TYPHOID-PARATYPHOID IN INSTITUTION SEWAGE

BY

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The occurrence of sporadic cases of typhoid and paratyphoid B, and outbreaks of the extreme seriousness of those at Malton and Denby Dale, emphasize the vital importance from a public health point of view of the detection of carriers, to the existence of whom practically all these outbreaks are due. In the general population this is, of course, a large and complicated undertaking, but in a hospital where several hundred people are collected together over a number of years the detection of carriers is a much simpler matter, although by no means as simple as it would appear on the surface. As part of this work the examination of the sewage from the Hereford Mental Hospital was undertaken soon after the search for carriers was begun. At the time when *B. typhosus* was first isolated from the sewage four carriers of *B. paratyphosus* B had been detected, but none of *B. typhosus*, and it was not for some days that a carrier of *B. typhosus* turned up.

Typhoid and paratyphoid carriers are probably much commoner in the general population than is at present admitted. Many mild outbreaks and sporadic cases of paratyphoid are undoubtedly missed, and so the proportion of carriers probably increases from year to year. The only figures which appear to be available are from foreign sources. The proportion varies between 3 per 1,000 (Chapin¹) and 50 per 1,000 (Welch, Dehler, and Havens²). In this latter case the examination was of both urine and faeces, and was carried out very thoroughly. Pickworth³ has shown that from a large town like Birmingham, among the admissions to the mental hospital 23 per cent. of 464 new admissions in one year agglutinated pathogenic organisms of the *coli*-typhoid group.

The isolation of typhoid and paratyphoid B organisms from sewage has always been regarded as a matter of no little difficulty, and it is very largely owing to the splendid work of Wilson and Blair in Belfast, and to the use of their technique, that progress has been and is being made. Wilson in 1928,⁴ using his special solid glucose-iron-bismuth-sulphite medium, found *B. typhosus* in the Belfast sewage. Gray in 1929⁵ found *B. paratyphosus* B in Edinburgh in three out of seven tributaries to the main sewer. Begbie and Gibson in 1930,⁶ using three different methods (MacConkey's, brilliant green, and Wilson and Blair's 1927 solid medium), examined fifty-eight samples of sewage from the various main sewers of Edinburgh, and found *B. paratyphosus* B in seven. The detailed examination of the results is interesting. The direct plating of sewage on MacConkey's medium was negative throughout; five out of the seven examples were the result of brilliant green enrichment, and two were on Wilson and Blair's medium. In none of these was a positive result obtained by both methods. The sewer from which Gray had obtained positive results in 1929 gave a negative result in 1930. These writers draw a tentative conclusion that "the presence of organisms of the enteric group in sewage indicates a concentration of missed cases, convalescents, and transient contact carriers in the general population." In 1929 I made an attempt to isolate *B. typhosus* from the sewage at the Dorset Mental Hospital, where there were several known typhoid carriers. Wilson and Blair's solid medium was used, but the results were negative.

A FLUID ENRICHMENT MEDIUM

In the meantime Wilson and Blair were continuing their work in Belfast, using various modifications, and in 1931,⁷

using their solid medium, they found *B. typhosus* in twelve out of fifteen samples of Belfast sewage. They also isolated *B. paratyphosus* B. They point out that the isolation of *B. typhosus* from sewage is more difficult in July, August, and September, owing to the seasonal increase in sulphite-reducing organisms. They also carried out experiments showing that *B. typhosus* can live for thirty-eight days in sewage at room temperature, and *B. paratyphosus* B for twenty-one days. This is very much longer than had previously been realized, and the great importance of this from the point of view of water-supply contamination is evident. (Houston⁸ found *B. paratyphosus* B alive after twenty-one days in Epping sewage.)

