

end? Great care and judgment are necessary in arriving at a decision to rely solely on either X rays or radium for the cure of a new growth.

The first consideration is whether there is any prospect of curing an early case. Undoubtedly a number of cases have been cured by a thorough exposure to X rays or radium. Such cases are naturally early ones where the lesion is superficial, and therefore readily accessible to the radiations. Rodent ulcer can be so dealt with, and superficial epithelioma may also disappear after treatment and remain cured for lengthy periods.

Sarcoma is another condition in which success may be obtained.

One particular case occurs to me in which a recurrent growth on the face was completely cured by a course of radium exposures. The original growth had affected the eyelid. Recurrence had been dealt with on two occasions by operation, as had also the primary manifestation. The glands on the affected side in the cervical region had become involved. The patient was treated eight years ago and, so far as is known, remains healed. When last heard of about a year ago she was quite well.

The final judgment is, however, in favour of operation in all early cases of cancer, because the balance of opinion is against an attempt to cure by radiations when an operation can so easily be performed and a radical excision offers the best chance of cure. Delay in these cases is always dangerous, because it is not yet possible to be certain that radiations will invariably yield a successful result, and surgery may ultimately have to be employed under much less favourable conditions if we fail to bring about a disappearance of the growth by X rays and radium.

AN ACCOUNT OF
AN INFECTION IN MESOPOTAMIA DUE TO
A BACILLUS OF THE GAERTNER-
PARATYPHOID GROUP.

BY WILLIAM MACADAM, M.A., M.D., M.R.C.P. LOND.,
CAPTAIN, R.A.M.C. (T.C.); BACTERIOLOGIST ATTACHED TO
— BRITISH STATIONARY HOSPITAL, MESOPOTAMIA
EXPEDITIONARY FORCE.

(A Report to the Medical Research Committee.)

A SERIES of inagglutinable organisms culturally and morphologically indistinguishable from *Bac. para. B* have been isolated from the blood stream by the writer in Bagdad between July and December, 1918, and it is learned that similar findings have been recorded in a number of cases in other areas of Mesopotamia. In view of the bacteriological results obtained and pathological lesions revealed at autopsy in three fatal cases which occurred, an account of the findings, along with a note on the clinical history of the series of cases, has been deemed worthy of record to draw attention to the possibility of other cases of fever with or without marked pulmonary lesions being due to the same organism, as well as to raise the question of its relationship to the infections of the classical "enterica" group, especially paratyphoid B fever.

Characters of the Organism Isolated from the Blood and from
the Various Organs.

The several strains of the organism under review all have the cultural and morphological characters of the Gaertner-paratyphoid group. It is most closely related to *Bac. para. B* and, as will be shown, it does not appear to belong to the *Bac. aertrycke* type. Up to the present the organism has been obtained from nine cases, from seven of which it was isolated during routine blood-culture investigation of "P.U.O.s." In the remaining two cases it was isolated at autopsy from the lungs and spleen, no blood culture having been carried out during life. The organism has so far not been isolated from the urine or stools in spite of numerous examinations, but at one of the autopsies it was obtained in pure culture from the bile.

All the strains give similar microscopic appearances—an actively motile short, stout, Gram-negative bacillus or coccobacillus, with some tendency to pleomorphic formation. The growth on agar is less transparent and oily in appearance than the usual paratyphoid cultures, and is usually more profuse. There is no liquefaction of gelatin. On

MacConkey's medium the colonies are indistinguishable from the paratyphoids. Biochemically the organism produces acid and gas in mannite, glucose, dulcitol, maltose, galactose and arabinose, no change occurring in lactose, saccharose, and inulin. Litmus milk becomes at first slightly acid, changing to alkalinity on the fifth to seventh day; there is no production of indol.

Serological Characters.

On isolation, all the strains were inagglutinable even in low dilutions of the high-titre sera (Lister Institute) for *B. typhosus*, *B. para. A*, *B. para. B*, and *B. enteritidis* (Gaertner). After eight subculturings in broth spread over a fortnight, all the strains had become agglutinable to para. B serum in dilution of 200 and 250; while in the case of four of the strains, each of which was subcultured on 30 occasions, agglutination was obtained in considerably higher serum dilutions. Fine soft flocculi with a distinctly opalescent supernatant fluid were present in dilutions ranging up to 1000 and 2000 (titre of the para. B serum 6000), but marked sedimentation was never present in dilutions higher than 200 or 250. In none of the tests with para. B serum did I obtain the clear supernatant fluid which usually results in similar tests with *Bac. para. B*. Consistently negative results were obtained in the agglutination tests with all other high-titre sera (Dreyer's method slightly modified being the technique adopted).

