# MENINGITIS DUE TO *B. ENTERITIDIS* GAERTNER.

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(With one Chart.)

## Introduction.

In discussing a case of meningitis caused by *B. paratyphosus* B, Brahdy (1925) calls attention to the extreme rarity of such a condition. An exhaustive survey of the literature led Brahdy to the discovery of only eight cases of paratyphoid meningitis, these being recorded by French or German observers.

Therefore it would appear that only nine cases of meningitis have been traced to the paratyphoid group of organisms: seven to *B. paratyphosus* B, one to the *B. paratyphosus* A, and one to a bacillus of undifferentiated type. The scanty reference to paratyphoid meningitis in the literature is readily explained by the occurrence of few cases. It is nevertheless recognized as a distinct pathological condition by several authors. Thus: Hurst (1918) maintains that "in exceptional cases...dysentery, cholera, or meningitis may be so closely simulated that the possibility of paratyphoid fever is not considered until the bacteriological examination of the stools and cerebro-spinal fluid demonstrates the absence of the specific organisms of these diseases and the presence of *B. paratyphosus*." Ker (1920) observes that "all the severe complications of typhoid fever may occur in the paratyphoid varieties and that haemorrhage, perforation, meningitis...are all met with." MacCallum (1920) writing of paratyphoid infections, remarks on the existence of paratyphoid meningitis; while Hiss and Zinsser (1922) point out that "isolated cases of meningeal infection with *B. paratyphosus* have been reported."

Having failed to find any reference in medical literature to meningitis caused by the *B. enteritidis* Gaertner we herewith record an apparently unique case that we have observed.

### *History of case.*

The patient was an eleven year old boy, of Greek parentage, residing in Jerusalem. On October 1st, 1925, his illness was ushered in with two attacks of profuse epistaxis, very severe headache, and marked catarrhal symptoms. The tongue was white and coated, the temperature 101·3° F., the pulse, in relation to the temperature was slow, full in volume, of low tension, dicrotic. In view of the characteristic signs and the typhoid epidemic then prevailing in Jerusalem, the attending physician on October 5th had the boy transferred to hospital as a case of enteric fever without, however, having previously submitted blood to the laboratory for cultural investigation. On admission

to hospital the patient was found to be suffering from symptoms of meningitis, and later passed into an almost comatose condition. On October 7th he developed, after a very restless night, a right hemiplegia, while convulsive movements occurred on the left side, in the arm and leg, as well as in the tongue and lips. Thereafter until the date of his death, the patient remained in absolute coma, all nutrition through the normal channels being impossible, and constipation, doubtless resulting from intestinal paralysis, being complete and prolonged.

This state persisted for twelve days and was marked just before death by great acceleration of the pulse and by an elevation of temperature to 109·4° F. Death occurred on October 19th after an illness which had lasted altogether nineteen days.

Unfortunately, as is generally the case in this country, no autopsy was allowed. The observations on the patient while in hospital were made by Dr Roux, medical officer in charge of the French Hospital, Jerusalem, while the accompanying Chart (p. 162), indicating the relation of pulse rate to temperature, has been compiled from figures supplied by that officer.

*Laboratory investigations.*

On no occasion during the whole course of the disease was a request for blood culture made by the doctors in attendance. Twice, however, on October 6th and 12th, blood serum was forwarded for the Widal Reaction. On both occasions the patient's serum was found to agglutinate *B. paratyphosus* B in a dilution of 1 in 100 and *B. paratyphosus* C in a dilution of 1 in 50, whilst *B. typhosus*, *B. paratyphosus* A and *B. enteritidis* Gaertner were not agglutinated.

On account of the meningeal symptoms, a specimen of the cerebro-spinal fluid was submitted for examination. Coming out under pressure, the fluid showed no apparent turbidity; the centrifugalised deposit was small in amount, and the white cells present were mostly lymphocytes. Inoculation of the deposit was made into broth and ox-bile media from each of which a single bacillary strain was recovered. The organism proved on further examination to be an actively motile, Gram-negative bacillus which formed acid and gas in glucose broth, was a non-fermenter of lactose, and produced no indol. A study of its fermentation reactions showed that the bacillus (*a*) had the power to ferment glucose, mannite, dulcite, sorbite, dextrin, maltose, galactose, laevulose, rhamnose, arabinose, xylose; (*b*) produced no change in lactose, saccharose, raffinose, salicin.

Were the fermentation reactions of the paratyphoid-enteritidis group insusceptible to variation, the organism could at once have been identified with certainty as *B. enteritidis* Gaertner, since it differed from *B. paratyphosus* A in fermenting xylose, and from *B. paratyphosus* B in fermenting dextrin.

Having regard to the possibility of such variations, however, we felt justified only in assuming that we were dealing with an organism which

possessed certain fundamental fermentative properties that are characteristic of *B. enteritidis* Gaertner.

