tertian, it became the practice during the second heat wave (even before receiving the laboratory report) to administer an intramuscular injection of 8 or 9 grains of bihydrochloride of quinine.

The mortality during July was as high as 25.65 per cent.; that during August, when quinine was always administered immediately, was only 11.76 per cent. This, to my mind, is the most striking factor pointing to malignant malaria as being the primary cause of hyperpyrexial heat-stroke. For it was not until the second heat wave that quinine was given as a routine, and during this period the death-rate fell by well over 50 per cent.

Starting with the physiological assumption that there is a heat-regulating centre, it is reasonable to suppose that one of the symptoms of an infection with the parasite of malignant tertian malaria is the intoxication of this area. It readily follows that, when once the heat-regulating apparatus is upset, the body must naturally assume, as nearly as possible, the temperature of the atmosphere. Thus it is a fallacy to suppose that heat-stroke supervenes if one stops sweating. The truth is, on the contrary, that a patient ceases to perspire because he has got heat-stroke, because he is suffering from paralysis of the heat-regulating centre, due to intoxication by the parasite of malignant tertian malaria.

The clinical charts 1 to 4 will serve to illustrate the marked hyperpyrexia which has been observed even in cases which have recovered, and which have appeared mentally to be none the worse for their illness. All the charts are of cases which were regarded as "heat-stroke," in which were observed the classical symptoms described as being those of heat-stroke, and yet in the blood of each and every case were found the characteristic ring forms of the *Laverania malariae*, the parasite of malignant tertian malaria.

Charts 5 and 6 show the maximum dry and wet bulb thermometer readings for July and August, 1917.

BASAL LEPTO-MENINGITIS RESEMBLING BOTULISM.

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WHILE so much interest is being aroused by cases which resemble botulism, it may be well to record the particulars of the following case, which for a few days was thought to be that disease:

F. P., a girl aged 5 years, was admitted under my care on May 14th, 1918. There was a history of ten days' previous illness; she had seemed drowsy, and had vomited repeatedly for the first two days. For a month previously she had been feeding on "porridge, bread, sausages, chitterlings, and ham."

On admission, the temperature was 99° F., the pulse 100, and respirations 20. She was drowsy, but by no means comatose, and realized her surroundings sufficiently to "want to go home." She was very irritable, and complained of pain in the head and back. There was no paralysis; the eyes were kept closed, though she could open them; the pupils were dilated. There was very slight head retraction, but Kernig's sign was absent. The tongue was very foul, and the breath fetid. The bowels had not been open for at least four days previous to admission. She was incontinent of urine. Castor oil was administered without effect.

On May 15th calomel gr. $\frac{1}{4}$ was given hourly for twelve hours, with the result that the bowels were open three times the next day, when she seemed more wideawake and sat up in bed, but was still very refractory and resistive so that the reflexes could not satisfactorily be determined.

On May 17th the respirations assumed a Cheyne-Stokes character, combined with marked slowing—at midday they were only 7. This continued for three days, the respirations never rising above 16 till the evening of May 19th, when they were 20. I performed lumbar puncture in the afternoon; the cerebro-spinal fluid came away under greatly increased pressure; it literally shot out; about 28 c.cm. were removed. Immediate microscopic examination showed it to contain fresh red blood corpuscles, presumably the result of the puncture. The fluid was sent to a pathologist, who discovered no other abnormality in it.

On May 18th there was low delirium; respiration continued slow, the tongue still furred, the head still a little retracted, the pupils still somewhat dilated, and Kernig's sign still absent. There was left-sided facial palsy with inability completely to raise the left upper eyelid. The knee-jerks were absent. At times the child cried out, but not with

a typical meningeal cry; at others she lay "as if dead," as the sister put it. From this day onward hexamine in 5-grain doses was given three times a day.

On May 19th she seemed a little improved. Both eyes were well opened, and the facial palsy was much less marked. The mouth was still dry, but she took milk much better. She lay quieter, and her forehead, which hitherto had been constantly wrinkled into a fixed frown, was placid. During the night of May 19th-20th some blood-stained muco-pus came from the nose and mouth. The stench was horrible.

On May 20th she was incontinent of urine and faeces; her brow again assumed the frowning expression, and she cried out continually. The pulse was running and somewhere about 200.