As the result of a number of experiments Wilson and Blair produced a fluid enrichment medium. It is with the use of this medium that the present paper is concerned. They used a standard bismuth broth, to which they added varying amounts of different alcohols and a 1 in 10,000 solution of perchloride of mercury. With their modification containing 1 c.cm. of absolute ethyl alcohol and 4 c.cm. of a 1 in 10,000 solution of perchloride of mercury they isolated *B. typhosus* three times out of five. This enrichment medium proved very useful for isolating *B. typhosus* and *B. paratyphosus* B from faeces when other methods were unsuccessful. Their fluid enrichment medium consists of 100 c.cm. mannite broth (Fairchild's peptone), 6 c.cm. sodium sulphite (20 per cent. solution), and 0.22 c.cm. bismuth solution. To the boiled mixture 0.5 c.cm. of a 1 per cent. solution of brilliant green is added. To every 100 c.cm. of mannite broth 1 c.cm. of absolute alcohol is added, and 4 c.cm. of a 1 in 10,000 solution of perchloride of mercury. The use of alcohol and perchloride of mercury destroys *B. coli* and *B. proteus*.

In February, 1931, at the beginning of an outbreak of paratyphoid in Epping, Houston⁸ isolated *B. paratyphosus* B from 1 c.cm. of the sewage effluent from the township of Epping. Subsequently the sediment deposited on the sewage irrigation area was found to contain the paratyphoid bacillus. These results were confirmed by Scott.⁹ *B. paratyphosus* B was found in the Epping sewage for some months after the epidemic had subsided.⁹

ITS USE AT HEREFORD MENTAL HOSPITAL

The examination of the sewage of the Hereford County and City Mental Hospital was commenced in July, 1932. Two carriers of *B. paratyphosus* B had been isolated towards the end of June, and it was thought that the examination of the crude sewage from the hospital might prove interesting and instructive from a public health point of view. Collection of the sewage was made from an inspection chamber at such time as it was believed that the flow of bath and laundry water was at a minimum. For the first seven examinations the solid Wilson and Blair bismuth-sulphite-glucose-iron medium alone was used for direct plating; and in addition peptone water brilliant green cultures were subcultured on MacConkey plates. All these examinations proved negative. On August 20th the liquid enrichment medium of Wilson and Blair was introduced, and proved at once successful.

The technique used was as follows. Three solutions were made up—A, B, and C. A consisted of 60 grams bismuth citrate, 50 c.cm. distilled water, 20 c.cm. ammonia (S.G. 880), and, when these were mixed, sufficient distilled water to make 500 c.cm. B consisted of 120 grams sodium sulphite (A.R.) and 300 c.cm. distilled water, to which 150 c.cm. of A was added and the whole warmed slightly. C consisted of 30 grams of sodium phosphate dissolved, by warming slightly (not boiling), in 150 c.cm. of a 1 in 20 glucose solution. This was added to the AB mixture and boiled slightly for one to two minutes. This mixture can be kept in a stoppered bottle.

To make the liquid enrichment medium the following were used: 30 c.cm. of stock ABC mixture; 50 c.cm. trypsinized

broth; 100 c.cm. peptone salt water (difco); 1.5 c.cm. 8 per cent. ferric chloride solution; 0.1 c.cm. 1 per cent. brilliant green; and 3 c.cm. absolute alcohol. This mixture is divided into a convenient number of large tubes, and 10 to 15 c.cm. of crude sewage sown into each in proportionate quantities. These tubes were incubated for thirty hours, after which small quantities were plated on Wilson and Blair's solid medium: nutrient agar 2.5 per cent., 100 c.cm.; ABC mixture, 20 c.cm.; brilliant green 1 per cent., 0.25 c.cm.; ferric chloride 8 per cent., 1 c.cm. The plates were incubated for a number of days and examined daily. Typical colonies were picked off and examined in the usual way—that is, they were tested direct for agglutination by the slide method, subcultures being made from positive colonies for fermentation and absorption tests. This technique is slightly modified from that of Wilson and Blair. The results were as follows:

August 23rd, 1932	...	...	<i>B. typhosus</i> isolated.
August 24th	...	...	Negative.
August 29th	...	...	Negative.
September 5th	...	...	<i>B. paratyphosus</i> B isolated.
September 6th	...	...	Negative.
September 12th	...	...	<i>B. paratyphosus</i> B isolated.
September 19th	...	...	Negative.
September 26th	...	...	Negative.
October 3rd	...	...	Negative.
October 10th	...	...	Negative.
October 31st	...	...	Negative.
November 7th	...	...	Negative.
December 5th	...	...	Negative.
December 12th	...	...	<i>B. typhosus</i> isolated.