Agglutination tests were made with the bacillus, using various immune sera for the paratyphoid-enteritidis group prepared by the Sachsisches Serumwerk A.G. Dresden. Table I gives the results of twelve series of agglutination tests performed:

Table I. *Highest degree of agglutination obtained with immune sera.*

| Immune serum | *B. paratyphosus* A | *B. paratyphosus* B | *B. paratyphosus* C | *B. suipestifer* | *B. enteritidis* Gaertner |
|---|---|---|---|---|---|
| Titre of serum | 1 : 5000 | 1 : 3000 | 1 : 3000 | 1 : 3000 | 1 : 9000 |
| Maximum agglutination with organism | 1 : 400 | 1 : 400 | 1 : 50 | 1 : 50 | 1 : 1600 |

In view of the clinical history and serological reactions of this case, and particularly the rarity of the observation, we considered it expedient to forward subcultures of the organism for independent identification to Dr A. Felix,

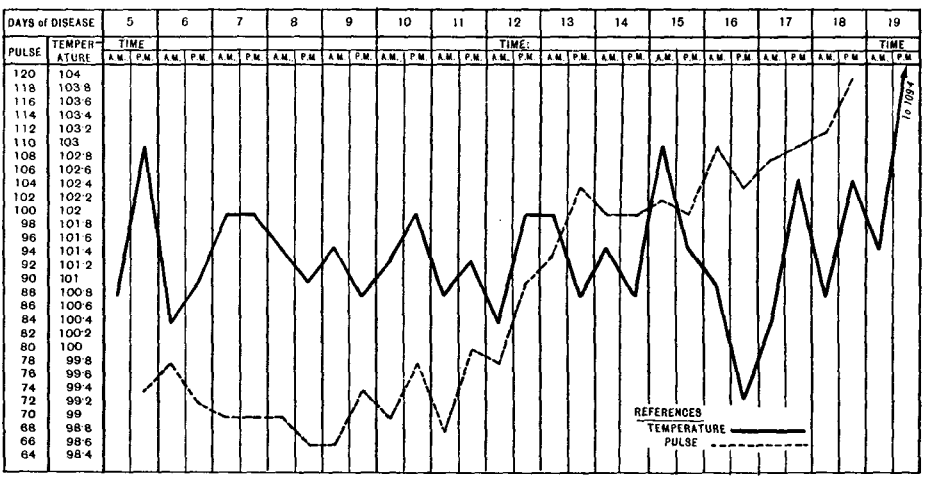


Chart shewing relation of pulse to temperature of patient in case of meningitis due to *B. enteritidis* Gaertner.

Director of Hadassah Laboratories for Palestine. It was also felt that the case afforded a suitable opportunity for determining the value in diagnosis of "qualitative receptor analysis" as advanced by Weil and Felix (1920), these workers, by means of artificial immune sera, having reached certain conclusions regarding the receptor apparatus of *B. typhosus*, *B. enteritidis* Gaertner, *B. paratyphosus* A and *B. paratyphosus* B.

A brief summary of Weil and Felix's conclusions is appended because the value of Dr Felix's corroboration of our observations will be fully appreciated:

Each organism of the series referred to possesses two sets of receptors:

(1) Thermolabile (destroyed by heating at 100° C. for 2 hours)—specific.

(2) Thermostable (unaffected by equal exposure) consisting of

(*a*) main receptors—specific for each of the species;

(*b*) group receptors.

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Immune serum produced artificially for any one of these organisms contains two types of agglutinins:

(1) Large flaking: reacting with the thermolabile receptors of the antigen.

(2) Small flaking: reacting with the thermostable receptors.

Practical application of "qualitative receptor analysis" should therefore greatly facilitate the identification of any organism belonging to the group under consideration in that *large-flaked agglutination occurs only with the homologous strain, while group agglutinins are exclusively small flaked.*

Tables II and III record the experiments carried out by Dr Felix. They confirm our opinion that in this particular case of fatal meningitis the *causa causans* was *B. enteritidis* Gaertner.