Specific sera for three of the strains have been obtained by the immunisation of rabbits, a titre of 6000 to 10,000 being reached without any difficulty. All the nine strains were agglutinated to practically the full titre, whereas two stock strains of *Bac. para. B* never showed any signs of clumping in higher dilution than 1 in 250. For example, strain No. 6, which was obtained in pure culture from the lungs at autopsy by plating the lung juice on MacConkey's medium (as also from the heart blood and spleen), was agglutinated immediately after isolation by the rabbit immune sera for the strains No. 3 and 4 in dilutions of 8000 and 10,000 respectively, while para. B. sera (Lister Institute, titre 6000) failed to produce any reaction with this strain in dilution 1 in 50. "Zones of inhibition" were occasionally met with in the agglutination experiments both with the specific para. B serum, as well as with the sera obtained from the immunised rabbits, but no reference need be made to them in the present connexion.

It has unfortunately not been possible to obtain from England subcultures of recognised *B. aertrycke* strains, but through the kindness of Lieutenant-Colonel Ledingham, R.A.M.C., I was enabled to compare the reactions of a strain of presumed *Bac. aertrycke* isolated from an epizootic among guinea-pigs by Major Gloster, I.M.S., at Amara. The behaviour of this bacillus with the sera produced from the immunised rabbits was very different from that of all the nine strains of the organism under review. Agglutination with sedimentation was present up to the 250 dilution, while the same indeterminate type of clumping associated with the fine soft flocculi as was obtained with the stock *B. para. B* was present up to a dilution of 1 in 1000. Nor did this *B. aertrycke* strain become more agglutinable after repeated subculturings, while it may be noted that it clumped with the Lister para. B serum practically up to titre. Thus it appears improbable that the series of organisms under investigation belong to the *B. aertrycke* group, although the evidence is meantime incomplete in the absence of experiments with specific *B. aertrycke* sera.

Agglutination of organism with patient's serum.—One case—No. 1—is of special interest, in that it was possible to

Dilutions of Serum of Case No. 1.

	25	50	100	200	250	500
No. 1	++	++	++	±	±	-
No. 2	+	+	±	-	-	-
No. 3	++	++	+	±	±	-
No. 4	++	++	+	+	-	-
No. 5	++	+	+	-	-	-
Stock <i>B. para. B</i>	+	+	-	-	-	-
Stock <i>B. para. A</i>	+	-	-	-	-	-
Stock <i>B. typhosus</i>	+	+	-	-	-	-

carry out agglutination tests with two lots of this man's serum against his own organism as well as against the others of the series. Unfortunately no serum was obtained before the twenty-fourth day of illness. On this occasion the

serum gave negative results. On Oct. 28th, 1918—i.e., the forty-second day from the onset of No. 1's illness—blood was again obtained, and the following results were obtained in macroscopic agglutination tests with the serum against five of the strains and against our stock T.A.B. emulsions. This patient has been inoculated with T.A.B. vaccine in November, 1916, and again in February, 1918.

Absorption tests.—Although it was not to be expected that much information was to be gained from absorption tests when the Para. B agglutinogens of all the strains of the organism are relatively slight in character and produce such atypical flocculi as compared with those of the homologous organism, yet a number of such tests have been carried out. Out of six experiments with Strain No. 4 immune serum the following result was recorded in two instances :—

Strain No. 4 rabbit immune serum (titre 6000). Titre before and after absorption with (A) *Bac. para. B* and with (B) Strain No. 3 :—

	(A)		(B)	
	Original titre.	After absorption.	Original titre.	After absorption.
<i>B. para. B</i>	250	<50	250	<50
Strain No. 4	6000	6000	6000	500
Strain No. 3	6000	5000	6000	{ > 500 < 1000

It is seen that *Bac. para. B* removed all the para. B co-agglutinins from the rabbit immune serum, but did not touch the agglutinins for the homologous or similar organism, whereas after absorption with a presumably similar bacillus (Strain No. 3) more than five-sixths of the agglutinins for the homologous organism were removed, as also were all the para. B co-agglutinins. In the other four tests such removal of the para. B co-agglutinins, by the strain presumably similar to the homologous organism, did not occur. This may have been due to the use of an insufficiency of organisms in the saturation of the serum, although from the extent of the removal of the homologous agglutinins this does not appear probable. The atypical character of the flocculi present in the ordinary agglutination tests and the incompleteness of the reaction, as shown by the persistent opalescence in the supernatant fluid, may throw some light on the inconstant results obtained, and further investigation in this direction is required.

In four experiments in which para. B. high-titre serum was saturated with strains No. 1 and 4 there was no absorption of the agglutinins for those organisms or for the homologous organism *B. para. B*. It is very probable, therefore, that we are dealing with a specific organism the serological characters of which are quite distinct from those of *B. para. B*.

