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

LIEUT.-COLONEL C. J. MARTIN, F.R.S., A.A.M.C.,

CAPTAIN P. HARTLEY, R.A.M.C.,

AND

SISTER F. E. WILLIAMS, A.A.N.S.

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.

contained 10 or more agglutinin units to *B. dysenteriae* Flexner. The figures for *B. dysenteriae* Shiga were as follows: 3.3 per cent. contained 5 agglutinin units, 2.8 per cent. contained 7 agglutinin units, and 2 per cent. contained 10 agglutinin units.

Our results, set out in the preceding tables, confirm those of Dreyer, and indicate that, using his method, the presence of 10 or more agglutinin units per cubic centimetre of serum is, for all practical purposes, diagnostic of an active bacillary dysenteric infection caused by the bacillus agglutinated, and that the presence of 7 units is highly suspicious of dysenteric infection. The error introduced on account of the reaction of the serum of normal persons to the standard agglutinable cultures used amounts to 2½ per cent. in the case of *B. dysenteriae* Flexner, and to 2 per cent. in the case of *B. dysenteriae* Shiga infections.

Our group of cases due to infection by *B. dysenteriae* Shiga is small, but it is to be noted that in every case of proved Shiga infection the patient's serum agglutinated the standard agglutinable culture used, and this agglutination was always complete in the highest dilution of the patient's serum tested. As far as our observations go, the results indicate that in the case of infections due to *B. dysenteriae* Shiga determination of the agglutinin content of the patient's serum constitutes a valuable method of diagnosis.

This is, however, far from the case with patients infected by members of the mannite-fermenting group of dysentery bacilli. We tested the serum from 151 cases of dysentery from whose stools bacilli of this group had been isolated, and found that in only 58 did the patient's serum contain 10 or more agglutinin units, that is, less than 40 per cent. of the persons who had recently been infected by a member of the Flexner-Y group exhibited an agglutinin content in the serum of 10 or more units. The low proportion observed might have been due to the fact that in many patients the infection was very mild and the agglutinins produced so small in amount that they were not demonstrable; but in the light of the well ascertained fact that there is a family of mannite-fermenting dysentery bacilli, it appeared more likely that some patients had been infected by one member of the group and others by another.⁵ That this latter view is the correct one is suggested by the results of the experiments set out below, which were carried out to investigate this point.

Three strains of *B. dysenteriae* Flexner which had been isolated during this year's epidemic were grown on ordinary nutrient agar for eighteen hours, the growth washed off and emulsified in normal saline, and formalin added to make a concentration of 1 per cent. The formalized emulsions were placed in an ice chest for a week. At the same time a similar formalized emulsion was made from a strain of *B. dysenteriae* Flexner which we obtained from the Lister Institute, and also an emulsion of *B. dysenteriae* Y, which we obtained from the same source.

The agglutinating power of the serum of 40 patients, from the stools of each of whom mannite-fermenting dysentery bacilli had been isolated, was determined against each of the above emulsions and also against Dreyer's standard agglutinable culture (Flexner). The patient's serum was tested at dilutions of 1 in 20, 1 in 40, and 1 in 80 against each of the above strains of *B. dysenteriae* Flexner. It is not possible, of course, to express the results obtained in terms of standard agglutinin units.

In addition to the above series of 40 "positive Flexner" cases, a second series of serums from 40 normal persons was examined in precisely the same way. The mixtures of diluted patient's serum and dysentery emulsions were heated to 55° C. for four and a half hours, and read from fifteen to thirty minutes afterwards.

The "Y" strain used was a direct descendant of Hiss and Russell's original "Y." On being tested against forty samples of normal serums it was found to give standard agglutination at a dilution of 1 in 40 or over in 13 cases—that is, in 32.5 per cent. The figures obtained for this "Y" emulsion have accordingly been excluded from the tables given below, in which the results of these experiments are expressed.

TABLE V.—The Agglutinating Power of the Serum of 40 Patients from whose Stools *B. dysenteriae* Flexner had been recovered, Tested against Five Different Strains of *B. dysenteriae* Flexner.

Dysentery Emulsion Used.	Number giving Standard Agglutination at 1 in 20 or over.	Per cent. giving Standard Agglutination at 1 in 20 or over.	Number giving Standard Agglutination at 1 in 40 or over.	Per cent. giving Standard Agglutination at 1 in 40 or over.
Dreyer's standard agglutinable culture	19	47.5	16	40.0
Flexner (Lister Institute)	20	50.0	11	27.0
No. 16	18	45.0	15	37.5
No. 65	15	37.5	10	25.0
No. 86	19	47.5	10	25.0

TABLE VI.—The Agglutinating Power of the Serum of 40 Normal Persons Tested against Five Different Strains of *B. dysenteriae* Flexner.