On May 21st the discharge from the nose and mouth continued. The heart was failing, the pulse was still running, about 200, the respirations were 62, and she was deeply cyanosed. Kernig's sign was still absent. At 10 p.m. the chest was full of coarse râles, and there were generalized convulsions. She died a few minutes later, with a temperature of 104.8° F. A morning and evening temperature chart is attached. The four-hourly chart was no further help.

Post-mortem Examination.

The pia mater showed general hyperaemia, whilst over the base of the brain, especially over the optic chiasma, pons, and front part of the medulla, the meninges were swollen, oedematous, and jelly-like. There was no definite pus, though between some of the convolutions there seemed to be a little turbid fluid. On section the brain showed no gross naked-eye changes. The other organs were healthy.

The signs and symptoms which were thought to point to botulism were vomiting, transient facial palsy, transient ptosis, absence of spinal paralyses, drowsiness, absence of temperature, and constipation with dryness of the mouth and nose.

THE EARLY AND EFFECTIVE REDUCTION AND FIXATION OF GUNSHOT FRACTURES OF THE FEMUR.

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THE adoption of the Thomas splint in the treatment of compound fractures of the femur caused by gunshot wounds has done much to alleviate the suffering resulting from the injury, has saved many lives and limbs, and has led to much improved functional results.

From the casualty clearing station at the front to the general hospitals at the base there is every facility for the application of the splint and the carrying out of the principles which its use entails. In front of the casualty clearing station, however, these facilities are not forthcoming, and the full value of the splint has not been obtained owing to the difficulty of applying simple and efficient first-aid extension.

At the regimental aid post the use of extension by adhesive strapping or glue and calico bandage, applied to the skin, is out of the question; nor is it advisable, having in view the fact that an anaesthetic will have to be administered and an operation performed at the casualty clearing station, to adopt these measures at a field ambulance.

The ideal method of procedure, then, would be to employ so simple a method of extension that it can be applied at, or as near as possible to, the spot where the casualty occurs; and which is at the same time easy and rapid of application, efficient, and need not be changed till the patient is on the operating table at the casualty clearing station.

Before describing any method in detail, it may be well to devote a little time to the following considerations.

(a) *Evacuation and the Time Required to Carry a Casualty along a Trench System.*

Usually the first point at which effective measures can be taken in the treatment of these cases is at the regimental aid post, which is generally situated at the rear portion of a system of trenches. Most of the casualties, however, occur some distance from this point, and the route to be followed to reach it may be over shell-pitted ground and through narrow, tortuous, angular, and congested trenches. To carry a casualty over a few hundred yards of such difficult route may take as much or even more time, and involve much more jolting and jarring of the limb, than would his conveyance in a motor ambulance over, say, five miles of moderate road. Evacuation along a trench system, then, is a matter of great importance and merits serious consideration.

FIG. 1.

FIG. 2.

(b) *Difficulties Peculiar to the Injury Itself.*

A fractured femur, of all injuries, is the one that presents most difficulty in transport, unless some effective measures are taken with this object in view. The lower limb, forming as it does a large proportion of the

FIG. 3.

body weight, becomes a large, heavy, and particularly unwieldy mass, which rolls about helplessly, causing most agonising pain and damage to tissues in the region of the fracture. The upper limb is less bulky and unwieldy, and if injured and helpless the other limb can come to the rescue. This not being the case with the lower limb, early and effective splintage becomes all the more imperative.

(c) *The Seriousness of the Injury.*

From the point of view of mortality, it should be placed in the same category of urgency as a brain injury or perforating abdominal wound. It requires very little consideration to convince oneself of this. The largest bone in the body is shattered; the missile and the fragments of bone, with their imparted momentum, tear up powerful and inelastic muscles; even if the main vessels escape injury, there must inevitably be a considerable amount of haemorrhage which escapes out of the wound or infiltrates the tissues, causing the limb to become tense.

FIG. 5.

(d) *The Importance of Applying Extension at the Earliest Possible Moment.*

The early complications responsible for the high mortality in these cases are shock and gas gangrene, and they occur in about equal proportions. At no section of the line of evacuation do the causes of these complications act with greater intensity than they do during the regimental

stretcher-bearer's "carry" to the regimental aid post. There is gross shortening, with lateral and rotary deformity; the spasm of powerful muscles and the rolling of the limb cause the fragments to grate one upon the other, and vessels and nerves may be wounded. Muscles are prodded and lacerated by sharp fragments; and infective material that has been introduced becomes much more intimately incorporated with the injured tissues. A process of mechanical devitalization takes place during this period that no subsequent measures that may be taken can retrieve.

