12. OLSZEWSKI, J. AND BAXTER, D.: Cytoarchitecture of the human brain stem, S. Karger, Basel, 1954, p. 68.
13. PENIDO, J. R. F. *et al.*: *Proc. Staff Meet. Mayo Clin.*, **32**: 239, 1957.
14. ROMANSKI, R.: *Am. J. Path.*, **30**: 1, 1954.
15. STOUT, A. P.: *Am. J. Cancer*, **25**: 1, 1935.
16. WHITE, E. G.: *Beitr. path. Anat.*, **96**: 177, 1935.
17. WILLIAMS, H. L. *et al.*: *Tr. Am. Otol. Soc.*, **43**: 264, 1955.

RÉSUMÉ

Des chimiodectomes impliquant le pneumogastrique peuvent quelquefois naître de cellules ressemblant à celles du sinus carotidien dans le glomus intravagal qui gît à l'intérieur ou sur le ganglion plexiforme de ce nerf cranien. Cette formation nerveuse particulière fut décrite pour la première fois chez l'homme en 1935. La littérature médicale comprend 12 cas de telles tumeurs provenant du vague. L'auteur présente ici le treizième.

Une femme de 60 ans admise à l'Institut Neurologique de Montréal en décembre 1955, était porteuse depuis 1939 d'une tumeur derrière l'angle du maxillaire inférieur droit. Cette masse fut reséquée trois ans après son apparition et l'examen anatomopathologique de la pièce en fit un neurofibrome bénin. Le grand hypoglosse fut sectionné au cours de l'intervention. En 1950 parurent des signes neurologiques d'envahissement intra-cranien. La douleur occipitale se manifesta en 1954 et enfin des nausées et des vomissements amenèrent son admission. A l'examen la T.A. était de 16/8, la voix éteinte par suite d'une paralysie des cordes vocales et la malade présentait un œdème de la papille, du nystagmus bilatéral et une masse rénitente mobile du côté droit du cou. La radiographie du crâne montra une énorme aire de destruction osseuse intéressant la partie droite du plancher de la fosse postérieure, surtout autour du condyle occipital et du rocher. L'atlas et l'axis étaient aussi touchés. A son cinquième jour d'hospitalisation la malade fut atteinte d'un ictus généralisé suivi le lendemain de trois autres. Elle mourut quelques jours plus tard sans avoir repris connaissance.

A l'autopsie on vit une masse s'étendant à 5 cm. au-dessous de la base de la fosse postérieure droite ainsi que deux petites masses tumorales dans la région sous-mandibulaire droite. L'examen microscopique montra une néoformation composée surtout de groupes de grandes cellules tumorales à cytoplasme fibrillaire quelque peu acidophile avec de gros noyaux ovales et sombres. En dépit d'un léger degré de pléomorphisme le tissu possédait une apparence d'épithélium polyédrique.

L'histologie des tumeurs du glomus intravagal est identique à celle des tissus chimiorécepteurs. Cette formation du vague ainsi que les tumeurs qui peuvent en naître ne semblent posséder aucune fonction physiologique.

TYPHOID FEVER: WHERE THERE'S A CASE, THERE'S A CARRIER*

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THE INVESTIGATION of a series of atypical cases of typhoid fever has been brought to a successful conclusion by the detection of a typhoid carrier, using the gauze swab technique advocated by Moore.[1-3]

Although the incidence of typhoid fever has shown a steady decline, ten or more incidents occur in the Province of British Columbia each year. During the past five years no fewer than 16 different phage-types of *Salmonella typhi* have been isolated from cases in this province, indicating multiple foci of infection. Since 1856, when William Budd[4] first demonstrated the contagious nature of this disease, a number of hygienic measures have been introduced for its control. In spite of these conventional control measures there still remains in most communities "an unextinguished residuum due to causes resistant to existing preventive measures".[5]

By the use of apt alliteration's artful aid we may recall that typhoid fever is spread by "dairies, drains, drinking water, the dust of dried dejecta, the repulsive regurgitation, dangerous droppings, and filthy feet of fæcal-feeding flies fouling food; and direct infection"[6] from cases, contacts, convalescents, cooks and carriers. It has been estimated that about 3% of cases of typhoid fever become chronic carriers who continue to excrete typhoid organisms either intermittently or persistently for a period of at least one year after infection.[7] In the final analysis the persistence of this disease is dependent on the continued presence of the undetected chronic carrier, and it is nearly always true to say: "Where there's a case, there's a carrier."

In order to detect the chronic carrier responsible for this *unextinguished residuum* of cases, new methods for laboratory diagnosis and epidemiological investigation have been developed. These include the bacteriophage typing of *Salmonella typhi* introduced by Craigie *et al.*[8-10] for the epidemiological "finger-printing" of strains, and the evolution by Moore[1] of a method for continuous sampling of sewage using gauze swabs immersed in the sewage system.

