followed by a fall of the evening temperature & later a very marked morning remission of 2° or even 3° - The pulse becomes better - the tongue becomes moist - & not so red & the patient may thus gradually recover but even in a mild case the convalescence may be much prolonged. The patient must be extremely careful specially with regard to diet - as a relapse soon more than once is by no means uncommon even when the greatest care is taken. A relapse is often more serious than the original attack & will be at once noted by the rise of temperature & return of diarrhoea & abdominal pain. The disease may prove fatal at any period of its course. In the very early stages from acute virulence of the poison - later from some complication but more usually during the third week either as above mentioned from severity of the symptoms or some complication. Death may thus occur from hyperpyrexia acting directly or indirectly as by

increasing the delirium & producing coma or convulsions also by increasing the muscular waste till death—occurs from Cardiac Syncope.

Haemorrhage—from Intestine, lungs or nose

Peritonitis due to the ulceration of Peyer's patches extending through the muscular coat & usually perforating the peritoneal & thus allowing escape of the intestinal contents into the peritoneal cavity

Severe & persistent—Vomiting. Paralysis of the bowel

Anæmia chiefly due to impoverished ^{blood} due to the excessive & long continued febrile state.

During the whole course of the fever there is liability to death from Complications such as Pneumonia, Congestion of the lungs (Acute & passive) Bronchitis, oedema glottidis, Laryngitis, Diphtheria Bright's disease of Kidneys, inflammation of bladder ureters, pelvis of Kidney &c.

Erysipelas, Erysipelas, Gangrene

Mania, Hemiplegia, Imbecility, Marasmus

Amaurosis. Tubercular disease of lungs or brain

Phlegmasia dolens, Diseases of bones, joints, Sars &c

All of which have been noted. The lung complications are the most common indeed a state of passive congestion is almost invariably present—owing to the cardiac weakness & high temperature

For the same reasons the Kidneys are frequently
 affected. The other complications are more un-
 common. M. Wille of Lyons has noted the
 frequency of desquamation consecutive to Typhoid
 & M. Vidal (La Medicine Moderne 1897) notes that
 the osseous complications are nearly always late
 generally appearing in the first month following
 convalescence. It seems that in a subject half
 immunized by an attack of Typhoid fever
 Eberth's Bacillus may still multiply at points
 where it has by chance been left. If the immu-
 nity is incomplete it is at least enough to give
 the bony tissue force to resist & the action of
 that tissue results in a local phagocytic
 inflammation which manifests itself
 clinically in osteitis of various types. There are
 exceptions to every rule & he had recently
 a case of osteitis of the rib developed not during
 convalescence but in the course of a prolonged
 Typhoid fever, an osteitis which underwent
 resolution coincident with defervescence.
 Many of the diseases mentioned as complications
 are of the nature of Sequelae & these may pro-
 long the period of convalescence to a great length.
 Intercurrent diseases too may be affected thus

in a case of Hydatids of the liver suppuration occurred in the cysts during the course of an attack of Typhoid (verified by Widal's test) the man recovered from the fever but died later after the suppurating cysts were opened & drained from exhaustion. Typhoid fever may leave behind such an amount of disorganisation & destruction of the glands in the intestine as to permanently impair the functions of the intestinal tract - with the result of causing permanent ill health.

The clinical history given above is that of a typical case but there have been various Varieties described such as

1. Mild including abortive in which the fever comes to a sudden end with recovery in 2-3 weeks some cases of gastric or bilious fever may be of this variety
Infantile Reluctant

which is held by some to be typhoid without a rash

Latent or ambulatory

in which the early symptoms are so light that the patient walks about doing his work frequently taking his usual food - at the same time the ulceration process in the

intestine is going on without causing much pain or discomfort. It is in these cases that perforation is most apt to occur & be very suddenly fatal.

2. Grave in which all the symptoms mentioned under clinical history are marked

3. Putrid in which all the symptoms are very severe. The patient - even in the early stage has marked delirium passing from wild restlessness into a low muttering condition. He lies indifferent to everything - rapidly becomes much emaciated - teeth are covered with sores & herpes labialis is frequently present - there may be persistent vomiting. The bowels are very loose & are passed involuntarily; while the urine tends to accumulate necessitating the use of the catheter. The heart becomes very feeble & the pulse can scarcely be felt. Bedsores are very apt to form. Passive congestion of the lungs occurs frequently & it is in these cases that the sequelae are apt to occur with a very prolonged convalescence if recovery take place but the majority of cases of this variety end fatally.

The Anatomical Characters as found post-
 mortem will of course vary with the stage
 to which the disease has progressed when
 death took place; the presence or absence
 of complications & the immediate cause of death.
 If it occur during the first-week the only sign
 of disease will be in the intestinal tract—chiefly
 the lower part of the small intestine. Peyer's
 patches & the solitary glands will be found
 to be red, inflamed & unduly prominent,
 with a smooth-surface, surrounded by an
 inflamed area which may extend not only
 laterally but below the patch through to the
 peritoneum. These glandular patches are filled
 with a soft material, which appears greyish
 white usually on section. Microscopically, on
 examination after staining, the inflammatory
 process is seen to be due to the presence of
 a Bacillus (Eberth-Gaffky's) causing a prolifera-
 -tion of the cell elements, a deposition of granular
 matter & oil globules in the glandular sacs
 whose lining membrane is thickened. These
 sacs may burst & the contents infiltrate the
 mucous & submucous layers causing prolif-
 eration there & also marked congestion of

the blood vessels. Murchison states that the deposition takes place on the first or second day Rousseau not till the fourth or fifth. The mesenteric glands are early affected being congested & swollen owing not only to the irritation & inflammatory process in the intestine but to the actual presence of the Bacilli. The spleen shows the same process chiefly in the Malpighian corpuscles where the Bacilli are found in abundance. The other organs of the body may be healthy as death usually due to excess of the poison.

