

rarely the subject of gas gangrene, though localised gas infection is common. Group II. is formed of long, strap-like muscles (with the exception of the gluteus maximus) that are particularly prone to gas gangrene. Group III. is formed of muscles that are still more prone to gas gangrene when the subject of any severe laceration.

From these observations, then, it would seem highly probable that vascular distribution in muscle has a most important bearing on the origin and spread of gas infection in muscle. This subject is to be referred to fully in a further communication. In consequence of injury to the arterial supply the mass of muscle to which the damaged artery is distributed in Classes 2 and 3 either completely dies or becomes devitalised to a marked extent owing to the slow re-establishment of the circulation. When infecting organisms, particularly the bacilli of gas gangrene, invade muscle in this condition they find a nidus suitable for their growth. This, we think, is what happens in many cases of war wounds, with the result that gas gangrene makes its appearance.

We can readily see, then, the importance in war surgery of conserving the blood-supply to all muscles generally and to certain muscles in particular (gracilis, crureus, and the two heads of the gastrocnemius). The necessity for doing so was well realised in pre-antiseptic days when operations were specially planned along those routes which interfered least, if at all, with arterial supply. This is particularly well illustrated by the classical posterior route for excising the head of the femur. Here the incision is so placed as to divide the gluteus maximus muscle approximately along the line of separation between the portions supplied by the gluteal and sciatic arteries.

*Conclusions.*

1. The arteries in muscle are as much "end-arteries" as those in gut or brain; but in none of these cases are they strictly "end-arteries."
2. If the blood-supply to a muscle is cut off locally (especially over large areas) death of masses of muscle may take place owing to the difficulty in re-establishment of the collateral blood-supply.
3. During operations the blood-supply to muscles and inside muscles should be conserved in the most jealous fashion.
4. When excising wounds of muscles, a knowledge of the internal arrangement and distribution of the arterial supply is essential to success. Take care to make the excision in such a way that the main vessels and branches of supply are not interfered with, otherwise much larger areas must be excised.
5. Ischæmia of muscle due to damage of the arterial supply is a most important factor in the production of gas gangrene.
6. Should a large artery supplying a muscle be damaged and the wound already the subject of "gas invasion," cut away the damaged muscle till definitely bleeding surfaces are exposed. Should the case, however, be early and not yet (clinically) "gas infected," excise the wound locally and do not sacrifice too much tissue. At the same time take care to relieve all tension locally so as to allow of early re-establishment of the circulation. (This may explain the advantage of "delayed primary suture" over "primary suture" in gunshot wounds.)
7. In the case of muscles possessing only a single vessel of supply (e.g., crureus, gracilis), owing to the risk of cutting the main artery of supply inside the muscle it is wiser not to attempt excision of the track, but simply to clean out the track very carefully with strips of gauze. Before being satisfied with this course, however, make sure that the blood-supply is intact by seeing whether or no free bleeding occurs from a small incision made in the muscle at some distance from the wound.
8. When dealing with muscles prone to "gas gangrene" take every step after operation to raise and keep raised the arterial tension.
9. In "resuscitation cases" take care to slacken all tight bandages so as to allow as much blood as possible to reach any ischæmic masses of muscle by way of the fine collateral channels that exist.

We wish to acknowledge our thanks to Colonel C. H. S. Frankau, D.S.O., A.M.S., consulting surgeon to the 5th Army, for the opportunity he most readily gave us for carrying out this work.

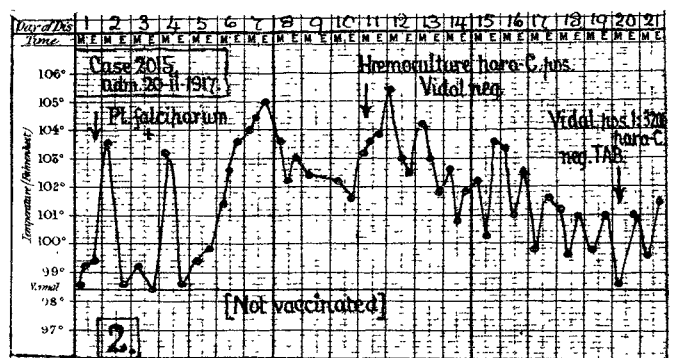
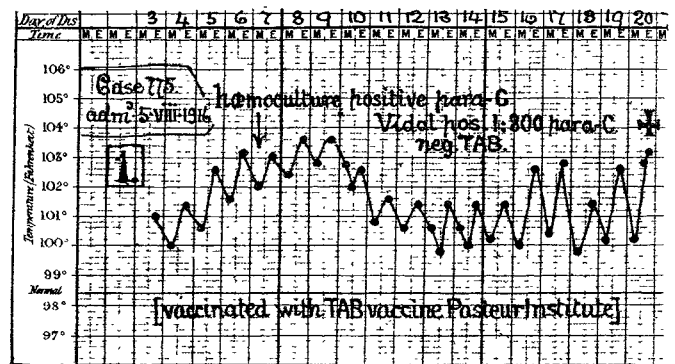
A NEW GERM OF PARATYPHOID.<sup>1</sup>