In the present paper, it is proposed to describe four clinical cases of typhoid fever, to detail the methods used in detecting the vehicle and reservoir of infection, and to enumerate some of the more important lessons learned during the clinical, epidemiological and bacteriological investigation of this typhoid incident.

CLINICAL CASES

The histories of these patients are of considerable interest, because, so far as we were able to determine, only four cases occurred and these were widely separated in time and space. At first there appeared to be no common vehicle or reservoir of infection to associate them, but diligent epidemiological and laboratory investigations finally dis-

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Canad. M. A. J.
Feb. 1, 1959, vol. 80

closed a single source. The first case occurred in November 1953; the second in March 1955; the third 11 months later in February 1956; and the last case was investigated in January 1957. The interval between cases was thus roughly one year.

CASE REPORTS

CASE 1.—November 1953:

On November 17, 1953, R.M., a boy aged 7 years, complained of fever and loss of appetite. His temperature chart showed the typical step-ladder rise, reaching 105° F. by November 21. The following day he vomited and had loose watery stools, felt listless and sustained a severe epistaxis. He was admitted to hospital on November 28 complaining of nausea and vomiting with a temperature of 103° F. Physical examination failed to indicate localizing signs except for slight right abdominal muscle guarding. In view of a past history of rheumatic fever at 4 years of age, a provisional diagnosis of pyrexia of unknown origin (rheumatic fever suspected) was made and the boy was treated with salicylates without obvious improvement. The final diagnosis of typhoid fever was made when *Salmonella typhi* was isolated from both blood and stool cultures on December 2, the 16th day of the illness. After treatment with chloramphenicol, R.M. was sent home, having spent 42 days in hospital.

CASE 2.—March 1955:

On March 7, 1955, R.H., a boy aged 8 years, was found to have a mild left otitis media with a temperature of 101° F. He had suffered from recurrent attacks of fever for two months, and a tentative diagnosis of rheumatic fever was made. On March 11, he developed a generalized morbilliform rash which was diagnosed as measles. During the ensuing two weeks the temperature rose to 106° F., but the rash faded and no chest complications supervened. His symptoms when admitted to hospital on March 26 were diarrhœa, vomiting and frontal headaches associated with high fever. Stool culture yielded *S. typhi*. In the case summary, the physician reported: "has nearly all classical symptoms of typhoid fever—high fever, vomiting, loose stools, relatively slow pulse in relation to fever, generalized lymphadenopathy, enlarged spleen and leucopenia". After three days' treatment with chloramphenicol, the fever abated, and the boy made steady progress until discharged from hospital (after three negative stools) on April 19 (25 days in hospital). Assuming that the first manifestation of typhoid fever occurred on March 7, and not two months earlier, the diagnosis of typhoid fever was made bacteriologically on the 20th day of illness.

CASE 3.—February 1956:

L.W., a boy aged 12 years, complained of headache, diarrhœa and fever on February 1, 1956. During the ensuing three weeks his condition was diagnosed as sinusitis and bronchopneumonia. There was no clinical improvement when he was treated with aureomycin. On February 20, the boy's left elbow was red, swollen and painful, and he had diarrhœa and vomiting. He was admitted to hospital on February 23. Blood and stool cultures yielded *S. typhi* on February 24 (the 24th day of the illness). He remained in hospital until March 26, a total of 33 days.

CASE 4.—January 1957:

On January 10, 1957, C.P., a boy aged 8 years, woke with fever. On January 18, he was admitted to hospital with a history of sickness and fever for one week but no diarrhœa or abdominal symptoms. He had a red and inflamed pharynx and a systolic mitral murmur. On this evidence the condition was diagnosed as a possible rheumatic infection. On February 7, he had four loose stools from one of which *S. typhi* was isolated on February 11, the 33rd day of illness. He remained in hospital for only 12 days.

The findings in these four patients are summarized in Table I.

TABLE I.—SUMMARY OF FINDINGS IN FOUR TYPHOID FEVER PATIENTS AND THE UNSUSPECTED CARRIER

Case and year	*Age in years*	*School and ravine*	*Month of onset*	*Provisional diagnosis*	*Days from first symptom to firm diagnosis*	*Days in hospital*	*Organism isolated*
1 1953 R.M.	7	Yes	November	PUO ? rheumatic fever	15	42	*S. typhi* type E8
2 1955 R.H.	8	Yes	January February or March	Rheumatic fever	20	25	*S. typhi* type E8
3 1956 L.W.	12	Yes	February	Sinusitis and broncho-pneumonia	24	33	*S. typhi* type E8
4 1957 C.P.	8	Yes	January	Rheumatic infection	33	12	*S. typhi* type E8
Carrier 1953-57 Mrs. X	59	Faulty septic tank drained into stream		Biliary dyspepsia	—	—	*S. typhi* type E1 *S. typhi* type E8

EPIDEMIOLOGICAL INVESTIGATIONS

Thorough epidemiological investigations, carried out after the diagnosis of each of the first three cases of typhoid fever in 1953, 1955 and 1956, had failed to reveal a vehicle or source of infection. The existence of a vehicle and source common to all the cases appeared likely from the results of phage-typing, which showed that all four cases were caused by the same uncommon phage-type E8 (previously known as Type 31—Wilson and

Edwards[11]). In February 1957, when the diagnosis of the fourth case was established bacteriologically, a further detailed survey of the area was undertaken and the epidemiological evidence was re-examined.