By the second week the deposit of material in Peyer's patches & solitary glands with the inflammatory condition set-up has produced a hyaline degeneration of the blood vessels & excessive infiltration into all the glandular spaces & therefore a breaking down of the whole gland. The material undergoing degeneration may be thrown off gradually or through small openings on the mucous surface or may slough off later in one mass. The process in the mesenteric glands & spleen is exactly similar except that the glands seldom suppurate to any great extent although small

puscules may form in the substance of the gland which are subsequently absorbed. By this time there may be general emaciation & degenerative processes in other organs due to the fever but not in a marked degree. Thus the kidneys may be congested as well as the lungs & liver. There may also be some circumscribed peritonitis without any perforation.

In the third week the ulcerative process becomes marked - the whole patch may break down & slough off leaving an ulcer which may penetrate to the muscular coat or even to the peritoneal. The ulcers are typical having no hard margin or base but with overhanging edges & varying in size as it is a ~~P~~ Peyer's patch a solitary gland or a number of these combined which have broken down. The mesenteric glands are soft and inflamed with often foci of pus. The mesocolic glands will also be affected if there be ulcers in the colon. The spleen shows softening not only in the blood spaces & malpighian corpuscles but in the infarcts, caused by the blocking of the blood vessels, which break down. The liver also frequently contains patches of inflammation. —

This is the stage at which death - more commonly
 takes place. The following are the post-mortem
 appearances in a typical case dying at the
 end of the third week of the period of invasion
 from exhaustion. G.R. aged 28 had passed through
 the early stages of an attack during which he
 had great delirium, much vomiting & copious
 diarrhoea. During the third week the temp-
 erature ranged high necessitating cold sponging
 Blood was passed in the stools necessitating
 ice cradle & other treatment. The tympanitis
 became intense & the diarrhoea rather suddenly
 stopped before death. On post-mortem examina-
 tion made the day after death - Rigor mortis
 was well marked - blood fluid - Great ex-
 emaciation, but no bedsores. The large intestine
 was very much distended with gas. The
 peritoneal surface of the ascending colon
 was inflamed in patches & was dark
 coloured & almost gangrenous for about 4 in
 in its length & an inch in breadth along its
 free border. There was no perforation. There
 were numerous ulcers in the ileum & a few
 in the ascending colon corresponding to the dark
 coloured part of the peritoneum. The liver was

Enlarged, dark coloured & congested especially where it had been impinged upon by the distended transverse colon. The Spleen was much enlarged & pulpy & dark coloured. The mesenteric glands were also enlarged. The heart was practically normal. The pleural cavity contained a small amount of fluid. The right lung was pressed upwards by the liver & contained dark red patches of inflammation areas. The brain was practically normal. There was no microscope examination made of any organ except the Spleen. A section of which showed the Bacilli & a typical growth - was obtained both on serum & gelatine. During life Widal's test had been very well marked.

In post-mortems of persons dying of intercurrent disease or complications of course evidence of that will be found. The Typhoid Bacillus produces the typical lesions in the intestines the mesenteric glands & the Spleen but the appearances in other organs are due to other Bacilli entering the system, partly by the ulceration produced in the intestines, and to the high fever and emaciation.

During the fourth week the ulcers cicatrize without any puckering or constriction and without any tendency to reproduction of glandular tissue. The mesenteric glands & spleen & other inflamed organs gradually return to their normal state any small pustular masses being absorbed.

Although the typical lesions in typhoid fever are ulceration of Peyer's patches & solitary glands; - infiltration & enlargement of the mesenteric glands & spleen - the ulcers may be confined in some cases to the solitary glands in the colon. Hodgepyle in the British Medical Journal 25th Dec-1897 has reported a case after noting a number of cases previously reported before the bacteriological tests were so severe he writes of a case in which "careful examination of Peyer's patches by transmitted light failed to reveal the slightest lesion" & microscopically "Sections of the small intestine including some of the solitary lymph nodules & Peyer's patches shewed no lesions except desquamation of the lining epithelium probably an artifact -" while "the colon was dilated and thickly studded with ulcers varying in

diameter from 2 to 15 m. m. mostly circular in outline & having sharp edges & smooth bases. The ulcers were present throughout the entire length of the colon, except the sigmoid flexure & rectum "microscopically sections through some of the ulcers in the colon showed hyperplastic lymphatic tissue about the edges with inflammatory infiltration of their bases." From the spleen colonies were developed which showed all the biological characters of *Bacillus Typhosus*.

Diagnosis by the aid of clinical symptoms only is difficult during the first week but is arrived at by noting the gradual onset; headache, progressive rise of temperature, condition of tongue, diarrhoea &c. There may be confusion with the following diseases chiefly - Typhus fever in which the onset is abrupt -

The rash comes out early & consists either of a subcuticular mottling or mulberry spots. Severe gastro intestinal catarrh in which there is usually a history of exposure or indiscretion in diet. Sudden onset. The abdomen is tender all over & not especially in right iliac fossa. Temperature not that of Typhoid.

Acute tuberculosis - In which although there is an evening rise of temperature the progressive rise is wanting - The bowels often constipated & stools dark. There is no rash - May find signs of tuberculosis in lungs

Tubercular meningitis - Only point of resemblance is fever & headache but the temperature is not that of Typhoid & there is no rash.

Scarlatina. Cases of Typhoid with a red rash and sore throat in the very early stages have been taken for Scarlatina but the development of the characteristic symptoms of Typhoid in a day or two will decide. A slight delay will diagnose

Simple continued fever from Typhoid also.

Ulcerative colitis. The temperature & course

to distinguish this. The ulcers are not typical

Influenza During recent years some cases of Influenza show abdominal symptoms with fever & nervous conditions that are very similar to symptoms of commencing Typhoid. This was particularly noticed in the epidemic of Typhoid in Boston in 1897 (due to milk) It would seem that some cases there were so

Similar that the serum was the only differential one in the early stages.

