

Material and Methods.

This investigation was conducted during the months of February, March, and April, 1916. A daily personal visit was made to the hospital and a moderately large sample of the stool of each patient under investigation was taken. Each sample was treated in the following manner. Half a cubic centimetre of sterile normal salt solution was poured into a finely graduated measuring cylinder, and to this fæces was added in tiny portions from different parts of the sample, until the level of the salt solution was at the one cubic centimetre mark. Thus an exact volume—namely, half a cubic centimetre—of fæces was measured on each occasion. This was further diluted with sterile normal saline solution and was thoroughly emulsified, the dilution being continued until an emulsion sufficiently thin for microscopical examination was obtained. The dilution varied with the consistency of the stool, dilutions of 10, 20, 40, and occasionally 80 being employed. A drop of the emulsion was placed in the chamber of a Thoma-Zeiss hæmocytometer, precautions similar to those used in making blood counts being observed. Usually the counting chamber was filled four times over for each estimation, great care being taken to ensure that the emulsion was as perfect as possible before the sample drop was taken. The number of cysts in a cubic millimetre of the stool examined could thus be estimated. One-half cubic centimetre of stool was employed for dilution, whether the stool were formed, semi-formed, or diarrhœic in character.

The volume of certain of the stools of different patients was determined in cubic centimetres on some occasions. The significance of this, in relation to the probable number of cysts in the whole of an infected stool, is considered later.

It was not possible to retain some of the patients in hospital for as long a time as was desirable from the point of view of extended enumerations. However, certain deductions can be made already from my work, and these will now be indicated.

Cases Studied.

A few general statements may be made in connexion with the cases studied. Some of the patients were relatively convalescent when they came under observation. All of them showed weakness, especially after exertion. With regard to the temperature charts, in the cases of lambliasis there has been little noticeable during the time that I have been able to conduct observations. Occasionally the temperature was slightly subnormal. One patient (Case 1) was in a weak condition when admitted and has remained so from the time he was first under observation up to the present. No parasite other than lamblia has been found in him, and the case is regarded as one of pure lambliasis. This patient, who contracted lambliasis in Flanders, had a stool that was almost always bulky and diarrhœic in character. Its colour and consistency also were peculiar, having been compared with khaki, mud, whipped cream, and putty. Many of the lamblia-infected stools were sulphur-yellow in colour, but in some cases the colour was hardly different from that of normal stools. At times most of the men were somewhat constipated.

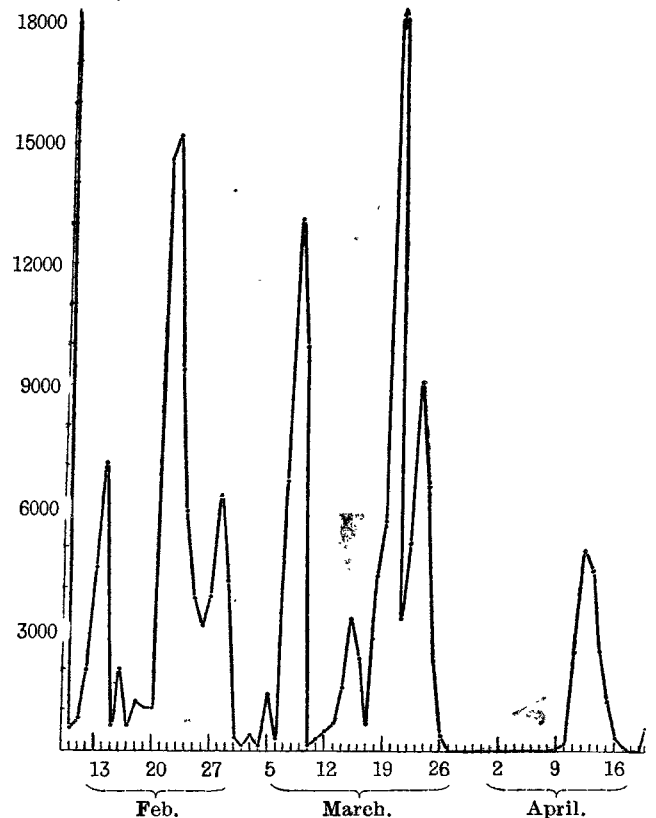
Most of the lambliasis patients had received a number of injections of emetine before they reached England. From the time that they came under observation no Entamoeba histolytica was found in their stools, and E. coli and blastocystis occurred only very occasionally in some of them. Spirochætes were not observed. The emetine injections seemed to have had little action on the lamblia.

The statements relating to each of the cases studied may now be set forth, but it is not always possible to give details of the earlier history of some of the men.