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IN many of the specimens of blood sent to the laboratory to be examined for typhoid or paratyphoid, germs have been isolated by culture in bile which behaved, bacteriologically, like paratyphoid bacillus B, but were not in the least agglutinable by the corresponding specific serum. In August, 1916, I isolated such a strain from the blood of patient No. 775. The reaction of Widal with Eberth, paratyphoid A, and paratyphoid B was entirely negative in this case, whilst the serum of the patient agglutinated the germ in question, even in dilution 1 in 800. The serum of this patient has been employed since, along with the sera anti-Eberth, anti-paratyphoid A, and anti-paratyphoid B, for the serological differentiation of strains isolated in hæmoculture. With the help of this serum I have discovered in hæmoculture 11 more cases of the same serological individuality in the latter half of 1916, 5 further cases in 1917, and 2 cases in 1918. The relative scarcity in 1917 and 1918 is explained by the fact that the polyvalent vaccine (of Castellani), which I have prepared since the beginning of 1917 for the Serbian Army, contains this strain also.

The clinical picture, temperature, &c., of patients infected by this germ is that of paratyphoid fever. The temperature chart of the patient in question shows the classical febrile course (Chart 1). Chart 2 shows the febrile course of another



patient suffering from tropical malaria and typical paratyphoid. I emphasise the fact that the two patients did not react to Widal except with the germ in question, and therefore it was not a case of an infection superimposed on typhoid or paratyphoid, but solely an infection provoked by this germ. We have also observed cases less severe and less typical.

*Characteristics of the Organism.*

From a bacteriological point of view there is no difference between the germ in question and the bacillus paratyphoid B. We have proved the absence of gas and of acidity in lactose, the production of acid and gas in dextrose and mannite, the acidity in dulcitate with the production of gas retarded, acidity and production of gas in levulose, and after the first production of acid further typical alkalinity in litmus milk.

<sup>1</sup> A paper read before the Inter-Allied Medical Society in Salonika on Dec. 10th, 1918.

Broth with neutral red becomes fluorescent. It darkens the medium with subacetate of lead. It does not produce indol.

The bacilli are endowed with typical movements and are Gram-negative. They are not agglutinated either by the agglutinating sera coming from the Pasteur Institute of Paris, the Lister Institute of London, the Greek Laboratory of Salonika, or by those which I brought with me from Switzerland, although all these sera possess agglutinating qualities in a high degree for paratyphoid B. On the other hand, the sera of the patients possess considerable agglutinating power towards this germ. The serum of a patient agglutinated with a dilution of 1 in 3000, though it did not in the least agglutinate the bacillus of Eberth, paratyphoid A, or paratyphoid B. The serum of rabbits immunised by the germ in question is absolutely specific for this strain. The serum that I employ in my laboratory agglutinates this strain up to 1 in 2000, while it does not agglutinate Eberth, paratyphoid A or paratyphoid B at all.

We may therefore consider this germ a serological variety of paratyphoid B provoking, clinically, paratyphoid fever. This bacillus can be very virulent. Besides finding the bacillus in patient 775, who died of the disease, I have isolated the same germ post mortem from the heart of a patient who succumbed to paratyphoid. This variety is more frequent in the Serbian Army than paratyphoid B. I give the monthly statistics from my laboratory:—

Our experiences partly confirm the observations of authors on the mutability of the species paratyphoid B. We have seen that a bacillus with the biochemical properties of the paratyphoid bacillus B can change its serological specific properties. It seems to us interesting that it is only some of the serological characteristics of the paratyphoid bacillus B which are capable of changing, while the agglutinability of other germs, above all paratyphoid C, remains constant.

*The Question of Preventive Vaccination.*

It is two years ago since I first discovered this germ in the blood of one of our Serbian patients. In August, 1916, I communicated the fact to the French Service de Santé. This atypical strain not having been notified by the laboratories of the Allies, this question did not appear to be of practical importance to any other Army than the Serbian.