During the two years the Infectious Hospital has been opened in Newport - the chief disease erroneously notified as Typhoid has been pneumonia with high fever & low muttering delirium. I then gave a negative result with the serum test. One case of Cancer of liver & one of abscess of liver were notified as typhoid in which there was abdominal pain & irregular temperature. Both in their course indicated their true nature & both were verified by post-mortem examination. As Newport is a seaport town many of the cases are imported from foreign ports. These cases have usually been ill some days or even weeks before coming here & some of them may have been working although ill almost up to time of entry into the port. The diseases I have found most difficult to distinguish from Typhoid are Dysentery if there be also ague (one has to settle the diagnosis at once in these ship cases & cannot always see the stools which in such a case would aid the diagnosis)

Ulceration colitis, appendicitis, typhlitis & perityphlitis. It is in such cases where ambiguity occurs that the serum test is so useful not so much that its absence is proof of the absence of Typhoid as that its presence is a proof of the presence of Typhoid. The extreme importance of an early diagnosis of Typhoid has resulted in various tests & reactions being brought forward within recent years - one of these is known as Ehrlich's Diazo Reaction Ehrlich originally used two solutions (Charité Annalen VIII 1883) A. a saturated solution of Sulphanilic Acid in a 5 p.c. solution of Hydrochloric Acid B. a 0.5 p.c. aqueous solution of Sodium Nitrite.

40 parts of A are mixed with one part of B. to form a test solution. Equal parts of this test solution & of urine from the suspected case are mixed & the mixture rendered alkaline with ammonia. Normal urine gives a yellow or orange colour while the urine of Typhoid fever gives a deep reddish colour very like that of port wine. On shaking the froth becomes pink & on

standing for 24 hours a greenish precipitate
 forms. Hewlett in the British Medical
 Journal 18th January 1906 notes that "certain
 precautions should be taken" the solution
 of sodium nitrite should not be more than
 a day or two old; it is better to prepare it
 as required. The test-solution should be
 mixed at the time of using. Any excess
 of sodium nitrite must be avoided or a
 pseudo reaction may be obtained. The urine
 should be freshly passed & acid." He gives
 the names of a very large number of sub-
 stances tested by himself & others to see if
 they gave the reaction but with a negative
 result. The substance he found that gave
 a reaction at all resembling it was Morphine
 & its salts. The nature of the substance that
 gives the reaction is still unknown. Cultures
 of *Bacillus Typhosus* fail to give the reaction.
 The principal diagnostic point is the
presence of the Eberth-Gaffky's Bacillus
 and taking into account the history of
 the fever & its chief characteristics one
 would naturally turn to the excreta as being
 certain to contain the Bacilli more especially

in the sloughs thrown off from Peyer's patches
 Two methods may be used in the isolation
 of the Bacillus from faeces (Richardson in
 the British Med. Journal 25th December 1917)
 In Elsner's method use is made of a gelatine
 medium so combined with potato extract &
 Iodide of Potash that the growth of all bacteria
 is restrained except that of Typhoid & Colon
 Bacilli & these two organisms grow in such
 a way as to be easily distinguished

Capaldi uses an agar medium & upon this
 also Typhoid & Colon Bacilli grow in a
 manner sufficiently characteristic. By this
 method the only restraining influence is that
 exercised by the temperature of the incubator
 in which the organisms are grown. For
 details see Zeitschrift für Hygiene Vol
 xxi & xxii It will be readily understood
 that these methods are extremely difficult
 & that the differentiation of the Bacillus
 Typhosus from stools is rarely attempted.
 It is much easier to obtain the Bacilli from
 parts of the mesenteric glands & spleen but
 that one becomes useful in cases that have
 ended fatally without a definite diagnosis

having been arrived at - & more specially when on post-mortem examination the intestinal lesions are atypical.

The *Bacillus Typhosus* (Stevenson & Murphy feature on Hygiene & Public Health - Vol II p 168) consists of a cylindrical rod of varying length - with rounded and having numerous flagellae & is thus in the fresh state possessed of active locomotion. They grow well at 16° - 20° C on & in gelatine better of course at 25° - 37° C e.g. in alkaline broth, on agar, in gelatine on blood serum. On boiled potato at 35° - 37° C they grow in a fairly characteristic manner forming on it a transparent thin pellicle whose thickness increases as the growth proceeds. On the surface of gelatine they form colonies visible after 36 hrs as translucent-pauid dots which during the 3rd & 4th days become flat-translucent plaques with crenate outline; under the microscope they are brownish in transmitted light & granular. In streak cultivation the line of inoculation becomes marked after 2-3 days as a greyish translucent-band with uneven knobbed or crenate outline; in stab culture the stab after a few days is seen as a grey line - under the microscope, & in transmitted light -

it is made up of light-brownish droplets; on the surface of the stat is a crenate thin grey plaque on agar they form a rapidly growing, paint-like, cohesive greyish white to light-brown pellicle; broth is made uniformly turbid after 48 hours a greyish powdery or floccular precipitate, no distinct pellicle being formed. The broth culture gives no color reaction with Sodium Nitrite & Sulphuric Acid (Preliminary report on the growth of the Typhoid Bacillus in soil by Sidney Martin M.D. 26th Annual Report ^(Supplement) of L. G. B. 1896-97 p 231). Milk is not coagulated & in a "shake" gelatin culture no gas bubbles are formed. The Bacilli are facultatively aerobic but can be cultivated as an anaerobe & even in an atmosphere of Carbonic Acid. As regards resistance to external conditions it can withstand a great degree of cold for instance 0°C or even lower. It is also somewhat resistant to heat. It is closely related in this respect to the Bacillus coli communis which is on the whole more resistant than Bacillus Typhosus. A method of differentiation between these two Bacilli by Dr. Hiss is given in the British Med. Journal 18th Decr/97. He has devised two media one tube culture & the

than plate culture. The tube medium contains agar 5 g., gelatine 80 g., NaCl 5 g., extract of beef (Liebig's) 5 g., & glucose 10 g to the litre & has a reaction indicating 1.5 p.c. of normal acid, phenolphthalein being the indicator. The plating medium contains agar 10 g., gelatine 25 g., NaCl 5 g., beef extract 5 g. and glucose 10 g to the litre & reacts 2 p.c. acid to phenolphthalein. The *Bacillus Typhosus* alone, of all the organisms investigated during these experiments, has displayed the power of giving rise both to thread forming colonies in the plating medium & to the uniform clouding of the tube medium when exposed to a temperature of 37°C .