Pathogenicity to Animals.

No special experiments to test pathogenicity have been carried out owing to the small number of experimental animals available. Some observations were made, however, during the course of preparation of immune sera in rabbits. One animal, which had previously received two intravenous injections of 225 and 900 million of dead bacilli, was found dead on the third morning after an intravenous dose of 500 million living organisms; while another rabbit died after 300 million live bacilli following on three doses of 300, 1200, and 3000 millions respectively of killed organisms, all given intravenously.

Post-mortem examination showed that both animals had died of a hæmorrhagic septicæmia. Petechial hæmorrhages were present on the pleural surfaces, as well as in the substance of the lungs. Some were larger than petechiæ, and in the case of the second rabbit one extensive hæmorrhage involved a third of the right lower lobe. Small hæmorrhages were present in both spleen and kidneys.

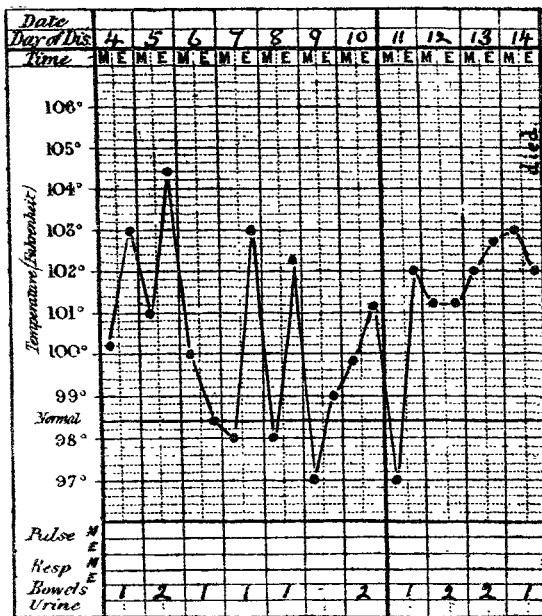
The intestinal tract also showed lesions of considerable interest. Discrete hæmorrhagic areas ranging in size from a pinhead to a millet seed were to be seen in the lower part of the duodenum, while in the jejunum and ileum they were well marked over a length of three inches, and extending in less degree for nine inches below. There was some associated œdema of the mucous membrane, but there was no naked-eye involvement of the lower part of the ileum or of the appendix. The great intestine appeared normal.

The Clinical Aspects of the Infection with Some Notes on the Morbid Anatomy.

The clinical history, &c., along with the post-mortem findings in the three fatal cases, is as follows :—

CASE 3.—Pte. W., aged 30, was admitted to hospital at Bagdad on Sept. 16th, 1918, with a fever, the temperature curve being suggestive of malaria, and the clinical symptoms of "influenza," of which there was an epidemic in Bagdad at the time. The man had been transferred from a convalescent camp, having been invalided from Persia for debility following clinical malaria. No malaria parasites had been found previous to admission, nor were any detected during several examinations while the patient was in hospital. After five days' intermittent temperature (98° to 104°) (see Chart 1) there appeared definite signs of a right

CHART 1.



basal pneumonia, spleen being palpable on deep inspiration. Condition became very critical and six days later patient died. There was no paratyphoid eruption. Leucocyte count on day before death 12,000 per c.mm.

Autopsy (10 hours after death). Lungs: Right middle and lower lobes in state of grey hepatisation. Upper lobe acute congestion. Left lung normal. Pleura; Right cavity contains 8 ounces clear serous fluid with a recent exudate of lymph over the affected lobes. Heart: Signs of dilatation. Myocardium soft and friable. Spleen: Twice the normal size, soft and diffident. No pigment deposit to be seen by the naked eye or in smears. No malarial parasites detected. Intestines: Peyer's patches apparently perfectly healthy. Nothing abnormal seen in any part of the alimentary canal.

Bacteriology.—Cultures from the spleen and consolidated lung made direct on to MacConkey's medium gave a pure culture of the cocco-bacillus described above. This organism was agglutinated by its homologous serum obtained from an immunised rabbit in 1 in 6000 dilution. Originally inagglutinable to all the specific sera, after numerous sub-culturings, it reacted with para. B serum (titre 6000) as follows: Dilution 1 in 1000 +; 1 in 2000 ±.