First-aid Considerations.

From the foregoing considerations it is obvious that more effective first-aid measures must be taken in front of the regimental aid post, and should, whenever possible, be carried into effect at the place where the casualty occurs. Such measures as tying the injured limb to the sound one, or making extension and counter-extension to the poles of the stretcher are certainly serviceable, but they are far from being effective in the sense of complete extension and immobilization. The measures taken, then, will have to be carried out by the regimental stretcher-bearer, and under difficult conditions. They must therefore be simple, effective, and rapid of application.

As has already been indicated, the main difficulty lies in the application of extension, and to overcome this difficulty the brace described below is suggested.

THE EXTENSION BRACE.

The brace, which is intended for application over the boot, is made of strong webbing in the form of two Y's, one of which lies on each side of the boot (Figs. 1 and 2). The diverging limbs of the Y's merge into each other so as to form an anterior or dorsal strap in front of the ankle, and a posterior or heel strap behind the ankle. On one side they are fastened together by means of a stud. The stem of each Y forms a loop to which strong cloth strapping is stitched.

FIG. 4.

Details of Construction.

Strong webbing, similar to the webbing of a small box respirator, 2 in. wide, is used. It is cut into four pieces, two of which are 10 in. long to form the anterior and posterior straps, and two of which are 12 in. long to form the loops (Fig. 3).

The ends A of the anterior and posterior straps are sewn together at an angle of 90 degrees, and the loop is sewn to this junction

FIG. 6.

in such a way as to bisect the angle, and form with strap an angle of 135 degrees (Fig. 4).

Of the ends B, that of the anterior strap is sewn to one end of the loop strap at an angle of 135 degrees, and that of the posterior strap to the other end of the loop strap at a similar angle. A metal stud is placed at the anterior strap-loop junction, and a corresponding stud slit is made at the posterior strap-loop junction. The stud slit must be in line with the loop strap. It is important that the anterior and posterior straps be not longer than 10 in., otherwise the brace does not maintain so effective a grip on the boot.

Three feet of strong cloth strapping, 1½ in. wide, is stitched to each loop to form extension straps.

The advantages of the brace are that:

1. It allows of strong and efficient extension being made with a minimum of discomfort.
2. There is no possibility of it coming off, as the

greater the extending force the tighter and more secure the grip.

3. There is no constriction of the ankle or pressure on the malleoli.

4. The foot is maintained at right angles to the leg, and the limb cannot roll.

5. It can be put in position in two seconds.

6. When not in use, it can be compactly and securely fixed to the splint and so be always available.

I have submitted this brace to Colonel Sir Robert Jones, C.B., and he has expressed his approval of it.

The Slings.

The slings are made of strong calico bandage and five are required for each splint.

To make a sling, take a piece of strong calico bandage 4 in. wide and about 40 in. long. Each piece is doubled on itself and the loop so formed fixed to the inner bar by safety pins or stitching (Fig. 5). The free ends are split into tails of equal width for a distance of about 10 in. and serve for tying to the outer bar. When in use the tail A is tied to A¹ and B to B¹. Three of the slings are supporting, and are placed under the ankle, knee, and thigh respectively; two are fixing, and are placed one above and one below the knee. The latter prevent flexion of the knee and rolling of the limb.

All Thomas splints in advanced medical units should be prepared for immediate use by having the brace compactly fixed to the junction of the ring and inner bar, and the slings fixed, rolled round, and tied to the inner bar, as depicted in Fig. 6.

Application of the Splint.

When the splint is about to be applied the brace is taken

FIG. 9.

off, the slings unrolled and left to hang by the inner bar. One stretcher-bearer applies the brace over the boot and with it extends and rotates the limb into its correct position; this having been done extension is maintained by steady traction on the brace (Fig. 7).

No. 2 stretcher-bearer then passes the splint over the brace and boot, No. 1 still maintaining extension, first with one hand then the other, so as to allow of this being done (Fig. 8).

Being satisfied that the ring of the splint is well

up into the groin and pressing against the tuber ischii, No. 1 ties the extension straps of the brace to the foot of the splint as described below, and depicted in Fig. 9, A, B.