Description of the Area

Burnaby is a municipality with a population of some 85,000. The residential area with which we are concerned is situated on a southern slope not far from the north arm of the Fraser River (Fig. 1). The houses are moderate-sized single family homes, and the method of sewage disposal is by individual septic tanks in the gardens, as no water-borne sewage disposal system is available. Storm-water from this area is collected in unlined open drains which lie close to unpaved sidewalks. This water flows southwards, entering underground storm-water drains which are accessible through manhole covers, and finally pours through a wide drain pipe into a ravine which empties into the Fraser River. Immediately north of the ravine is an elementary school. The ravine itself has steep banks and is densely wooded. During the winter months the stream is swift-flowing, receiving storm-water from west, north and east. The wooded ravine is a youngster's paradise, providing excellent terrain for camping, games, fishing and picnicking, and there is little doubt that many of the boys from the neighbouring school disappear into the woods when school is over and slake their thirst in the stream.

Factors

The epidemiological data indicated that:

1. All four cases were in boys aged between 7 and 12 years.
2. All lived in the same general area (Fig. 1).
3. All attended the same school.
4. All had ready access to the ravine and probably drank from the stream.
5. The onset of illness in each case was during the winter months between November and March.
6. All four cases had a slow, insidious onset lasting from 15 to 33 days with ill-defined symptoms, suggesting either a small infecting dose or lowered virulence of the infecting strain.
7. None of the close contacts of the patients gave a history of sickness, and their stool cultures proved negative.
8. The organism isolated from each patient was of the same phage-type, E8.

Search for the Carrier (see Map, Fig. 1)

The factors presented suggested that the storm-water passing beneath the school and spilling southwards as a stream through the wooded ravine might be the vehicle of infection. Sites for sampling this water were selected at points south of the school. The method of sampling selected was the gauze swab technique of Moore,[1] as it was likely

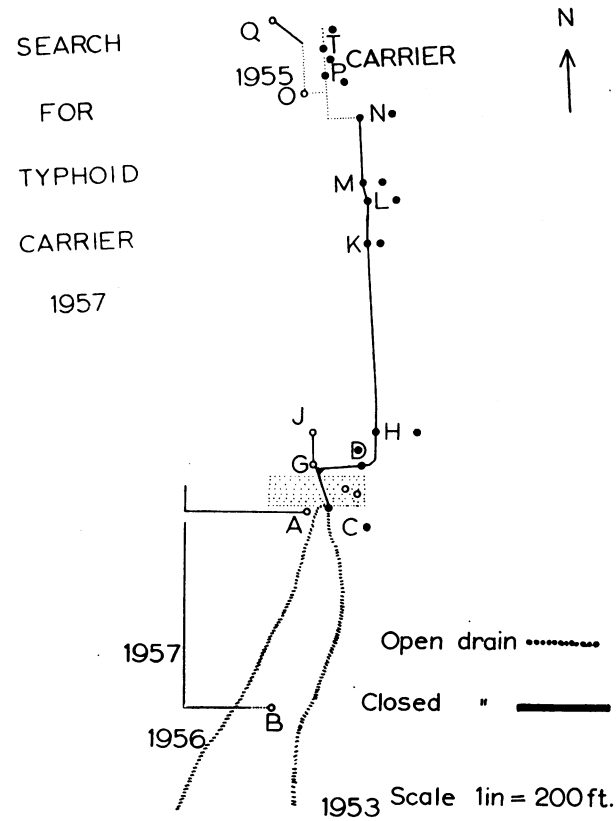

Fig. 1.—Map of residential area (streets not shown). Key: Homes of patients indicated by date of occurrence, e.g. 1953. School area stippled with ravine to south. Sampling points indicated by letters adjoining a black dot if *S. typhi* isolated and an open circle if negative.

to provide a greater chance of success than direct sampling. Accordingly, on February 18, 1957, gauze swabs were tied in position at sampling