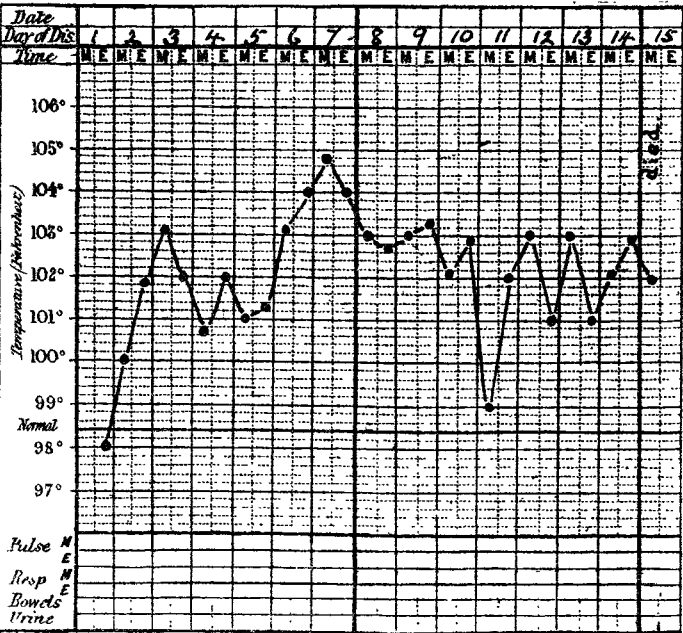
CASE 4.—Sgt. G., aged 40, had been 12 days in hospital suffering from vague nervous symptoms, having suffered from shell shock in France in 1915, from which he had never completely recovered. Patient appeared to be doing well during his 12 days' residence, when his temperature suddenly shot up to 102° (Chart 2) and there developed symptoms of bronchitis and rhinitis. On the third day of fever signs of a right apical pneumonia developed. Five days later the right lower lobe and also the left apex showed signs of involvement. No suggestive rose spots were seen. Restlessness and delirium latterly became a marked feature, the patient dying on the fifteenth day of illness.

Autopsy (14 hours after death).—Emaciation slight with moderate hypostatic lividity. Pleura: Right sac contains 8 oz. blood-stained fluid. No adhesions or lymph exudation. Left sac normal. Lungs: Consolidation of greater part of right lung—viz., whole of lower lobe, middle lobe, and posterior portion of upper lobe. In section the colour was yellowish grey, the consistence distinctly friable, with a suggestion of softening, while there was a purulent exudate on squeezing the consolidated areas. Left lung healthy except for marked congestion, especially of upper lobe.

Heart: Showed dilatation of the left ventricle with a large antemortem clot in the corresponding auricle. Myocardium pale, flabby, and easily friable. Spleen: Slightly enlarged, softish. Stomach and intestines (great and small): Normal in appearance except for a pink cedematous condition of the jejunum and upper part of the ileum. This may have been associated with the presence of several ascarides in the small intestine. Kidneys: Marked cloudy swelling with some fatty changes.

Bacteriology.—Three blood examinations for malaria during life were all negative. Blood culture on the ninth day of illness gave a pure culture of a Gram-negative coccobacillus with the characters above described, while at autopsy the same organism was obtained from spleen, lung, and contents of gall-bladder. Although originally inagglutinable, all four strains after a week's subculturing were agglutinated by para. B serum in 1:2000 dilution, tests with the other specific sera being negative. The serum of the animal immunised with this strain easily reached a titre of 10,000. Smears from the sputum during life, as well as from the lung juice at autopsy, showed some Gram-positive cocci in addition to numerous Gram-negative bacilli, but no organism morphologically resembling the pneumococcus was seen.

CHART 2.



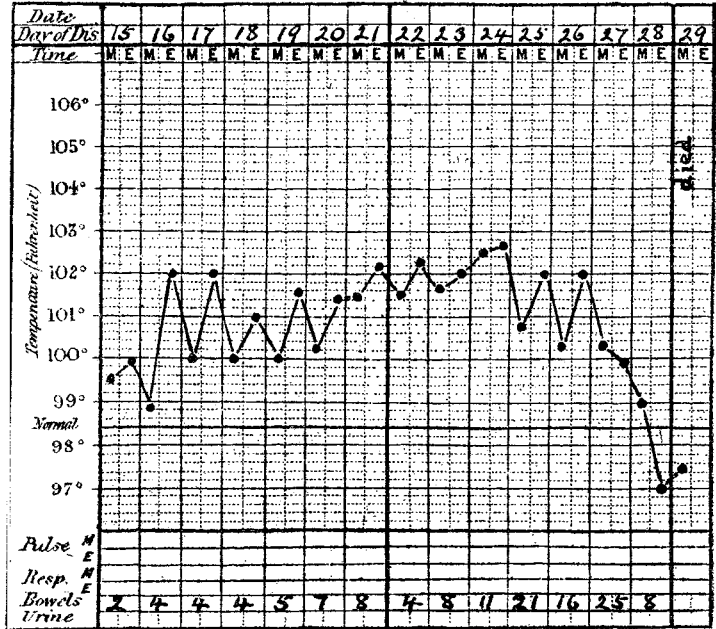
CASE 6.—Pte. D., aged 32, admitted to hospital on Nov. 20th, 1918, as suffering from anæmia, thought to be due to bleeding hæmorrhoids, gave a recent history of diarrhoea and colicky pains for the preceding 12 days. History of intermittent bleeding from the bowel during the previous two months was elicited, blood with clots being passed along with formed stool, while the occasional occurrence of prolapse on defæcation was reported. Four days after admission patient developed a condition which was diagnosed as acute bacillary dysentery. Fever asserted itself so that the patient's temperature reached 102° (Chart 3), while 4-6 non-fæcal motions were passed daily consisting chiefly of bright red blood associated with blood clots and a little mucus in the form of sago-like granules. Their appearance was altogether much more suggestive of intestinal hæmorrhage than of the usual acute dysenteric "B. and M." stool. On microscopical examination the cytology did not suggest bacillary dysentery, very few cellular elements being present apart from blood cells. No entamoebæ were seen while on cultivation on MacConkey's medium on three occasions, no non-lactose fermenters were in evidence. Blood films failed to reveal the presence of any malarial parasites. The blood picture did not suggest a primary blood disease. The only striking feature was the pallor and distortion of the red cells, but no megalocytes or nucleated red cells were seen.