Dysentery Emulsion Used.	Number giving Standard Agglutination at 1 in 20 or over.	Per cent. giving Standard Agglutination at 1 in 20 or over.	Number giving Standard Agglutination at 1 in 40 or over.	Per cent. giving Standard Agglutination at 1 in 40 or over.
Dreyer's standard agglutinable culture	3	7.5	1	2.5
Flexner (Lister Institute)	1	2.5	—	—
No. 16	4	10.0	3	7.5
No. 65	4	10.0	3	7.5
No. 86	2	5	—	—

Of the 40 positive serums tested (Table V)—

11 failed to agglutinate any of the 5 emulsions used;
29 agglutinated one or more of the 5 emulsions used;
2 serums agglutinated all 5 emulsions;
4 serums agglutinated 4 emulsions only;
3 " " " 3 " "
7 " " " 2 " "
13 " " " 1 " "

Of the 13 serums which agglutinated one strain only—

4 serums agglutinated Dreyer's standard agglutinable culture only;
3 serums agglutinated No. 16 only;
3 serums agglutinated No. 65 only;
3 serums agglutinated No. 86 only.

Reference to the figures given in the two preceding tables shows that of the five strains of *B. dysenteriae* Flexner used, Dreyer's standard agglutinable culture gives the most satisfactory results. Yet, even when this strain is used, only 40 per cent. of the cases, from each of which dysentery organisms of the mannite-fermenting group had been recovered, gave a positive result. If the patient's serum is tested against a number of strains, the number of cases giving a positive result increases.

Patient's serum tested against:	Number giving Standard Agglutination at 1 in 40 or over.	Per cent. giving Standard Agglutination at 1 in 40 or over.
Dreyer's standard agglutinable culture only	16	40.0
Dreyer's S.A.C. and Flexner (Lister Institute)	17	42.5
Dreyer's S.A.C. and Flexner (Lister Institute) and No. 16	22	55.0
Dreyer's S.A.C. and Flexner (Lister Institute) and Nos. 16 and 65	26	65.0
Dreyer's S.A.C. and Flexner (Lister Institute) and Nos. 16, 65, and 86	29	72.5

S.A.C. = Standard agglutinable culture.

That is, if the serum of patients who have recently suffered from infection by a member of the Flexner group of dysentery organisms be tested against five strains of the group, the percentage giving a positive result is nearly twice as great as the positive findings when only one strain is used; and it is reasonable to suppose that the number

yielding a positive result would be still further increased if the patient's serum were tested against a still greater number of locally isolated strains.

In conclusion we express our indebtedness to Captain B. G. Klein, R.A.M.C., medical officer in charge of the dysentery wards, for his kind co-operation.

REFERENCES.

- ¹ Major G. Dreyer and Captain A. C. Inman: The agglutination curve and its importance in the diagnosis of typhoid and paratyphoid infections, *Lancet*, 1917, i, p. 367. ² See Lentz, *Handbuch der pathogenen Micro-organismen*. Kolle and Wassermann, 1913, p. 947. ³ Ledingham and Penfold, *BRITISH MEDICAL JOURNAL*, 1915, ii, p. 704. ⁴ J. R. Ritchie, On the agglutination reaction of the typhoid-dysentery group with normal sera, *Lancet*, June 24th, 1916. ⁵ C. J. Martin and F. E. Williams, *BRITISH MEDICAL JOURNAL*, April 14th, 1917.

POST-OPERATIVE PULMONARY EMBOLISM DUE TO THE CONDITION OF THE BLOOD.

BY

A. LAPHORN SMITH, M.D., M.R.C.S.ENG.,

FORMERLY SURGEON-IN-CHIEF OF THE SAMARITAN HOSPITAL FOR WOMEN, MONTREAL.

OPERATING surgeons all over the world are greatly indebted to the writers of the two very interesting articles on post-operative thrombosis and embolism which appeared in the *BRITISH MEDICAL JOURNAL* on March 9th and 23rd. With every word in these two articles I most heartily agree—with one exception, and that is, instead of putting the quality of the blood last on the list I would put it first.

Early in my professional career I came under the influence of Sir William Hingston, who pointed out to me the great demands of the human system for water. The kidneys, the skin, the bowels, and the lungs are all calling for it to enable them to carry on their functions. These apply equally to men and women, but in the case of nursing women lactation makes a large additional demand. Some years later I listened for an hour to the scholarly presidential address of Dr. Mathew D. Mann of Buffalo before the American Gynecological Society, in which he pointed out that many of the aches and pains from which women suffered would not have afflicted them if they had been water drinkers. Since then I have seen many women operated on at the Mayo Clinic for gall stones who would never have had them if their bile had not been a supersaturated solution of biliary salts, ready to throw down crystals on the slightest pretext; and I have removed in women many stones from the kidneys and ureters which were due to supersaturation of the urine with solid matter that would never have been formed if the specific gravity of the urine had been kept down. Early in my career as an abdominal surgeon, as well as in consulting obstetrics, I came to the conclusion that the tragic deaths from pulmonary embolism, which at that time were much more frequent than they are now, both after operations and confinements, were due principally to a hyperfibrinous condition of the blood, and all these years I have taken great and laborious pains to see that all these patients were allowed to drink freely.