At all these examinations direct plates were made on the solid Wilson and Blair medium and proved negative, although exactly the same batch of media were being used for the examination of faeces at the same time, and were proving successful.

During the period from June to December carriers of *B. typhosus* were isolated on September 2nd and 21st; and of *B. paratyphosus* B on June 6th, July 20th, August 16th and 19th, October 11th and 31st, and November 3rd and 15th. As carriers were found their stools were disinfected before being disposed of, so that the positive result on December 12th showed that there were still undetected carriers among the hospital population. (Only some two-fifths of the patients had been examined up to that date.)

At no time during the course of the work did colonies develop on the MacConkey plates.

CONCLUSIONS

1. The liquid medium introduced by Wilson and Blair for enrichment has proved invaluable in the isolation of *B. typhosus* and *B. paratyphosus* B from sewage, and appears likely to introduce a new era in sewage bacteriology.

2. Direct plating on MacConkey's medium after Wilson and Blair enrichment is quite useless in the examination of sewage.

3. From a public health point of view very great importance attaches to the examination of sewage.

4. Crude sewage, which in the past has often been deemed harmless, should not be spread on horticultural and agricultural land. Wilson and Blair have shown that *B. typhosus* can live for thirty-eight days in sewage. It may live much longer in portions of faeces in the sewage; we do not know that it cannot do so.

My thanks are due to Mr. J. D. Becket, laboratory technician, for much hard work, skill, and for useful suggestions on technique; and to Dr. W. M. Scott of the Ministry of Health for advice and encouragement.

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Memoranda

MEDICAL, SURGICAL, OBSTETRICAL

UPPER ABDOMINAL PALPATION IN THE "DANGLE" POSITION

Abdominal palpation is a physical investigation the ease and effectiveness of which varies enormously with the build, tonus, and mentality of the patient. The combined difficulties of rigidity, depth from the surface, and cover by the hard parietes are nowhere so apparent as in the hypochondria and the epigastrium; particularly does this apply to conditions of the spleen, stomach, and gall-bladder, which are apt to be retracted under cover of the lower chest wall by inspiratory spasm. Examination by the method to be described (of which no mention has been discovered elsewhere) will be found to obviate both of the disadvantages referred to.

The Method

The patient is seated on a lowish stool or chair, with his feet on the floor. The knees should flex to a right angle, or preferably a little less; the thighs should be in contact. The trunk and head are now allowed to incline forwards practically by their own weight, the upper limbs hanging loosely by the side of the thighs. It is essential that the trunk should not be held forwards by the patient. The condition of the arms is an excellent indication of the effectiveness of the position; if the correct relaxation is obtained they dangle flaccid by the side of the thighs, swaying easily to the slightest push. (The patient, however, should not swing them himself.) A right-handed examiner will now palpate the upper abdomen, standing to the right side and behind the patient. If the correct co-operation of the subject has been obtained, it is found that the examining hand sinks with surprising ease almost knuckle-deep into the hypochondria and epigastrium, under and actually round the costal margin.

Particular Applications

This method, whilst not only obtaining remarkable relaxation of the upper abdominal parietes, has also an additional and most valuable property in that the spleen, stomach, and gall-bladder are carried by gravity downwards and forwards against the hand of the examiner, instead of away from it as in the usual supine position. (In the uncomfortable and undignified knee-elbow position these viscera incline upwards and forwards; the relaxation is definitely inferior.) The particular applications of the position lie in: (1) the detection of gastric tumours, the importance of whose early demonstration will readily be conceded; (2) the elicitation of gall-bladder tenderness—the method is in all cases far more effective than the "finger-hooking" sign, and gives positive results in a considerable number of cases in which "finger-hooking" is negative; (3) the palpation of minor splenic enlargements and the elicitation of splenic tenderness. Renal palpation, and, indeed, mid-abdominal examination in general, is also rendered easier by the method, which, however, is obviously not suited for the lower abdomen.

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