Pass both extension straps over the bars, cross underneath and then round the bars again to the U loop at the

foot of the splint. The straps must pass round the U loop in opposite directions, and be secured by a single knot. One strap is then passed under the crossing (Fig. 9, A), up between it and the sole of the boot, and tightened till the necessary extension is made. The free ends of the straps are now tied off at the U loop. The applied strap then assumes the appearance represented in Fig. 9, B.

The supporting slings are now tied, commencing with

the one remote from the wound. This means that the ankle support is tied first and then the knee or thigh support according to the site of the injury. Lastly, the fixing slings are tied above and below the knee (Fig. 10).

The application of the splint only has been described above, and the question of dressings has been left out, in order to simplify the description and because at this stage, unless bleeding is considerable, dressing is of secondary importance to reduction and fixation.

Whether or not the wound should be dressed before the patient is conveyed to the regimental aid post will depend on

many factors, such as the number of casualties to be collected, the amount of shelling that is going on at the time, the superficial extent of the injury, and lastly, the amount of haemorrhage.

Except in the last contingency, the dressing should be done last, as it can be done more effectively and with less pain and detriment to the patient after extension and fixation have been secured. Access for dressing is obtained by cutting open the trousers over the site of the wound; the dressing having been applied, it is secured by a bandage passing over the bars of the splint. In this way, should a second dressing be necessary, it can be done without disturbing the extension and fixation.

The patient can now with relative ease be lifted on to the stretcher. The projecting end of the splint is supported on a block of wood, brick, or article of equipment to keep the heel off the canvas.

On arrival at the regimental aid post a suspension bar is fitted on to the stretcher to replace the improvised support, the extension brace is further tightened if necessary, and, should it be deemed advisable, a Jones's gutter-splint or a piece of Gooch splinting is inserted under the ham by loosening the supporting slings, one at a time, and retying them.

The various measures for the prevention of secondary

FIG. 10.

shock are not within the scope of this paper, and mention only will be made of the importance of conserving the body heat by properly adjusted blankets; the application of warmth by hot-water bottles, hot bricks wrapped in sacking, or petrol cans and rum jars filled with hot water; the provision of hot drinks, the administration of a

hypodermic injection of morphine, and, lastly, speed in evacuation.

In order that a prepared splint may be within easy reach of any part of a trench system in which it may be required, it is suggested that they be taken to the front line; and that one at least should be kept in each stretcher-bearer's dug-out. As each case with a splint is brought to the regimental aid post, a prepared splint is given to the bearers to replace it.

CONCLUSIONS.

In conclusion, the following points may be emphasized:

1. The extension brace provides a standardized, simple, and effective means of extension, which is more rapid of application than any improvised method.

2. The Thomas splint, prepared as described, forms a complete armamentarium for "putting up" a fractured femur and does away with the necessity of carrying accessories. It is therefore well adapted for taking to the front line trench.

3. By having the fracture reduced and the limb extended and immobilized before the casualty is carried to the regimental aid post, the process of mechanical devitalization that takes place during this period more than any other in the line of evacuation is reduced to a minimum, and will lead to much improved functional results and reduce the mortality.

I have to thank Captain Edmund Price, R.A.M.C., for the figures illustrating this paper.

AGGLUTINATION IN THE DIAGNOSIS OF DYSENTERY.

BY

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THE VALUE OF AGGLUTINATION IN THE DIAGNOSIS OF DYSENTERY CAUSED BY *B. DYSENTERIAE* SHIGA AND THE MANNITE-FERMENTING GROUP OF DYSENTERY BACILLI RESPECTIVELY.

DURING the later months of 1917 we tested the agglutination titre of all patients who were suffering or had suffered from dysentery. The examinations were made between the tenth and thirtieth day from the onset of the illness. We also tested the serums of 214 control persons who had not had dysentery, and who had no recollection of having suffered from diarrhoea during the past two years.

Our observations are divided into three groups, as shown in Tables I, II, and III.

Method.