TABLE II.—ISOLATION OF *Salmonella typhi* FROM SAMPLING POINTS

Sampling point*	*Date in laboratory*	*Organism isolated*
Sewer swab	*1957*	
A	Feb. 20	———
B	" 20	———
C	March 6	*S. typhi* type E8
C 1	" 13	*S. typhi* types E8 and E1
D	" 13	*S. typhi* type E8
E	" 14	———
F	" 14	———
G	" 14	*S. thompson*
H	" 14	*S. typhi* types E8 and E1
J	" 14	*S. thompson*
K	" 14	*S. typhi* types E1 and E8
K 1	" 20	*S. typhi* type E8
L	" 20	*S. typhi* types E8 and E1
M	" 20	*S. typhi* types E8 and E1
N	" 20	*S. typhi* type E8
O	" 20	———
P	" 20	*S. typhi* types E1 and E8
P 1	" 25	*S. typhi* types E1 and E8
Q	" 20	———
T	" 25	*S. typhi* type E8
U	" 25	———
V	" 25	———
Water sample C	" 20	*S. typhi* type E8
Septic tank	April 1	*S. typhi* types E8 and E1

*See Fig. 1, map of residential area.

Canad. M. A. J.
Feb. 1, 1959, vol. 80

Fig. 2.—Open ditch adjoining home of carrier near sampling point P in dry weather.

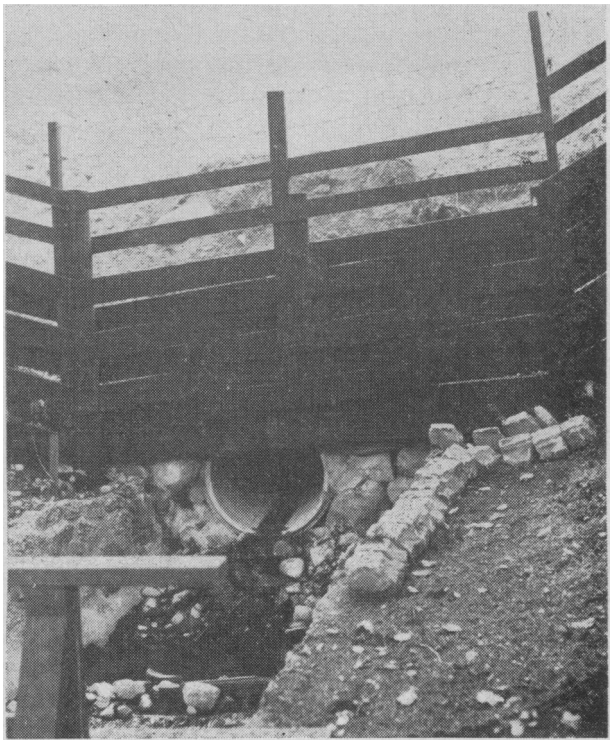

Fig. 3.—Sampling point C opening into north end of ravine taken in dry weather.

points A and B and left for 48 hours. The cultures proved negative, and a further swab was placed at point C on March 4. *S. typhi* was grown from this swab; it was therefore decided to pursue the investigation by placing swabs at two selected sites farther north in the storm-water drain system at weekly intervals. The results of culture of these swabs are recorded in Table II, which shows two points of interest: firstly, that the typhoid organisms isolated belonged to two different phage-types—one the cause of the typhoid cases, type E8, and the other a much commoner strain, type E1; and secondly, that *Salmonella thompson* was isolated from two of the sampling points which failed to yield *S. typhi*.

Week by week the positive findings led almost inevitably upstream to open roadside storm-water drains, and finally the field of search was narrowed to three houses. The seven occupants of these houses were interviewed and requested to provide stool specimens. From one of these specimens *S. typhi* was recovered on March 28, 1957.

The Carrier

Interrogation of the woman with a positive stool culture elicited the following history. Mrs. X is a 59-year-old woman living with her husband and one grown-up daughter. When a girl of 16, Mrs. X worked as a domestic servant on a farm on the prairies. She recollects a serious epidemic of typhoid fever in the neighbourhood during which three persons at her farm died, although she was not ill. The sanitary amenities of the farm were rudimentary. In 1918, she married and moved to a neighbouring farm. In 1923, Mrs. X sustained an acute attack of diarrhœa and fever for which a friend recommended a large dose of liniment by mouth. This cured the diarrhœa but proved almost fatal. During the months that followed she had alternating attacks of diarrhœa and constipation with occasional periods of vomiting, but these all subsided.

In 1947, the family settled in British Columbia and in 1953, the year of the first case in our series, they moved to the house in which we found the carrier. During the past four years Mrs. X has had intermittent periods of ill health. In August 1953, a cholecystogram indicated deficient gall-bladder function, but, in spite of periodic attacks of biliary dyspepsia, she consistently refused radical treatment. Although Mrs. X has regularly prepared meals for her family and has also carried out a number of food-handling jobs in the neighbourhood, it appears that she has not infected anybody directly.

Examination of Mrs. X's septic tank revealed no flaws in construction, but there was a small positive outlet from the disposal field to the storm ditch on the roadside, resulting in only a slight and occasional discharge of effluent into the open ditch which is illustrated in Fig. 2.