Lately, with a Bulgarian patient of the Hospital of Petit Karabaroun I have been able to isolate the same germs by hæmoculture. The patient succumbed to the disease. The culture from the fæces and urine of this patient gave a pure and abundant growth of paratyphoid C. Lately we have seen the Widal reaction positive up to 1 in 400 with only paratyphoid C in the case of a Greek patient in the town; therefore this germ exists among the Bulgars, and probably throughout the Balkans. In the last case Professor

	1916.												1917.												1918.												1916.		1917.		1918.
	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	%	Total.	%	Total.				
No. of hæmoculture ...	77	110	99	73	60	8	23	12	8	23	8	23	8	27	16	4	1	26	13	16	-	-	-	3	7	7	12	8	4	10	12	-	462	-	142	-	65				
No. of positives ...	17	36	39	11	7	1	7	2	1	1	1	1	-	-	-	-	-	1	2	1	-	-	-	-	-	-	-	-	2	1	-	120	-	8	-	7					
T. Eberth ...	3	13	19	1	2	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	-	40	34·5	1	12·5	2						
Para. A ...	11	18	14	5	2	1	2	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	55	43·0	1	12·5	1						
Para. B ...	1	5	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	9	7·7	1	12·5	2						
Para. C ...	1	-	1	5	2	-	3	-	1	1	-	-	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	1	12	10·3	5	62·5	2						
Not defined ...	1	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	4·0	-	-	-						
Of Vaccinated ...	?	?	?	5(4c)	2(1c)	1	-	-	-	-	-	-	-	-	-	-	-	1c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
Of Not vaccinated	?	?	?	6	5	1	6	2	1	1	1	1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				

I.—Inoculated with French vaccines (T., para A and B). II., III., and IV.—Inoculated with Serbian vaccines (T., para. A, B, C, and cholera).

Further researches must decide whether in our case it is a question of a bacillus with new serological qualities or whether a comparison with atypical germs of paratyphoid B isolated in the epidemics of alimentary intoxication, epidemic jaundice, inagglutinable strains isolated during paratyphoids, &c., will show the identity of my bacillus with strains isolated elsewhere. This variety, distinguished by the same pathogenic properties as the paratyphoid bacilli, and provoking clinically a paratyphoid fever, it would be suitable to call the bacillus "paratyphoid C," and to separate it from the many serological varieties of the paratyphoid bacillus B, which only provoke alimentary intoxication.

A point of great diagnostic importance in this atypical bacillus of paratyphoid B is its serological constancy. For two years I have studied this question in respect to the germ, and having continually practised growing it I have made the following conclusions:—

In the Serbian Army we have to deal with three different serological varieties:—1. The pure paratyphoid bacillus C. The quality of not agglutinating except with serum paratyphoid C remains constant. 2. The pure paratyphoid B bacillus. The greater part of the bacilli of this category retain their specific agglutinability. I have seen those, however, which in addition to their agglutinability by anti-paratyphoid B serum acquire, at least for a time, the property of reacting with anti-paratyphoid C serum. One strain (No. 228) even lost its agglutinability with anti-paratyphoid B serum, and would only agglutinate in the last two examinations with anti-paratyphoid C serum. 3. The bacilli which were agglutinated from the beginning by the sera anti-paratyphoid B and anti-paratyphoid C, and which even after being carefully isolated remained agglutinated by the two sera, and in consequence possess these two agglutinable qualities, can be called "bacillus paratyphoid B, C" (5 cases). These bacilli have lost in the course of the two years their agglutinability with anti-paratyphoid B serum. It was not a question in these cases of an absolute loss of agglutinability, as these varieties preserved the property of reacting to serum anti-paratyphoid C to the same degree.

Vallardi, chief of the Italian Central Laboratory, discovered by hæmoculture a paratyphoid C bacillus which agglutinated with my anti-paratyphoid C serum which I gave him. I gave a culture of paratyphoid C to Colonel L. S. Dudgeon, R A.M.C., who told me he had confirmed the serological peculiarities of my bacillus.

The question now arises whether the Allied armies occupying Bulgaria and Turkey are vaccinated against this species. I am not informed whether the vaccine employed in the East contains the local atypical bacilli also. As far as French vaccines are concerned I believe it is not so, for the following reasons: (1) The agglutinating sera of the Pasteur Institute, samples of which we received two months ago through the Medical Reserve, do not agglutinate paratyphoid C; (2) the Serbian Army was vaccinated in the month of May, 1916, by vaccines of the Pasteur Institute which contained Eberth, paratyphoid B, and paratyphoid A. In 1916 I saw eight cases of positive hæmoculture, although the patients had been vaccinated. Of these eight cases five were infected by paratyphoid C, one fatally.

Thus we see that the greater part of positive hæmocultures amongst vaccinated patients show paratyphoid C, in spite of the fact that generally paratyphoid C was in the minority. Since the end of 1916 the Serbian Army has been vaccinated with the vaccine prepared by me, which contains paratyphoid C in addition to Eberth, paratyphoid A and paratyphoid B. As a result we can announce the disappearance of this strain. All the positive hæmocultures since this time have been isolated from non-vaccinated subjects. Only one case of a vaccinated person showed very slight paratyphoid (fever lasting only three days). The efficiency of the vaccinations and the reactions, both local and general, has not been modified by the presence of these other bacilli in the vaccine. In view of the great practical importance of the question, I considered it my duty to publish these facts. I can put cultures of the paratyphoid C bacillus and its corresponding agglutinating serum at the disposal of any laboratories interested in the question.