At first the sigmoid felt definitely thickened and was acutely tender, but after several days this feature completely disappeared. The patient's general condition suggested marked toxæmia. He was treated with antidyenteric serum, but no improvement ensued. On Nov. 28th—i.e., the twenty-first day of fever—severe watery diarrhoea set in, the stools being pea-soup like with flecks of blood. On Dec. 4th the temperature fell, collapse set in, patient falling into a comatose condition, and death took place on Dec. 6th.

Autopsy (performed 20 hours after death).—Body considerably emaciated; blood watery. Respiratory system normal. Cardio-vascular system: Pericardium normal; dilatation of right ventricle. Myocardium pale and fatty

Nothing else of note. Alimentary tract: Stomach: Small erosions in the mucosa. Lower part of duodenum and upper part of jejunum—mucous membrane cedematous with signs of acute congestion. Scattered petechial hæmorrhages but no erosions. Ileum normal. Large intestine: Congestion of transverse and descending colon with numerous small

CHART 3.



erosions and hæmorrhages in the mucosa. No marked ulceration and no thickening present. Liver and kidneys: Marked cloudiness with fatty changes. Spleen: Normal in size, soft and diffuent. Suprarenals and thyroid normal. Red marrow of sternum and ribs—no marked hyperplasia.

Bacteriology.—A bacillus with the morphology and cultural characters of the other organisms of the present series was obtained in pure culture from the spleen and heart blood. In the first agglutination tests with this organism after isolation the findings were: Against immune serum of strain 4, ++ 1 in 5000, + 1 in 10,000. Against Lister Institute para. B serum (titre 6000), nil 1 in 50.

Summary of Chief Symptoms.

As for the cases in general, some of the clinical data have been tabulated in Table A, while a summary of the notes on the chief symptoms observed is given below. No special stress can be laid on any clinical feature which may not occur in the course of enteric group infections, although the prominence of respiratory symptoms has been somewhat striking in the present series of cases.

Course of the fever.—The fever, which was in most instances of sudden onset, appears to be of variable duration, depending partly on the relative severity of the infection, partly on the extent of involvement of the respiratory tract. The milder cases lasted 5-7 days on the average. Two patients (Nos. 1 and 7) each ran an 11-days' fever, at first intermittent and latterly of the continued type (see Chart 4). Of the fatal cases one of the pneumonias (No. 4) ran a continued fever during the whole 15 days' illness. The other (No. 3) showed a markedly intermittent course for ten days, becoming of the continued high type on the onset of extensive lung consolidation four days before death. The fatal "hæmorrhagic" case (No. 6) ran a 28-days' pyrexia, and was of the continued type during the 14 days he was under observation.

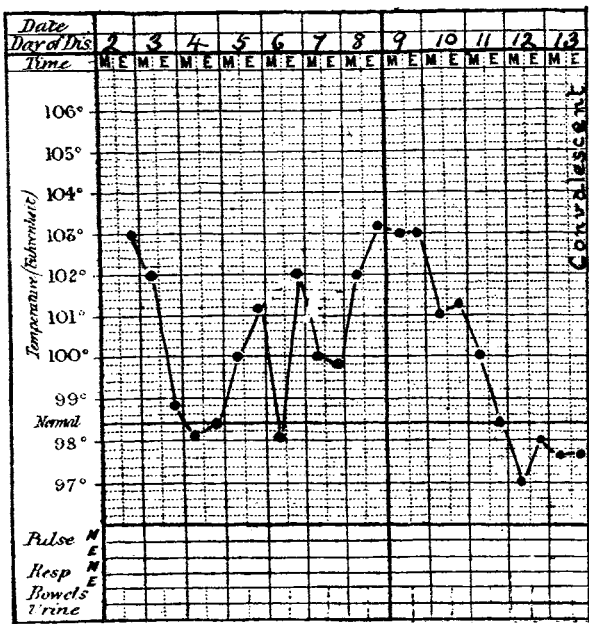
As regards relapses, none occurred while the patients were convalescing in hospital or subsequent to discharge, as far as could be learned from their after history.