To this fact more than to anything else do I believe that it is due that I have not yet seen a death from pulmonary embolism following any of my own operations, nor after any of the confinements that I have attended.

The other factor is one to which Colonel Symonds has done a service by calling attention. He says: "Is it necessary to keep the parturient woman on her back for days together?" From his experience after abdominal operations he is inclined to think that early movements of the limbs and frequent changes of position would diminish the number of cases of embolism. My answer is that not only is it not necessary, but positively harmful. The heavy uterus falls backwards and ceases to drain; adhesions form between the ends of the tubes and the peritoneum, and the woman is sometimes never quite well again. We should not only permit, but even urge, the patients to have their position changed frequently during the first few days and to move their limbs freely as soon as they are able to do it themselves. I have always told women after confinement to lie any way they like—right side or left side, or even on the face—rather than on the back. Most important of all is it to sit up on a chamber in bed three or four times a day to pass water and move the bowels.

Sir William Hingston, who knew the habits of the Iroquois Indians thoroughly, told me that they were almost absolutely free from the accidents of childbirth common to their white sisters, which he attributed to their not going to bed at all, but continuing the march with the papoose on their back after a few hours' rest.

The only cases of pulmonary embolism in which I have been even remotely interested occurred in the wives of two medical friends in other cities who had had ideal confinements and afebrile recoveries, and yet who died without any warning on the twelfth and fourteenth days at the moment when life seemed at its happiest; another in the wife of a lay friend, who made a perfect recovery, and died suddenly on the fourteenth day. As Colonel Symonds points out, the nurses trained twenty years ago are in favour of the dorsal position for ten days and very little movement; and I may add they were bitterly opposed to the patient being allowed cold water or fresh air for fear of a chill, and sunlight for fear of ophthalmia neonatorum. Our nurses trained to-day are taught that air, water, and sunlight are the great enemies of microbes, and that chills mean fever due to microbial infection. A closed and darkened room generally means a hot room, causing profuse perspiration, which, with lactation, would make the blood less liquid and more liable to clot in the veins. Lying on the back for ten days, with the blood getting daily more clottable, is a very good way to bring about thrombosis and death by embolism when the patient begins to move about.

While it is important to carry out all the suggestions of Dr. McCann and Colonel Symonds, I feel sure that some other factor has been operating silently in their favour, and that is that doctors are urging women to drink water, and nurses are more and more getting in the way of allowing them to do it. It must be in the experience of every accoucheur that what every woman craves for most is a drink, cold preferred. Elderly women who have had large families have assured me that the most unpleasant part of their confinement was the awful ten days of immobility on the back, and, next to that, the thirst. Medical friends who have been operated on have assured me that their greatest desire was a drink of hot tea, and acting on their suggestion I always prescribe it as soon as the patient comes out of the anaesthetic, whether they are vomiting or not. If the first cupful comes up it at least washes out the stomach.

Getting up several times a day to answer the calls of nature will not only ensure drainage of the uterus and vagina, but that and sitting up in bed for meals will prevent the stagnation of the blood, which Colonel Symonds points out is one of the factors in thrombosis. Many practitioners fear to allow the patient to sit up on a chamber for fear of all kinds of things happening—that the uterus may drop out of the body, that it may drop inside out, becoming inverted, or that there will be tremendous haemorrhage; but these are all bogies.

Another friend, Joseph Price, who was assistant to Lawson Tait, told me that he always placed his patients on their right side with their knees drawn up after abdominal sections, and as soon as they were able he allowed them to move about freely in bed, and to stretch and bend their legs frequently. Lawson Tait's idea was to relax the tension on the abdominal stitches, which were silk worm gut and through-and-through.

Pulmonary embolism is fortunately very rare, only 47 deaths having occurred from it at the Mayo Clinic in 63,000 operations. In former days, when the accident was more frequent, it was the custom to prepare the patient by drastic hydragogue catharsis for a day or two before. Then, again, haemorrhage was more frequent and more abundant; also the operating rooms were kept at 80°, so that the patient lost a large amount of water by the skin, while vomiting from the anaesthetic prevented replacement of the lost water. For this last reason I believe that the chances of embolism would be greatly lessened if a rectal enema were given by the slow method at the rate of 20 oz. of beef-tea or salt solution for every half-hour the operation lasts. If given at a temperature of 105° F. it would practically do away with shock and sub-normal temperature. I constantly resorted to it while in charge of Lady Wemyss's Hospital in France, with great benefit, as I reported in this *JOURNAL* two years ago, and I am glad to see by recent reports that it is being more