At the conclusion of the swabbing program one gallon of water was collected from point C (illustrated in Fig. 3) and *S. typhi* was recovered on culture. This suggests that the degree of contamination of the stream was considerable.

CONTROL MEASURES

Action Taken on Discovery of the Carrier

1. The carrier was warned of her condition and instructed in personal hygiene. She was excluded from food-handling jobs in the community and given instructions to prevent the spread of the disease.

2. Stools from the family and other close contacts of the carrier were tested and found to be negative.

3. In view of the known contamination of the open storm-water drains and the stream, an inoculation clinic for giving TAB vaccine to residents was established.

4. All physicians in the neighbourhood were warned of the possibility of further cases, but no more came to light.

5. The water closet and septic tank were carefully examined. The faults in the disposal field servicing the septic tank were made good and the whole system was liberally treated with bleaching powder. Subsequent bacteriological examination of water from the stream proved negative. A chemical toilet was provided at municipal expense.

6. The carrier was treated with a combination of monovalent typhoid vaccine followed by chloramphenicol as recommended by Carnes *et al.*[12] in an attempt to cure the carrier state.

7. This proved unsuccessful and, after much persuasion, Mrs. X underwent cholecystectomy. S. *typhi* was isolated from the gall-bladder wall, from the bile and from the interior of gall-stones. Culture of one stool specimen collected a week after operation yielded S. *typhi* but all subsequent stool cultures were negative.

LABORATORY INVESTIGATIONS

Only a brief outline of the salient laboratory findings will be given here. The details will be the subject of a further paper in a bacteriological journal.

Material and Methods

Swabs were prepared by folding a piece of gauze about four feet (1.20 m.) in length and six inches (15 cm.) wide into a pad of eight thicknesses and attaching it firmly by one end to a long piece of stout string. The swabs were wrapped and sterilized before issue. For sampling purposes the swab was suspended in the storm-water for 48 hours and then collected in a sterile wide-mouthed container and taken to the laboratory for culture.

Swabs were cultured after dilution of their contents with nutrient broth. Varying dilutions were both enriched and plated directly. The solid medium of choice was bismuth sulphite agar on which typical colonies were more readily distinguishable. Several suspicious colonies were picked from each plate and identified by biochemical, cultural and serological reactions.

Salmonella typhi, type E8

The strain was first isolated from a carrier of long standing at the Pennsylvania State Department Laboratories in 1951. Wilson and Edwards[11] were able to adapt Vi phage II type A to this organism, thereby establishing it as a new phage-type, designated type 31 and later changed to type E8. This is the first time that the new phage-type has been reported in Canada.

Bacteriophage-typing

In order to conserve phage and time, all colonies were subjected to screen phage-typing with only type E1 and E8 phages at our Provincial Laboratories. A suitable selection of strains was submitted to Mr. J.-M. Desranleau, Quebec Division of Laboratories, for confirmation.

From 12 gauze swabs and 10 preoperative stools of the carrier S. *typhi* was isolated. Phage-typing showed that type E8 was present in larger numbers than type E1.

The presence of two phage-types in the same carrier suggests two possibilities. Firstly, the carrier may have been infected from two different sources. Secondly, the transformation E1 ⟷ E8 may have occurred in the carrier. It is, however, of interest that all the cases infected by the carrier yielded only phage-type E8. Anderson and Fraser[13] have shown the relationship between type E1 and type E8 and advocate for the latter the structural formula E1 (26′), because type E8 can be prepared artificially from type E1 by lysogenizing it with phage 26′. The cycle connecting these two phage-types is illustrated in Fig. 4.

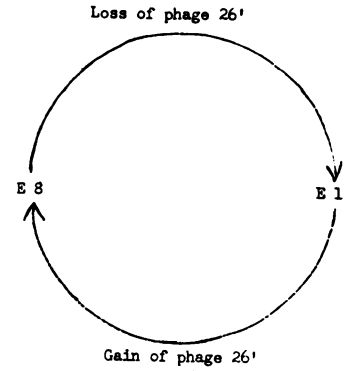

Fig. 4.—Probable relationship between *S. typhi* types E1 and E8.

Desranleau and Martin[14] carried out a systematic search for the presence of symbiotic phage in the cultures sent to them, but without success. These workers are also attempting to bring about the *in vitro* transformation E1 ⟷ E8.