Klein has found a *Bacillus* in the glands of a case of Summer diarrhoea of children extremely like Typhoid *Bacillus* in all respects the only difference he states is that the *Bacillus* of Typhoid possesses a markedly lower resisting power to Bichloride of Mercury. The *Bacillus* of Summer diarrhoea grows fairly well though retarded on gelatine to which Bichloride of Mercury is added in the proportion of 1 to 40000 while such an addition has a much more marked restraining power on the Typhoid *Bacillus* (Sturtevant & Murphy *Treatise on Hygiene & Public Health*)

The *Bacillus Typhosus* is extremely motile owing to the presence of flagellae. To stain them is not easy. The usual method used is Van Emmegeus's.

In the British Med. Journal of April 17th 1917 McCorie has published a method - he uses 10 c.c.m of a concentrated alcoholic solution of "methyl-blue" ~~as~~ an aniline blue.

+ 10 c.c.m of 10 p.c. solution of alum

+ 10 c.c.m of a 10 p.c solution of Tannic Acid.

It will be readily understood that all these methods of differentiating the *Bacillus* take up a considerable time - time which especially in the case of Typhoid is of the utmost importance, not only with regard to the future treatment of the case but to the early recognition of the source of infection. Ehrlich's Diazo Reaction test can be used early but it is not limited to Typhoid only, a similar reaction having been found to take place in pneumonia, pertussis & some other diseases. It is on account of this that Widal's sero diagnosis has become so important.

For some years numerous observers (Charrin, Rogers Hanoff & Pfeiffer with Metchnikoff & Babel-) have noted that the serum of an animal immunised against some particular *Bacillus*

Exercised a peculiar ~~an~~ action on cultures of that-particular Bacillus causing the Bacilli to rapidly form masses or clumps. Widal was the first to show that this reaction occurred long before the stage of immunity was reached & took place in the case of Typhoid at a very early day in the course of the fever. The procedure usually carried out is as follows. A small quantity of blood is drawn off the suspected case usually from the finger into a glass capillary tube or blown into a tube of medium ^{size}, which has been heated & drawn out into a pipette. The tube is carefully sealed up. Nine loop-fuls of a 24 hour bouillon culture of *Staphylococcus* Bacillus is placed on a slide & one loop-ful of Serum from the pipette, now of course broken. These ten loop-fuls are mixed & examined under a microscope. A positive reaction consists in the Bacilli almost at once forming clumps & leaving clear spaces between. The Bacilli in the clumps have lost all movement. The important-points to notice are (1) The cultures used must be virulent & show no signs of clumping - Attenuated cultures will clump with almost any serum -

(2) A 1 to 9 dilution of the serum is usually

used but - 1 to 2 may be used as a check

(3) It is necessary to have a time limit - & most observers hold that half an hour is a sufficient interval -

(4) The nature of the clumping must be typical being well marked & rapid & with an almost absolutely clear field between the clumps of motionless bacteria

It has been found that dead Bacteria also give this reaction but Grunbaum states that the reaction is not so typical & not so good as the clumping is not so defined & the interspaces not so clear.

A great deal has been written lately on this reaction & I would refer especially to a paper on the "Technique of Serum ~~diag~~ Diagnosis with special reference to Typhoid fever" in the British Med. Journal April 17th 1897 by Professor Delepine & a paper by Fison in the same journal of July 31st 1897 on "Widal's sero-diagnosis of Typhoid fever" both of whom give numerous references at the end of their respective papers showing the evolution of this method which as it is diagnostic during the first week of the fever is now very commonly employed.

Prognosis The mortality varies considerably in different epidemics from 5 p.c. to 25 p.c. The mortality in Newport in 1896 of all notifications of Typhoid was 21 p.c. & in 1897. 21.05 p.c. In the Infectious Hospital in 1896 the mortality was 13.3 p.c. & in 1897 it was 19.6 p.c. but it must be remembered that all the worst cases go to the Hospital all the Ship cases; the patients from the poorest parts of the town & one would naturally expect the mortality to be high.

It has been stated that persons who have been long exposed to the possible causes of Typhoid such as drinking from a sewage contaminated well for some time are more liable to a virulent attack should the water become infected with the definite germ. There is no marked difference in the mortality returns on account of sex. of course old age is unfavourable.

During the course of the disease the chief points unfavourable to prognosis are Cardiac weakness, shown by the extreme weakness of the pulse & great prostration;; Severe abdominal pain - Severe diarrhoea with excessive haemorrhage - Symptoms of peritonitis -

Excessive tympanitis which seems to point to paralysis of the large intestine.

The most important guide is the temperature.

A very high temperature is unfavorable - a rapid fall frequently denotes hæmorrhage & if accompanied by acute abdominal pain & collapse points to perforation which is an extremely serious complication. A rapid rise would point to the onset of some complication such as pneumonia &c & is unfavorable. It has been noted that in mild cases the temperature falls at the end of the second week but in some cases it rather tends to rise - the greater this rise the more severe the case is going to be. Even in the mildest cases

the prognosis is always grave as serious symptoms may develop at any period of the disease & a case progressing favorably to all appearances may have a sudden attack of severe hæmorrhage imperiling life & many cases where perforation occurs have a very mild initial stage. Any concurrent disease is unfavorable as suppurative processes are apt to occur not only from the high fever but from the presence of the bacillus.

Treatment

Prophylactic or Sanitary.