Respiratory system.—Marked involvement of the respiratory tract was a feature of all the cases except three. Thus in four instances in which this inagglutinable paratyphoid-like organism was obtained by blood culture, the infections were of a mild character and of short duration, while bronchial catarrh was so prominent a feature that all four cases had been labelled "bronchitis" or "influenza with bronchitis." As already described, two of the fatal infections appeared clinically to be suffering from lobar pneumonia, as was subsequently proved at autopsy (Cases 3 and 4). Of the three cases with no respiratory symptoms two of them had been considered enteric infections, while the third was

regarded as a markedly toxic type of bacillary dysentery. Smears and cultures of throat swabs from a number of the patients gave nothing of pathogenic importance.

albuminuria was present in the cases examined. The presence of pus cells or other cellular elements was not observed.

CHART 4.



Alimentary system.—Gastric and intestinal symptoms were in most instances inconspicuous. Vomiting, except in case No. 6, was absent, while constipation was the rule. Case No. 5, considered clinically an “enterica” infection, suffered from diarrhoea in the early period of the illness, while in the fatal “pneumonias” (Nos. 3 and 4) there was no lesion of the intestinal tract except that one showed a pink oedematous condition of the jejunum and upper part of the ileum. The Peyer’s patches and solitary glands appeared quite normal.

Discussion.
The question as to whether this bacillus found associated with the present series of cases is an aberrant type of *Bac. paratyphosus B* or whether it is an undescribed organism (which for convenience may be called *Bac. paratyphosus C*) belonging to the Gaertner-paratyphoid group is a matter for discussion. The fact that, after as many as 30 subculturings, none of the strains of the organisms are agglutinated by specific para. B serum (Lister Institute) in any dilution at all approaching its maximum titre is important, especially when it is remembered that the isolation of readily agglutinable para. B bacilli during the course of routine blood-culture work in Bagdad has been far from uncommon. Consideration must also be taken of the unusual nature of such agglutination as was obtainable with high-titre para. B serum—viz., the very fine soft flocculi which seldom produced much sedimentation and which never left a clear supernatant fluid. Nor do the serological observations, described above, point to the organism having closer affinities to the *Bac. aertrycke* group, although it has to be noted that unfortunately it has not yet been possible to obtain from Europe any of the recognised high-titre *B. aertrycke* sera.

Clinically, although it is well recognised that marked respiratory symptoms may be a common accompaniment of paratyphoid B infections and, indeed, have been the chief feature of certain enteric epidemics, yet the local microbial infection in these cases is still a matter of dispute. Bacilli of the Gaertner-paratyphoid group have been reported on various occasions as having been isolated from the sputa, but as to whether they were originally present or were merely secondary invaders does not appear to have been conclusively settled. It has not been possible to consult the literature on the subject, but Miller,¹ in his recent Goulstonian lectures (1917) on Paratyphoid Infections, says:—

“The paratyphoid bacilli apparently do not attack the lungs and pleura themselves. Labbé, however, mentions

TABLE A.—Statement of Clinical Data.

No.	Clinical diagnosis of case.	Duration of fever.	Day of disease of positive blood culture.	Isolation of organism from other sources.	Probable place of infection.	Character of infection.
1	Bronchitis (N.Y.D. enteric group).	11 days.	9th day.	—	Bagdad.	A somewhat severe attack, the course suggesting an enteric infection.
2	Influenza with bronchitis.	6 „	3rd „	—	„	A short but very acute fever.
3	“Clinical malaria” followed by lobar pneumonia.	14 „	No culture made.	Lungs, spleen, heart blood.	Kermanshah.	Both very severe and fatal infections with all the signs of lobar pneumonia.*
4	Bronchitis followed by lobar pneumonia.	15 „	9th day.	Lungs, spleen, bile.	Bagdad.	
5	Bronchitis.	7 „	4th „	—	Kifri.	A mild infection.
6	Acute dysentery (bacillary?).	28 „ (?)	No culture made.	Spleen, heart blood.	Tekrit.	A very severe toxic infection, with a hæmorrhagic colitis ending fatally.†
7	Bronchitis (N.Y.D. enteric group).	11 „	9th day.	—	Bagdad.	Nothing of special note. Clinically very suspicious of an enteric infection.
8	Bronchitis.	5 „	4th „	—	„	Both mild short fevers.
9	„	7 „	4th „	—	„	

* See p.m. notes. † See detailed notes on clinical history and autopsy.