Virulence of Strains

The low incidence of typhoid fever in the presence of heavy contamination of the vehicle suggested the possibility that the infecting strain

Canad. M. A. J.
Feb. 1, 1959, vol. 80

TABLE III.—SUGGESTED LABORATORY INVESTIGATIONS OF PYREXIA OF UNKNOWN ORIGIN TO BE INSTITUTED IN ALL PATIENTS WITH FEVER WHEN DIAGNOSIS REMAINS IN DOUBT FOR OVER 72 HOURS

Day of illness	*Laboratory investigation*	*Remarks*
3rd, 7th	Blood culture	Venous blood to be inoculated at bedside into blood culture medium. Whole clotted blood to be despatched to laboratory for agglutination tests.
3rd (7th), 11th, 15th (19th), 23rd	Agglutination tests for: Enteric group Brucella group Infectious mononucleosis	 Widal test Paul-Bunnell test
8th-12th 15th-19th 22nd-26th	Stool culture	"Walnut" of fæces into buffered glycerin saline in screw-capped bottle.
1st, 5th	Chemical and microscopic examination of urine	Notes: 1. To arrive speedily at a correct diagnosis, the value of following a plan for routine laboratory examinations cannot be over-estimated. 2. In the diagnosis of obscure fevers, the following conditions should be kept in mind: (a) The enteric group of fevers, especially due to *S. typhi* and *S. paratyphi B.* (b) Undulant fever due to *Brucella melitensis* or *Br. abortus.* (c) Tuberculosis. (d) Septicæmias due to streptococci, staphylococci or pathogenic *E. coli.* (e) Pyelitis, liver abscess, empyema. (f) Lymphadenoma, infectious mononucleosis and certain new growths. (g) Certain tropical diseases.
4th	Microscopic examination of fæces for intestinal parasites.	
3rd, 6th, 12th, 19th	Total and differential white blood cell count.	

was of attenuated virulence. Comparative mouse virulence tests were carried out at the Laboratory of Hygiene by Drs. E. T. Bynoe and J. Yurack. These tests indicated that the type E8 strains were of appreciably lower mouse virulence than the standard Ty2 strain used. The mouse virulence of the type E1 strains was also with one exception (namely the strain first isolated from the carrier) less than that of the standard strain. This decreased mouse virulence of the infecting strain may account for the small number of cases reported and for the insidious onset of illness in these cases.

Histology

The chronic nature of the lesions was indicated by the 32 large and small stones found in the lumen of the gall-bladder, whose mucosa was roughened and thickened. Microscopically, the wall revealed a heavy infiltration of chronic inflammatory cells in the submucosal region, with prominent submucosal lymphoid tissue and infiltration of chronic inflammatory cells throughout. The wall was thickened by fibrous and collagen tissue. The pathologist's diagnosis was chronic cholecystitis and cholelithiasis.

DISCUSSION AND LESSONS LEARNED

As Cruickshank[15] has pointed out: "The investigation and control of enteric fever demands the full co-operation as equal partners, of the practitioner, the medical officer of health, and the bacteriologist." Teamwork was the keynote of the present investigations. It may be of value to discuss some of the lessons which each member of this team learned.

The Practitioner—Diagnosis and Treatment

The prevention of typhoid fever is fundamentally the responsibility of the attending physician, as it consists of the successful treatment of the patient and prevention or cure of the carrier state.

The most important clinical lesson from these patients was the realization that typhoid fever may present as a mild disease of uncertain origin with vague symptoms and no localizing signs. In three of the four cases, a provisional diagnosis of rheumatic fever was made, and in none of the cases was the final diagnosis suspected before bacteriological confirmation was obtained, between 15 and 33 days after the onset of illness. In the interests of the patient and the community, it is important that the attending physician should consider the possible diagnosis of enteric fever in all cases with fever of obscure origin lasting for more than 72 hours. Suggested laboratory investigations which may assist in establishing the diagnosis in cases of pyrexia of unknown origin are listed in Table III.

All four patients responded well to adequate treatment with chloramphenicol and none continued to excrete typhoid bacilli during convalescence. About 3% of typhoid patients become chronic carriers, and bacteriological control during convalescence is therefore essential to detect these prospective carriers.

The carrier, Mrs. X, was relieved of her carrier state, and the community of a health hazard, by removal of the diseased gall-bladder. Cholecystectomy offers the greatest prospect of cure in the carrier with chronic gall-bladder infection, rendering about 70% of fæcal carriers free from in-

fection. Chloramphenicol alone seems to have little or no place in the treatment of the carrier state, although it has been used with apparent success after a preliminary course of injections of monovalent typhoid vaccine.[12]

Typhoid organisms were isolated from the interior of gall-stones removed from the carrier's gall-bladder. It seems probable that mild infection favours the formation of gall-stones and that the presence of gall-stones increases the liability to bacterial infection of the gall-bladder. This creates a vicious circle, as one abnormality promotes or perpetuates the other.[7] It is therefore logical to remove the offending gall-bladder.

It is well known that chronic infection of the gall-bladder occurs in women about five times as often as in men. One large series of persons who excreted typhoid bacilli for over three months showed a similar striking difference in the sex incidence. It is probable that proneness to gall-bladder infection is an important factor in the relatively higher incidence of the carrier state in women. The detection of the typhoid carrier may thus be summed up in the time-honoured advice of all good detectives – "cherchez la femme".