It is within late years that the effect of efficient sanitation has been able to point to Typhoid as a disease that can at least be kept within bounds if not eradicated by cleanliness & good water supply. This is well seen in the maps & chart placed between pages 106-107 in the Supplement containing the Report of the Medical Officer - Twenty Sixth Annual Report of the Local Government Board 1896-97. In the chart by Dr Bulstrode it is shown that in South Wales (of which coalfield Newport is an outlet) in the decade 1871-80 the annual death rate from Enteric (with Continued) fever was 5.8 per 100,000 living whereas in the decade 1881-90 it had been reduced to 2.9 per 100,000 or exactly one half. From the aetiology it will be seen that it is extremely important that -:

1. The drainage of the land should be thorough so that the subsoil water shall be kept as much on a level as possible.

2. The land on which houses are built - & especially on the outskirts of large towns should be noted. If the land be alluvial clay

as it is in Newport - on the flat-river banks & unballasted the floors should be raised from the surface of the ground & a damp proof layer formed as of cement - on the part - the house is to stand on as well as damp proof courses in the walls.

If the land is ballasted the same should be done but - there is less chance of damp. It is more important - that the composition of the ballast - should be noted that it is not contaminated with town refuse.

3. The excreta & filth from the houses should be removed quickly & efficiently. In this respect - the removal by the agency of water is the best - provided it is done in a proper way. If it is imperfectly done it is absolutely injurious & as previously shown a most efficient - way of propagating the disease. It is in respect to this that the greatest advance has been made. It has been noted that it is essential to have

(a) The sewers water tight, large & well ventilated. Of course if the sewers are perfectly air tight - & so large that the sectional diameter is more than the sectional

diameters of the continued drains running into the sewer. Then the excreta & all incoming air would flow away provided there was sufficient fall. But this appears impossible in practice: the result being that the air in the sewer tends to flow against the current of excreta in sewers where there is little fall & seek the higher levels & is thus apt to pass any defective traps.

(6) No soil pipes or drains should be laid under the floors as it is well known that the upper surface of these pipes tends to corrode. The drains should have a trap in their course on immediately leaving the house & a ventilator between the trap & the sewer. They should not by any chance have any connection through a trap or otherwise with the system of drinking water. Cases have been known where such traps have been accidentally sucked dry with the result of the drinking water being contaminated —

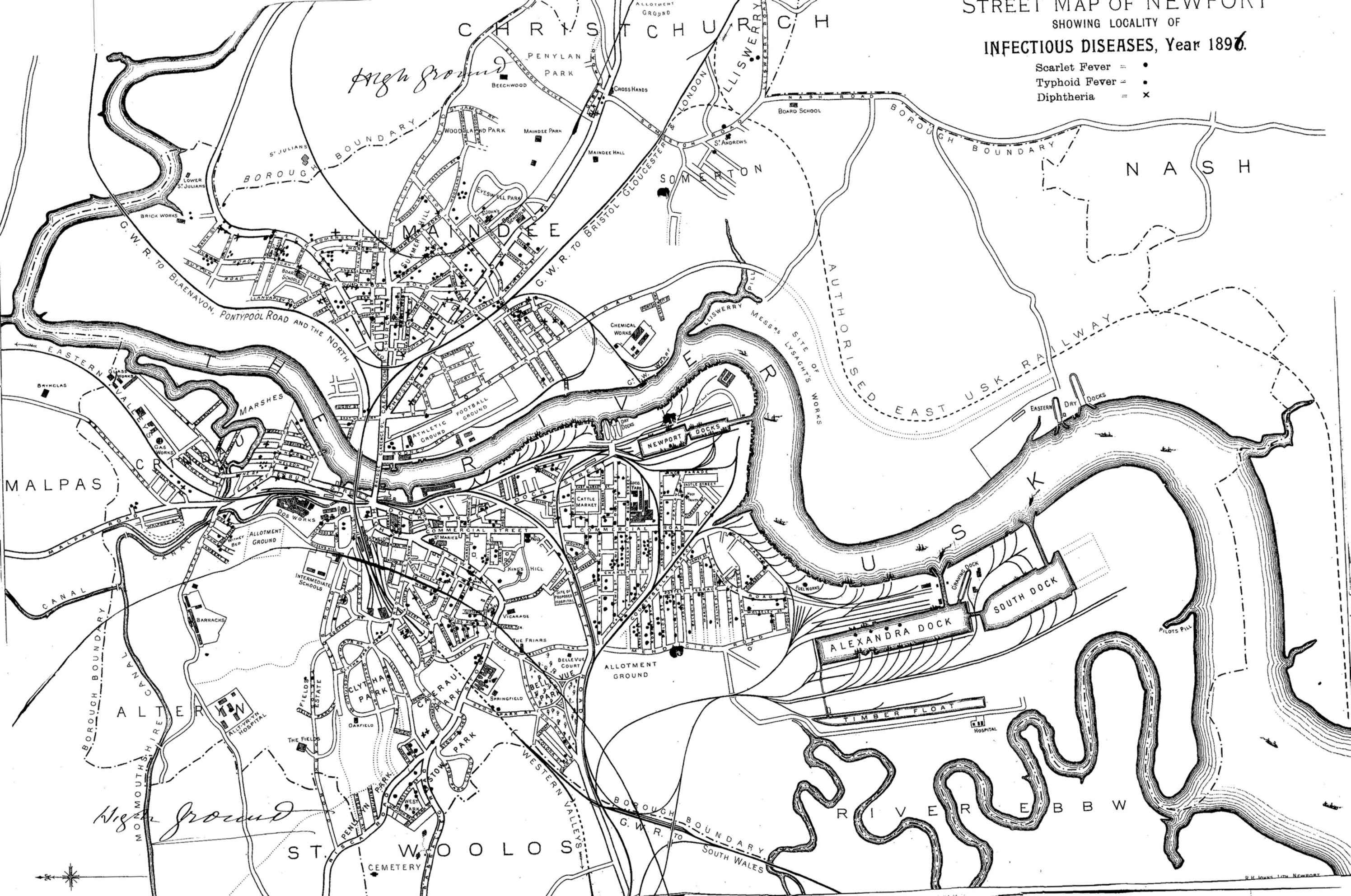
The Bacilli have not yet been noticed in sewer gas but various epidemics such as

The one notice here would tend to prove that there was something in the gas which could propagate the disease. In the discussion on Sewer Ventilation reported in the British Med: Journal of August - 31st 1895 Parry Laws stated that experiments showed that "it is extremely difficult to find any evidence of the presence of the typhoid fever bacillus in ordinary sewage & that instead of sewage being a favourable soil for its indefinite multiplication as stated by many advocates it gradually but surely extenuates it." He therefore considers that sewer gas produces bad effects "from the presence of some volatile & highly poisonous compound or compounds possibly of an alkaloidal nature."