The third fatal case (No. 6), however, showed distinct intestinal lesions, which have been described above. This patient had complained of marked hypogastric tenderness in the early days of his fever. Otherwise abdominal distension or tenderness was not a feature of the cases.

Nervous system.—There was no nervous symptom of special note. Delirium was present towards the end in the two fatal cases of pneumonia, while No. 6 sank into the typhoid state before death.

Skin.—Nothing suggestive of rose spots or of an eruption of any kind was seen in any of the series.

Abdominal organs.—*Spleen.*—Its size varied considerably in the different cases. Some of the notes report the organ as being slightly or distinctly palpable on deep inspiration. In one fatal case it was two fingers-breadth below the costal margin, while at the other two autopsies the organ showed nothing of special note. Malarial parasites or pigment was not seen in any smears of the splenic pulp. Liver, kidneys, and bladder: Nothing of special note. The usual febrile

a case of abscess of the lung from the pus of which *B. para. B* was isolated. Apart from this rather special case, I cannot find a recorded instance of paratyphoid bacilli being found in the pleural fluid ante mortem nor in the lungs post mortem. I can only think that if these organisms do attack the lungs and pleura it must be but rarely.”

In the two cases of the present series which showed extensive pneumonic consolidation the organism was isolated from the lung juice in pure culture on MacConkey’s bile medium, while, except for a few scattered diplococci which did not resemble the pneumococcus, it alone was seen in stained lung smears.

The duration of the bacillæmia is so far undetermined, as positive blood cultures were obtained from the third to the ninth days inclusive in the various cases. Marked involvement of the intestinal tract, except where the infection assumed the character of a hæmorrhagic septicæmia, was uncommon, and the absence of any lesion of Peyer’s patches,

¹ Miller: THE LANCET 1917, i., 831.

or of the solitary glands, may be of importance as a differential feature.

My attention has recently been drawn to an account by Neukirch² of an epidemic which occurred between March, 1915, and the early part of 1917 in Anatolia and Turkey from the cases of which an organism called *Bac. Erzindjan* was isolated. This organism, the author concludes, is closely related culturally to *Bac. para. B* and the *suipestifer* group, but it can be differentiated by serological tests. From the title of his paper Neukirch is inclined to identify the organism with the Glässer-Voldagsen group, placing his reliance on the agglutination test. Yet he states that all the strains of *Bac. Erzindjan*—like those isolated from the present series of cases—produced acid at first in litmus milk, followed later by alkali production, except one which showed no initial acidity. On the other hand, all the Glässer-Voldagsen strains tested produced acidity and remained acid until the end of the ten days recorded. It seems difficult to accept the serological similarity and ignore this constant biochemical difference between the organism under review and the Glässer-Voldagsen group. The cultural characters of *Bac. Erzindjan* cannot be compared with our *Bac. para C*, as Neukirch has so far described its action on glucose and lactose only.

This worker distinguishes two main clinical groups of cases from which the *Bac. Erzindjan* was obtained in pure culture: (1) the "typho-septic" type, with a mortality of 46 per cent.; (2) the dysenteric type, with a much smaller mortality of 6·7 per cent. For comparison he quotes a 5 per cent. mortality rate as having occurred among the infections of the "enterica" group. Two other groups are also mentioned—viz., four cases of slight general infection and a solitary case of pyelonephritis. Neukirch draws special attention to the very variable clinical picture met with, and to the difficulties of distinguishing these cases from those of typhoid, paratyphoid, and dysentery, apart from a bacteriological diagnosis. I have not had access to the original article to ascertain what types of infection are included in the group called "typho-septic," but it appears very probable that the causative organism in the present series of cases of infection among British troops is the same as that described as *Bac. Erzindjan*.

Most of the cases which are the subject of this paper appear to have been infected in the Bagdad area, although in three instances the evidence available pointed to the place of infection being much farther up the line—viz., at such widely separated places as Kermanshah, Tekrit, and Kifri. For the present it is impossible to say anything about the epidemiology. The probable prevalence of the infection among the native population requires investigation, while it would be of considerable interest to learn whether a similar para. C-like organism has been among the bacteriological findings in Palestine and in other areas of military operations in the Near East.

Summary.

1. A series of inagglutinable organisms culturally and morphologically indistinguishable from *Bac. para B* have been isolated by blood culture in Bagdad during the latter half of 1918, and it is learned that similar findings have been reported in other areas of Mesopotamia.