One aspect of the typhoid carrier which merits thought and care in handling is the devastating effect on the carrier of the publicity which her state evokes. From being a quiet and respected citizen she becomes a social pariah. The glare of publicity can be very demoralizing, and the practitioner and the public health authorities must exercise considerable tact and kindliness, if the carrier's whole-hearted co-operation is to be won.

After adequate treatment both cases and carriers require surveillance. This is the responsibility not only of the attending practitioner but also of the medical officer of health and his staff. The only satisfactory method of clearance is by laboratory tests including stool culture, urine culture and serological tests. The object is to prevent the return to the home environment of patients or carriers who are still excreting the organism.

The Medical Officer of Health—Prevention and Control

It is the responsibility of the medical officer of health to carry out thorough epidemiological investigation on the occurrence of an outbreak or even a sporadic case of typhoid fever, and to search among the contacts for ambulant, missed or latent cases. No epidemiological investigation can be considered complete unless four factors have been thoroughly investigated: (1) the bacterial cause of the symptoms; (2) the vehicle responsible for conveying the causal agent to the patient; (3) the reservoir from which the infecting organism originated; (4) the path from the reservoir to the infected vehicles.

In the present typhoid episode it appears that the links in the chain of infection were as follows.

Mrs. X was infected in 1914 or in 1923 or both, and continued to excrete typhoid organisms for many years. Apparently she did not infect any of her close contacts. From 1953 to 1957, while she was living in her present home, the organisms present in her gut contaminated the storm-water and stream in the neighbourhood, but only during the rainy season; the seasonal incidence of the cases supports this view. Many school children had access to this watercourse either as an open roadside ditch or in the wooded ravine. It seems most probable that the four cases were infected through drinking water from the stream.

The value of the maintenance of a typhoid register and a spot map showing, by phage-types, the locations of all known cases and carriers is emphasized. The fingerprinting by bacteriophage-typing of all strains of *S. typhi* isolated is of considerable value to the epidemiologist in associating the various sources of this organism.

The introduction of the gauze swab technique has made it possible to undertake continuous sampling of sewage instead of relying on a single sample. In the present investigations this technique was successfully applied to sampling storm-water drains.

The sanitary survey of the septic tank and the disposal field indicated only a minor and intermittent leak of effluent from the septic tank to the open ditch. It caused considerable surprise that so small a leakage of sewage effluent could result in such heavy contamination of the storm-water drain system. There is, therefore, a real need for waterborne sewage disposal systems in densely populated residential areas.

The Bacteriologist—Laboratory Diagnosis

Laboratory methods for the isolation of enteric pathogens have improved, and the use of selective and enrichment media has led to a higher proportion of positive cultures than in the past. The volume of laboratory work involved in isolating, identifying and phage-typing strains of the typhoid bacillus in this type of study is considerable, and careful planning is therefore advisable before investigations are undertaken. It is the considered opinion of the authors that this method should be used only when frank cases of typhoid have occurred in the community and when the epidemiological evidence suggests that the method is likely to prove successful.

SUMMARY

Four atypical cases of typhoid fever are described. The carrier responsible for infecting them was detected by placing gauze swabs in the storm-water drain system.

The organisms isolated from the cases were *Salmonella typhi* phage type E8, while those from the carrier were *S. typhi* types E1 and E8. This is the first time that type E8 has been reported in Canada.

The problems associated with the detection of a typhoid carrier are discussed and the lessons learned during the present investigations are enumerated.

Considering the awful potentialities of heavily contaminated open drains, it is indeed fortunate that only four cases of typhoid fever occurred.

We are indebted to the attending physicians of the four cases and the carrier for permission to make use of their case histories; to Dr. H. K. Fidler of the Vancouver General Hospital for the histology report on the carrier's gall-bladder; to the Chief Inspector, Mr. G. H. Armson, and the staff of the Burnaby Department of Health for their untiring efforts; to Drs. E. T. Bynoe and J. Yurack of the Laboratory of Hygiene, Ottawa, for examining the strains and carrying out comparative mouse virulence tests and to Mr. J.-M. Desranleau of the Quebec Division of Laboratories, Montreal, for phage-typing no fewer than 540 strains of *S. typhi*.