This may be so but as in the epidemic above noted it is impossible to ignore the part that the sewer gases played in the dissemination of the disease. It would seem as Hill pointed out in the discussion just alluded to that putrefaction was required which does not usually take place in sewers but in the drains. The epidemic at Maudsley

INFECTIOUS DISEASES, Year 1896.

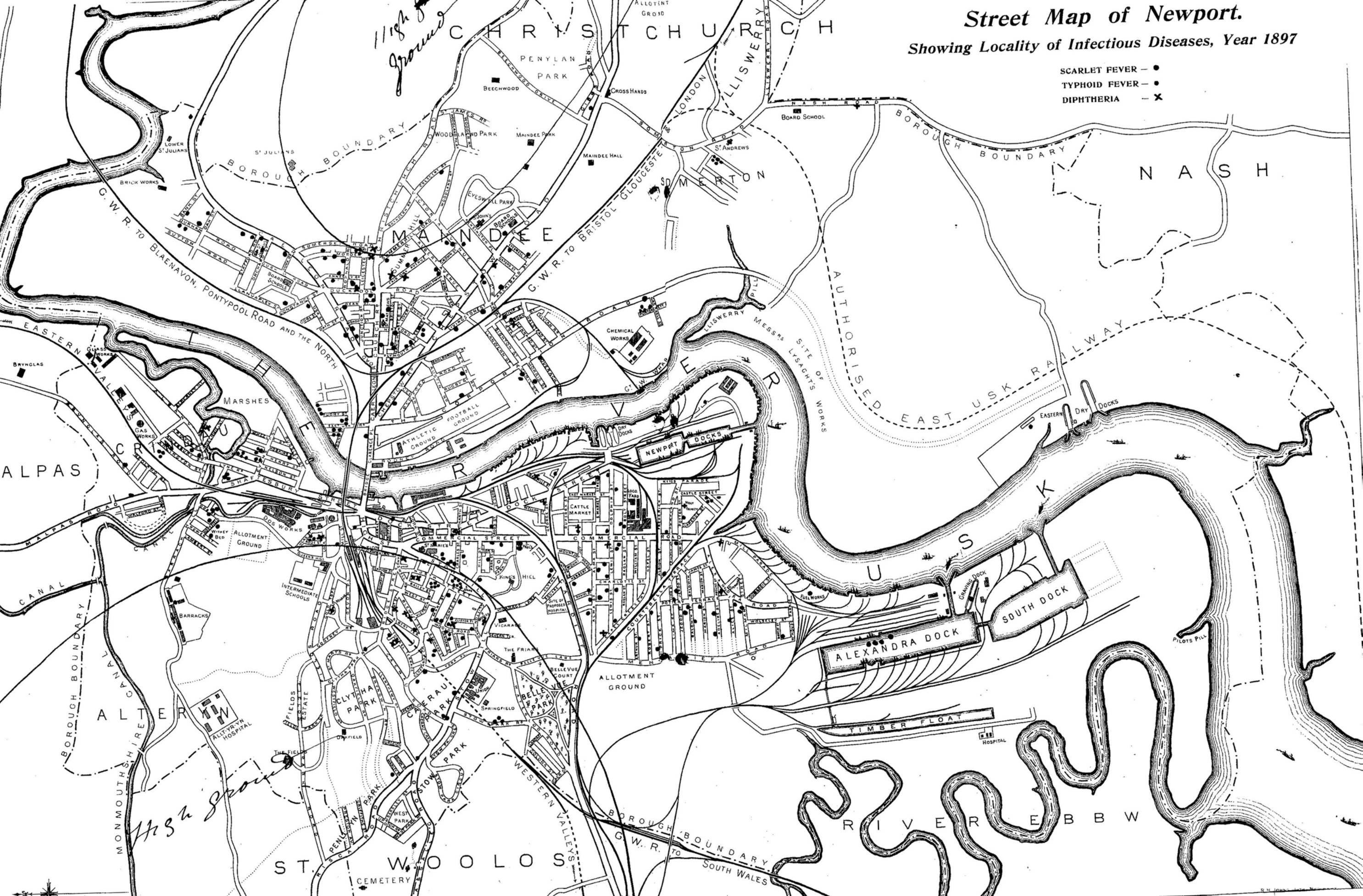
- Scarlet Fever = •
- Typhoid Fever = •
- Diphtheria = x



Street Map of Newport.

Showing Locality of Infectious Diseases, Year 1897

- SCARLET FEVER — ●
- TYPHOID FEVER — ●
- DIPHTHERIA — X



distinctly pointed to the initial cause being the contamination of certain of certain house drains & thus the main sewers by emanations from typhoid patients who were infected by drinking sewage contaminated water from wells -; that the disease was carried into various houses & persons were infected in these houses in which invariable the house drains were faulty -; & that the opening of ventilators into the sewers on the street-level allowing of the escape of pent-up gases & the admission of fresh air (oxygen) in large volume into the sewers at once cut short the epidemic.

allowing that exhalations from contaminated excreta can produce the disease explains the method of direct infection as noted by Presley - Medical Officer of Health Leicester in the British Med. Journal of Aug: 31st 1895 in which, the contaminated pails either not disinfected at all or imperfectly disinfected were the mediums of infecting numerous persons even though there was no actual contact by those persons with the

filth in the pails. The difficulty in such outbreaks being of course to prove that there could not have been any personal contact with the contaminated filth.

4. The drinking water should be pure. To obtain this the drainage area supplying the drinking water requires investigation periodically, that it may not be contaminated by decomposing animal matter - In this respect upland grazing land is better than land well cultivated & manured. The water itself requires periodical testing although unfortunately this does not mean absolute safety as the contamination ~~by~~ may be as it were transitory & on the other hand so slight as not be able to be detected & yet produce the disease.