Table II. *Agglutination tests.*

| Immune serum | Serum dilution | Agglutination with living emulsions of the strains: Organism X | *B. paratyphosus* A | *B. paratyphosus* B | *B. enteritidis* Gaertner |
|---|---|---|---|---|---|
| *B. paratyphosus* A, 60° C. | 1 : 500 | +s | + + +l (+s?) | +s | – |
| | 1 : 1000 | +s | + +l | – | – |
| | 1 : 2000 | – | +l | – | – |
| | 1 : 5000 | – | +l | – | – |
| | 1 : 10,000 | – | – | – | – |
| | 1 : 20,000 | – | – | – | – |
| *B. paratyphosus* A, 100° C. | 1 : 500 | +s | + +s | – | – |
| | 1 : 1000 | – | +s | – | – |
| | 1 : 2000 | – | +s | – | – |
| | 1 : 5000 | – | – | – | – |
| | 1 : 10,000 | – | – | – | – |
| | 1 : 20,000 | – | – | – | – |
| *B. paratyphosus* B, 60° C. | 1 : 500 | +s | +s | + +l | +s |
| | 1 : 1000 | – | – | + +l | – |
| | 1 : 2000 | – | – | + +l | – |
| | 1 : 5000 | – | – | + +l | – |
| | 1 : 10,000 | – | – | +l | – |
| | 1 : 20,000 | – | – | +l | – |
| *B. paratyphosus* B, 100° C. | 1 : 200 | +s | – | +s | – |
| | 1 : 500 | – | – | +s | – |
| | 1 : 1000 | – | – | – | – |
| | 1 : 2000 | – | – | – | – |
| | 1 : 5000 | – | – | – | – |
| | 1 : 10,000 | – | – | – | – |
| *B. enteritidis* Gaertner, 60° C. | 1 : 100 | + + + } l+s | +s | +s | + + + } l+s |
| | 1 : 200 | + + + } l+s | +s | +s | + + + } l+s |
| | 1 : 500 | + + + } l+s | +s | – | + + + } l+s |
| | 1 : 1000 | + + } l | +s | – | + + } l |
| | 1 : 2000 | + } l | – | – | + } l |
| | 1 : 5000 | + } l | – | – | + } l |

Signs: + + + = supernatant fluid water clear.
+ + = plentiful sediment, supernatant fluid turbid.
+ = small sediment; flakes in fluid, determined by magnifying glass.
s = small flakes.
l = large flakes.
l+s = large and small flakes.
60° = suspension of organism heated for ½ hour at 60° C.
100° = suspension of organism heated for 2 hours at 100° C. (in the autoclave without pressure).

Notes: (*a*) Agglutination: Total volume 1 c.c.
Saline suspension of living bacilli.
Readings made after 20 hours (2 hours at 37° C., 18 hours at room temperature).

(*b*) Sera: The monovalent rabbit immune sera used in this and in the following test were obtained by three intravenous injections of saline suspensions of bacteria.

(*c*) Organism X: Organism recovered from cerebro-spinal fluid.

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Table III. *Absorption tests.*

| Agglutination with strain | Serum dilution | Immune Serum G, 60° C. Treated with organism under investigation | Immune Serum G, 60° C. Not treated | | Immune Serum G, 100° C. Treated with organism under investigation | Immune Serum G, 100° C. Not treated |
|---|---|---|---|---|---|---|
| Organism under investigation | 1 : 50 | – | + + + | 1+s | – | + + + s |
| | 1 : 100 | – | + + + | | – | + + + s |
| | 1 : 200 | – | + + + | | – | + + s |
| | 1 : 500 | – | + + | 1 | – | + s |
| | 1 : 1000 | – | + | | – | (+)s |
| | 1 : 2000 | – | + | | – | – |
| | 1 : 5000 | – | + | | – | – |
| | 1 : 10,000 | – | (+) | | – | – |
| | 1 : 20,000 | – | (+) | | – | – |
| | 1 : 50,000 | – | – | | – | – |
| *B. enteritidis* Gaertner | 1 : 50 | – | + + + | 1+s | – | + + + s |
| | 1 : 100 | – | + + + | | – | + + + s |
| | 1 : 200 | – | + + + | | – | + + s |
| | 1 : 500 | – | + + | 1 | – | + s |
| | 1 : 1000 | – | + | | – | (+)s |
| | 1 : 2000 | – | + | | – | – |
| | 1 : 5000 | – | + | | – | – |
| | 1 : 10,000 | – | (+) | | – | – |
| | 1 : 20,000 | – | (+) | | – | – |
| | 1 : 50,000 | – | – | | – | – |

Signs: (+), traces. G, typical *B. enteritidis* Gaertner.

Notes: Immune Serum G, 60° C. Gaertner immune serum heated for ½ hour at 60° C. (containing large- and small-flaking agglutinins).
Immune Serum G, 100° C. Gaertner immune serum heated for 2 hours at 100° C. in the autoclave without pressure (containing small-flaking agglutinins only).

Technique as described in article by Weil and Felix (1920, see reference). 3 c.c. serum dilution 1 : 25 treated with the bacterial growth of one Kolle flask.

## Conclusions.

(1) The agglutination tests show that the organism under investigation is of the type *B. enteritidis* Gaertner with fully developed labile antigen.

(2) The absorption tests show that the organism under investigation and typical *B. enteritidis* Gaertner possess identical labile and stable receptor apparatus.

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