2. Of the three patients suffering from the infection who died, two of them were clinically regarded as cases of lobar pneumonia. At autopsy the same cocco-bacillus was isolated from the lungs and spleen, and in one instance from the gall-bladder also. Respiratory symptoms were a prominent feature of most of the cases, while the symptomatology and course of the fever were usually not suggestive of an enteric group infection.

3. Serologically all the strains on isolation were inagglutinable to the "enterica" high-titre sera (Lister Institute). After 30 subculturings of the organism agglutination of an atypical character was present in dilutions up to 1 in 1000 of specific para B. serum (Lister), while in comparison a 1 in 10,000 dilution of the same serum led to marked clumping with two stock strains of *B. para B*. Absorption tests tended to confirm those serological differences. The sera obtained from three rabbits immunised with different strains of the bacillus readily agglutinated the whole series of organisms in dilutions of 1 in 5000 to 1 in 10,000; whereas no reaction resulted with the stock *Bac. para B* in dilutions

higher than 1 in 250. Equivocal findings were also recorded in tests with a strain of presumed *Bac. aertrycke*.

4. The real identity of the organism is so far undecided. In its behaviour with specific sera it is distinguishable from both *Bac. para. B* and *Bac. aertrycke*, although closely related to both. It has been learned with interest that an epidemic in Turkey and Anatolia has been described as due to a paratyphoid-like organism with similarly atypical serological characters. If the bacillus should eventually be proved not to be a specific organism but to be simply a variety of *Bac. para. B*, the practical importance of its recognition seems to lie in the fact that the recognised high-titre para. B sera fail altogether to agglutinate it on isolation, and after numerous sub-culturings they react with it, to only a limited extent, while a special immune serum is necessary for its ready identification. Many of the organisms which have been from time to time reported as non-agglutinable or "temporarily inagglutinable" para. B bacilli may belong to this para. C-like group.

It is with pleasure that I acknowledge my indebtedness to Lieutenant-Colonel J. C. G. Ledingham, C.M.G., R.A.M.C., consultant bacteriologist to the Mesopotamian Expeditionary Force, for his great assistance and helpful criticism; while I desire to express my thanks to Lieutenant-Colonel H. J. Crossley, R.A.M.C., O.C. — Stationary Hospital, Bagdad, for access to and the use of the clinical records of the described cases.

Bagdad, January, 1919.

SOME OBSERVATIONS BEARING UPON THE COMMOTIONAL FACTOR IN THE ÆTIOLOGY OF SHELL SHOCK.

BY ALFRED CARVER, M.D. CAMB.,

LATE CAPTAIN, R.A.M.C.(T.C.); DIRECTOR OF THE BIRMINGHAM
PSYCHONEUROSIS CLINIC.

IN THE LANCET of Jan. 11th, 1919, Dr. C. S. Myers raises three important questions relating to the problem of "shell shock." The first is as to "the existence of distinct commotional and emotional syndromes." I believe that the following experiments, carried out with the assistance of Lieutenant A. Dinsley, R.A.O.C., prior to the appearance of Dr. Myers's article, will prove of interest as bearing upon this point. The conditions under which "shell shock" arises in man render accurate observations so difficult that experiments upon animals seemed advisable carried out so that the weight of explosive used could be kept constant, its nature and composition known but varied at will, and the actual distance of the animals from the centre of detonation measured.

Effects of High Explosives.

When a high explosive is detonated there arises first a sudden terrific blow which exerts a compressing and shattering force upon its surroundings in every direction. This is instantaneous and is followed immediately by an equally sudden decompression, thirdly rapid oscillatory or vibrating movements are set up, which die down only gradually. Each of the three results requires analysis when considering the effects upon living organisms. A further effect is the purely demoralising effect produced by the vibrations outside the sphere within which any demonstrable physical destruction or injuries occur. Evidence will be adduced to show that the Germans arranged their shell-fillings so as to enhance this peculiar effect. This, fully in keeping with other of their methods, might be described as "frightfulness by detonation."

If a high explosive be detonated at a point X three zones may roughly be mapped out around it, their radii depending, amongst other things, upon the weight of explosive.

Zone A is delimited by the extent of obvious gross disruption, and may be termed "the zone of brisance"; within it a crater is formed, barbed wire and other obstacles are blown aside, broken and distorted; animals are killed and usually lacerated; other high explosives immediately detonated.

Outside this is a second zone, B, which may be termed the "zone of decompression," for the disturbances within it seem mainly attributable to this factor, though coarse shaking movements also play their part. In zone B the

² Neukirch, 1918, Ztschr. f. Hyg. u. Infektionskrankh. lxxxv., 103.