Any filth beds require careful attention - The pipes carrying the water must be tested to be certain that contamination can occur en route.

All persons should be supplied from some public source that is under proper control & should not be allowed to use water from wells that can be contaminated by surface drainage or are liable to contamination from a distance through.

percolation through the soil.

Water is without doubt the chief method of dissemination & owing to the small relative amount of contamination required and the large number of persons usually using the water supply constitutes the chief danger in the propagation of Typhoid.

(5) The milk supply should be under control

(a) with regard to the cleanliness of the cow-houses & of the cows themselves

(b) with regard to the water used in the cleansing of the utensils used. No wells on the farm should be utilized for this purpose unless the water from it has been boiled for a considerable time

(6) The Cleanliness & Ventilation of the dwellings of the poor especially in populous districts should be under strict control as want of these certainly assists in the dissemination of the disease not only by the very fact of dirt being a nidus for the bacilli but because such surroundings render the inhabitants more liable to any disease.

Fresh air & sunlight have been found to have a marked effect on the virulence of the germs

Personal & Therapeutical Treatment.

When a case of Typhoid has been diagnosed it is best - if possible to remove the patient, isolate him & place him under the care of trained nurses. Among the poor this can only be done in an Isolation Hospital. The good nursing of a typhoid patient is of much more importance than the medical treatment & the importance of getting the case under efficient care in an early stage is well known.

If the patient has to be treated in his own house all the usual steps should be taken to place him in a large airy bedroom from which everything has been removed except what are absolutely necessary. He should be kept closely in bed from the first & should not be allowed even in the mildest cases to get up to vacuate or have his bed made. An attempt should at once be made to trace the source of infection attention being especially given to the drains, water supply & milk supply or whether the patient attributes the onset to eating some special article of diet such as oysters, ice cream, walnuts &c & if so whether these can be

the mediums for carrying the germs.

The greatest-care should be exercised by all those coming in contact with the patient to remove all excreta at once, & disinfecting them with 1-20 Carbolic or 1-800 Formaline. The same care should be taken with the Sputum. The nurses hands should be carefully cleansed after any contact with the patient or soiled linen. All utensils used by the patient should be carefully cleansed. Bedclothes should be changed frequently & all soiled linen placed at once in some disinfecting fluid.

The dieting is most important. It should always be light & easily assimilated therefore milk & soups are usually the articles used. I only allow milk with a small amount of stimulants at first - but some allow a large amount of beef tea. The amount of milk varies on the slightest sign of flakes of milk in the evacuations the amount is reduced. It is given often & in small quantities alone or with lime water especially when there is any tendency to vomiting. Some advise the addition of ice & sterilise the milk but if the

milk is really good & above suspicion boiling
 it does little good. I have given small quantities
 of some beef essence with advantage & have
 found great benefit from giving some Stim-
 ulant - usually Brandy from the early
 stages & increasing the amount if the heart
 shows any signs of failing. In severe cases
 with complete prostration with pulse extremely
 feeble & when there has been considerable
 haemorrhage during the third week I have
 increased the amount - to 16-20 oz in the
 24 hours continued for 3-4 days with the
 result of living the patient over the critical
 period. The Brandy does not produce any
 of the usual symptoms of intoxication but
 makes the patient quieter & certainly strength-
 ens the pulse. The regular dieting & careful
 avoidance of all solids is most important -
 even after the patient has become convalescent
 nothing will bring on a relapse quicker &
 with more certainty than injudicious feeding
 A large proportion of Typhoid cases will pass
 through an attack & recover excellently under
 careful nursing & dieting only & the majority
 of practitioners seem to recognize this & only

use Medicinal treatment - as symptoms call
Thus if the case be an ordinary mild attack
a simple fever mixture only is given such as

R Ac: Sulph dil 3iv

Linn Sulph grs vi

Syr Aurant - 3vii

Aq Carni ad 3vi

Sig 3℥ in water every 3-4 hours

If the case is one in which there is constipation
the exhibition of Calomel grs iv to vi alone or with
Pulv Jalap Co grs x every second day will do
good & is generally preferable to frequent-enemata
or the use of Glycerine Suppositories

Should the bowels move 4 or 5 times in the 24 hrs
there is no use of any astringent - but if the
diarrhoea be excessive the following is useful

R Imet. Catechu m 30-60

Imet. Opri m x

Imet. Cretai 3℥

Sig 3-4 times a day —

or may use

R Cup: Sulph grs 1/2
Mille x 11

Sig Several times a day

Sometimes find it very useful to give Starch.
enemata not too large.

Hyperpyrexia is treated by Quinine in doses of grs xx-xxx or Salicylate of Soda grs xx given usually with Brandy. If the high temperature continues use an ice bag or tin suspended from a cradle, cold sponging or cold pack in which the patient is enveloped in a sheet wrung out of cold, sometimes ice cold, water first and then in blankets, or place the patient in a bath in which the water is lukewarm & to which cold water is added till the patient's temperature is brought down to about $100^{\circ}F$. These measures are enumerated in order of severity & the last should only be used as a procedure of emergency. Cardiac depression when the pulse although rapid becomes soft & easily compressible is treated by Tinct. Digitalis in 5-10 drop doses, Strophanthus (Tinct.) in 3-8 drop doses, Ether Sulph in 15, Brandy in varying amount - but not less than $\frac{1}{2}$ fl oz every 3 hours, Stychnine is also very useful usually given Hypodermically $1-80^m - 1-100^m$ of a grain.

Haemorrhage from the nose may require plugging from the bowel is best treated by giving Turpentine internally in 3i doses or by

Liq: Ferri pernit: mxx every 2-4 hours.
 The use of the ice bag & Cradle is also useful.
Tympanitis may be treated by Turpentine Stupes
 Linseed meal poultices (made very light), using
 ementa containing 3i or 3ii of Turpentine
 or by passing a long tube into the descending
 Colon. The internal administration of Liq Stychniae
 or the same drug ^{grm} hypodermically is useful.
Acute Abdominal pain may be alleviated by
 hot fomentations with or without the addition
 of Belladonna and Opium. Poultices are useful.
Peritonitis is treated with Belladonna & Glycerine
 applied locally.