REFERENCES

1. MOORE, B.: *Month. Bull. Min. Health & Pub. Health Lab. Serv.*, **7**: 241, 1948.
2. *Idem*: *Ibid.*, **9**: 72, 1950.
3. MOORE, B., PERRY, E. L. AND CHARD, S. T.: *J. Hyg.*, **50**: 137, 1952.
4. BUDD, W.: *Typhoid fever, its nature, mode of spreading and prevention*, American Public Health Association, New York, 1931.
5. SCOTT, W. M.: *Lancet*, **1**: 389, 1941.
6. Great Britain, The War Office: Manual of army health, WO Code No. 10157-26, Publication 6756, Her Majesty's Stationery Office, London, 1954, p. 462.
7. WILSON, G. S. AND MILES, A. A.: *Topley and Wilson's principles of bacteriology and immunity*, Vol. II, 4th ed., Edward Arnold & Co., London, 1955. p. 1740.
8. CRAIGIE, J. AND YEN, C. H.: *Canad. Pub. Health J.*, **29**: 448, 1938.
9. *Idem*: *Ibid.*, **29**: 484, 1938.
10. CRAIGIE, J. AND FELIX, A.: *Lancet*, **1**: 823, 1947.
11. WILSON, V. R. AND EDWARDS, P. R.: *The Pub. Health Lab.*, **12**: 38, 1954.
12. CARNES, H. E. *et al.*: Experimental treatment of typhoid carriers, *In*: Antibiotics annual 1954-1955, edited by H. Welch and F. Marti-Ibanez, Medical Encyclopedia, Inc., New York, 1955, p. 391.
13. ANDERSON, E. S. AND FRASER, A.: *J. Gen. Microbiol.*, **13**: 519, 1955.
14. DESRANLEAU, J.-M. AND MARTIN, I.: *Canad. J. Pub. Health*, **49**: 30, 1958 (Abstract).
15. CRUICKSHANK, J. C.: *Month. Bull. Min. Health & Pub. Health Lab. Serv.*, **6**: 88, 1947.

RÉSUMÉ

Cet article sur quatre cas atypiques de fièvre typhoïde illustre l'adage: Dans chaque cas cherchez le porteur. Quatre garçons âgés de 7 à 12 ans furent atteints de fièvre typhoïde entre novembre 1953 et janvier 1957. Tous étaient originaires d'une ville de 85,000 habitants dont les quartiers d'habitation font usage de fosses septiques. Les terrains de cette localité sont irrigués par des fossés à ciel ouvert qui se déversent dans un ravin avant d'atteindre le Fraser. La *Salmonella typhi* isolée dans ces cas était de type bactériophagique E 8. Le dépistage du porteur (en l'occurrence une porteuse âgée de 59 ans avec des antécédents lointains de diarrhée et de contact typhique) fut réalisé par l'immersion pendant 48 heures de tampons à prélèvement dans le réseau d'égout pluvial. Cette femme portait des micro-organismes du type E 1 et E 8. Les traitements habituels ne réussirent point à la débarasser de ses germes et elle finit par se laisser persuader de subir une cholécystectomie qui produisit les résultats espérés. Des mesures d'hygiène publique furent aussi prises pour enrayer les dangers d'épidémie.

C'est la première fois au Canada que l'on isole le type E 8. Il est heureux de constater qu'en dépit du grand potentiel infectieux présenté par les fossés ouverts seulement quatre cas de typhoïde se sont produits. Des considérations techniques sur le dépistage et la conduite à tenir dans ces cas sont données dans le texte.

NUTRITIONAL DEFICIENCIES IN PATIENTS ADMITTED TO MENTAL HOSPITAL*

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IT IS WELL ESTABLISHED that the nervous system requires certain nutrients for normal function, and that diets deficient in these essential substances may result in organic neurological disease,[3, 7] psychoneurotic syndromes[1, 4, 8] or frank psychoses.[1, 7] Nutritional deficiencies may be produced by a variety of mechanisms, which have been enumerated elsewhere.[2]

Deficiencies of certain vitamins have been considered important contributory factors in the etiology of organic psychoses associated with alcoholism and senility.[2] It has also been said that secondary nutritional deficiencies occur in many patients with "functional" psychiatric disorders accompanied by anorexia or refusal of food. Even where no deficiency is known to exist, special diets or vitamins have been prescribed in the hope of benefiting patients with psychiatric disorders.[2, 5]

To date, however, there appear to be little factual data on the nature and extent of nutritional deficiencies among mentally ill patients. The present investigation was carried out in an attempt to compare frequencies of various nutritional deficiencies in selected diagnostic groups of psychiatric patients at the time of their admission to mental hospital, before being placed on a standard diet.

METHOD

The data recorded and analyzed in the present study consist of reports on tests performed in the Clinical Nutrition Laboratory of the Department of National Health and Welfare in Ottawa, on samples of blood and urine collected from 312 patients admitted to a mental hospital and 71 hospital employees. The patients were all admitted to the Ontario Hospital, London, Ontario, during a six-month period commencing in October 1957. Patients returning to hospital after an extended trial visit in the community were also included in the study. The hospital employees were all self-selected volunteers, whose specimens were collected during the month of January 1958.

Blood specimens were normally obtained from patients before breakfast on the morning after admission. A few c.c. of blood was allowed to coagulate and

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