The method employed was that recommended by Major Dreyer, namely, keeping equal volumes of the emulsions and progressive dilutions of the serums in a bath at 55° C. for four and a half hours and reading after fifteen to thirty minutes. The emulsions employed in the first series of our observations were supplied from Professor Dreyer's laboratory at Oxford. A degree of agglutination which could be comfortably seen with the naked eye against a black background corresponding to Dreyer's "standard agglutination" was taken as the end point. The results are expressed in terms of Dreyer's standard agglutinin units¹ by taking into account the factor on the bottle representing the relative agglutinability of the particular sample according to its behaviour with some arbitrarily selected serum.

The results obtained are set out in the following tables:

TABLE I.—Observations on the Serum of Patients from whose Stools Dysentery Bacilli were isolated.

Total number of positive Flexner cases, 151.			
Number yielding 5 units	...	79 =	52 per cent.
" " 7 "	...	76 =	50 "
" " 10 or more units	...	58 =	38 "
Total number of positive Shiga cases, 13.			
Number yielding 5 units	...	13 =	100 per cent.
" " 7 "	...	13 =	100 "
" " 10 or more units	...	13 =	100 "

TABLE II.—Observations on the Serum of Patients who had Suffered from Dysentery but from whose Stools Dysentery Bacilli were not recovered, nor *E. histolytica* found.

Total number of cases of clinical dysentery, 342.

Flexner:			
Number yielding 5 units	...	76 =	23.4 per cent.*
" " 7 "	...	70 =	21.5 "
" " 10 or more units	...	40 =	12.3 "
Shiga:			
Number yielding 5 units	...	17 =	5.0 per cent.
" " 7 "	...	17 =	5.0 "
" " 10 or more units	...	11 =	3.0 "

* The 17 Shiga cases have been deducted from the total of 342 in calculating the percentages.

TABLE III.—Normal Persons.

Total number of normal serums examined, 214.

Flexner:			
Number yielding 5 units	...	23 =	10.0 per cent.
" " 7 "	...	17 =	8.0 "
" " 10 or more units	...	5 =	2.5 "
Shiga:			
Number yielding 5 units	...	7 =	3.3 per cent.
" " 7 "	...	6 =	2.8 "
" " 10 or more units	...	4 =	2.0 "

The "Y" emulsion issued by the Standards Laboratory at Oxford was not agglutinated by the serum from patients of this epidemic except in a few cases (see Table IV below).

TABLE IV.

Group of Cases Examined.	No. of Cases Examined.	Agglutination with "Y" Emulsion.	Per Cent.
Positive Flexner cases	102	2	2.0
Clinical dysentery cases	172	6	3.5
Normal persons	52	—	—

The serum of normal persons may contain agglutinins to *B. dysenteriae* Shiga and to dysentery organisms of the Flexner-Y group in amount sufficient to cause confusion in diagnosis.² Ledingham and Penfold³ (1915) concluded from their observations that agglutination by dilutions of 1 in 50 in the case of *B. dysenteriae* Shiga and 1 in 200 in that of the Flexner-Y group was significant. An extensive series of observations was undertaken by Ritchie⁴ in 1916 in order to determine the degree of agglutination occurring with the serum of normal persons. He investigated the serum of 792 men and women, none of whom, as far as they were aware, had suffered from dysentery. Ritchie used suspensions of living organisms in his experiments, incubated the mixtures of organisms and diluted patient's serum in air at 37° C. for two hours, the result being read off on the microscope stage, using a $\frac{1}{2}$ in. objective. He found that 4.6 per cent. of the cases examined agglutinated the Shiga organism at 1 in 64, and considers that complete agglutination in a dilution of 1 in 64 and above should be regarded as diagnostic. With *B. dysenteriae* Flexner he found that 30 per cent. of the cases examined gave agglutination at a dilution of 1 in 128, and concluded that complete agglutination in a dilution of above 1 in 128 should be looked upon as diagnostic, but in a dilution of 1 in 128 or lower cannot be relied upon for diagnostic purposes.

Our experiments on the serum of 214 normal persons differed from those of Ritchie in several important respects:

1. Dreyer's standard agglutinable cultures, selected on the grounds of their relative insensitiveness to the serum of normal persons, were used.

2. The standard agglutinable cultures used were formalized, which reduces considerably the agglutinability of dysentery bacilli.

3. The macroscopic method, as recommended by Dreyer, was used.

Using this different technique we found that 10 per cent. of the persons examined contained 5 agglutinin units, 8 per cent. contained 7 agglutinin units, and 2½ per cent.