Perforation If the Collapse & pain & point-
 definitely to perforation having occurred then
 the question of surgical interference must
 arise. Some cases may certainly show all
 the typical symptoms of perforation & yet
 recover & thus there is always considerable
 hesitation in operating except as a last chance.
 The mortality after operation is extremely high
 which one can readily understand must be the
 case in an operation performed as the last-
 hope of saving life & where when on operating
 one perforation may be found there is certainly

that another does not already exist or will subsequently be produced. Some cases of undoubted perforation die very rapidly in others the amount of extravasation is small and sets up an adhesive inflammatory action gluing together the coils of intestine & allowing the extravasated material to work up to the abdominal surface in the effort to discharge itself without setting up any general peritonitis. I have operated in one such case only. J. G. aged 24 yrs a marine engineer was admitted into Hospital on the 29th June 1897 from a ship on board which he had been feeling ill with headache, slight diarrhoea &c for three weeks, yet he so little realised the severity of his illness that having been told that the ambulance would be sent to the Dock for him in an hour or so he got up & dressed & stand to be ready. On admission he had all the symptoms of typhoid except that there was rather a tendency to constipation. On the 1st July he had sharp abdominal pain a marked drop of temperature from 102° F to 98° F. He vomited frequently, there was sharp diarrhoea & the typhoid, slight on admission, became

marked, The pulse rate rose from 60 to 96 in the minute. This was evidently the period of perforation. Next-day his temperature rose to $101^{\circ}F$ he had paroxysmal pain in the abdomen & a slight resistance in the right-Ileac fossa could be detected with slight dullness & localized tenderness. The stools were very offensive & contained small clots. There was profuse sweating & the urine contained a trace of bile. For the next four days he remained in statu quo but after that he became markedly weaker & the localized dullness & tenderness in the right-Ileac region became more marked so much so that on the 10th July I decided to operate. On making an incision through the peritoneum over the centre of the dull area I opened at once into a collection of very offensive pus which was completely shut off by adhesions from the general peritoneal cavity. I washed out the cavity which passed downwards and backwards towards the caecum with sterilised water & put a drain in not considering it advisable to break down the strong adhesions & find the perforation. He stood the

operation well but there was no permanent improvement in the symptoms. On the 12th July the vomiting recommenced even though the discharge from the wound was free & contained faeces. He then had incontinence of urine & became delirious then comatose & died on the 16th July.

The abscess cavity led to a perforation about the size of a shilling in the ascending colon & there were other ulcers in the colon which had penetrated to the peritoneum but not through. I had unfortunately thought that the symptoms at the time of perforation hardly warranted operation & trusted to adhesions forming to shut off the extravasated matter from the general peritoneal cavity. This certainly did happen but the opening of the abscess cavity thus formed & draining it had not a happy result. It would certainly be better if one could be perfectly certain of perforation to operate at once but the symptoms simulate those of perforation so markedly sometimes and yet there is recovery that one is apt to hesitate. This patient's brother had been operated on in America for perforation with success.

Based on the Microtic origin of the form some authorities have advocated the exhibition of drugs that would tend to render the intestines aseptic. This is of course by no means an easy matter as the drug used has to pass through the stomach & the greater part of the small intestines before it reaches the affected part. Carbolic acid in 1-2 drop doses has been used. One of the latest reports on this treatment is contained in the British Med: Journal of May 29th 1897 by Thacker who gives the result in 23 cases treated by Carbolic acid in 3m doses well diluted as 4.3 per cent of deaths. Salol has also been used.

With the idea of getting rid of the poisonous material ~~through~~ off into the intestine as quickly as possible a Saline purge has been given at the beginning of the attack followed up by Calomel or grey powder in small doses alone or combined with an antispasmodic during the course of the attack. The Calomel of course acting both as a slight purgative & antispasmodic. This form of treatment is useful in the cases where there is constipation but requires careful watching when diarrhoea present.

Some authorities have advocated the heat-
 ment of all cases in baths. In this method
 the patient is kept constantly immersed
 in a bath kept at an equable temperature
 Its advocates state that the results are
 good & that the patient feels extremely com-
 fortable & that there is less risk of hyper-
 pyrexia & cardiac debility & also of perforation
 than in any other form of treatment.
 Within late years serum treatment has
 been brought forward in the case of Typhoid
 as in all diseases due to the action of a germ.
 Ernest Steele has reported a case in the British
 Med. Journal of April 17th 1897 in which he
 attributes the favourable result to this
 treatment.

In the preceding pages I have endeavoured
 to state shortly the present position of
 Typhoid fever.

There are still many points of some
 importance not definitely settled such as whether
 the earth is the natural habitat of the Typhoid
 Bacillus or whether the Bacillus known by
 that name is not simply a degraded form

of a Bacillus normally present in the human intestine in a harmless state. I have indicated to show that the former is probably correct.

The action of the Typhoid Bacillus on human blood has still to be determined as although the germ has not been found in the blood itself yet - it produces some profound change in the serum that is shown by the action of that serum on cultures of the Bacillus.

The method of infection without direct personal contact with Typhoid emanations is still in a doubtful stage. What it is that is in sewer gas that can produce Typhoid has yet to be definitely settled. The growth of the Bacillus in certain soils is still under investigation & the importance of this is very great especially with regard to the eradication of the disease. There is no doubt that better treatment, better nursing, better method of isolation has assisted in reducing the mortality rate in the last 20 yrs but still it is certain that the chief factor in the improvement has been improved sanitation in its broadest sense. The growth of the Bacillus in certain soils

increases the work of the sanitary authorities as these so called infected areas will have to deal with - if Typhoid is to be relegated to the position of an almost unknown quantity, as Typhus fever has been by similar methods.