CASE 1.—This case was of special interest, since the patient had never been out of England before he proceeded to Flanders, where he only stayed two months, and where he contracted lamblial diarrhœa of a severe type on Dec. 18th, 1915. He was invalided and sent to England. During the acute stage of the illness he passed 17 motions daily. No emetine was given. On reaching England he was in hospital in the Thames Valley, and then had a short furlough, after which he was sent to the School of Tropical Medicine Auxiliary Military Hospital from his depôt on Jan. 21st, 1916. He was then passing 14 motions per day, but there was a rapid decrease after treatment with pulv. cret. arom. on Jan. 24th to five and four motions per day, and since April 6th there have been three or four motions daily. On Feb. 15th some blood was passed with the stool. On the 19th β naphthol was given, but it produced vomiting. On the

25th much blood was present in the motion. The bacteriological examination of this blood and of the stool was negative for dysentery-producing bacilli on this and on subsequent occasions, but many lamblia cysts were present. Much blood was also passed on the 27th, 28th, and 29th, and on March 1st. On Feb. 28th mist. terebinthinæ was given and was stopped on March 1st, while on March 2nd and 3rd β naphthol was administered, but produced vomiting. On the 8th mist. terebinthinæ was given again, and on the 15th

CHART 1.



The chart shows the number of lamblia cysts per cubic millimetre from day to day in Case 1.

salol was given. On the 24th treatment with bismuth salicylate three times daily was tried, a level teaspoonful being the dose. The lamblia cysts gradually disappeared under this treatment, which was discontinued on April 5th. The cysts then began to reappear. On the 14th treatment with bismuth subnitrate in 10-grain doses three times daily was begun. The cysts decreased in numbers, but had not entirely disappeared from the stool on the 17th; then followed two days negative, and on the next day the cysts returned, showing that the dose of bismuth subnitrate was hardly large enough.

The daily enumerations in this case were as follows:—

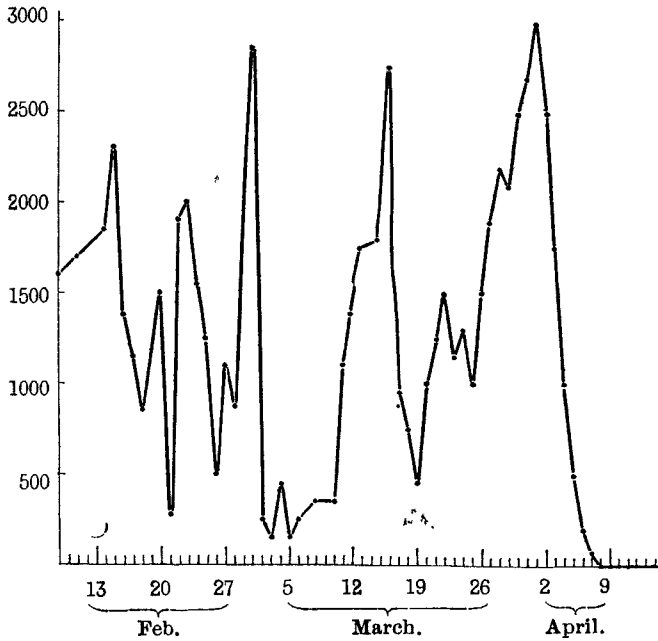
Date.	Lamblia cysts per c.mm. of fæces.	Date.	Lamblia cysts per c.mm. of fæces.
Feb. 9	18,200	March 10	150
" 10	550	" 11	300
" 11	800	" 12	500
" 12	2,000	" 13	700
" 13	4,500	" 14	1,600
" 14	7,050	" 15	3,300
" 15	600	" 16	2,300
" 16	2,000	" 17	650
" 17	600	" 18	4,350
" 18	1,200	" 19	5,700
" 19	1,050	" 20	25,400
" 20	1,050	" 21	3,300
" 21	14,600	" 22	5,150
" 22	15,200	" 23	9,150
" 23	9,400	" 24	6,550
" 24	5,900	" 25	2,250
" 25	3,750	" 26	400
" 26	3,100	Mar. 27 to Apr. 8	Negative.
" 27	3,800	April 9	50
" 28	6,300	" 10	200
" 29	4,200	" 11	2,500
March 1	300	" 12	5,000
" 2	150	" 13	4,500
" 3	400	" 14	2,500
" 4	150	" 15	1,250
" 5	1,400	" 16	375
" 6	300	" 17	100
" 7	6,650	" 18	Negative.
" 8	13,200	" 19	"
" 9	10,000	" 20	600

The graphical representation of the foregoing results is shown in Chart 1. Owing to limitations of space, in Cases 2 to 7 the graph alone is given.

Case 1 shows that *Giardia (Lamblia) intestinalis* is, to say the least, not without pathogenic significance, as it is the only organism that has been found in the patient that can in any way bear a causal relation to the diarrhoea from which he suffered.

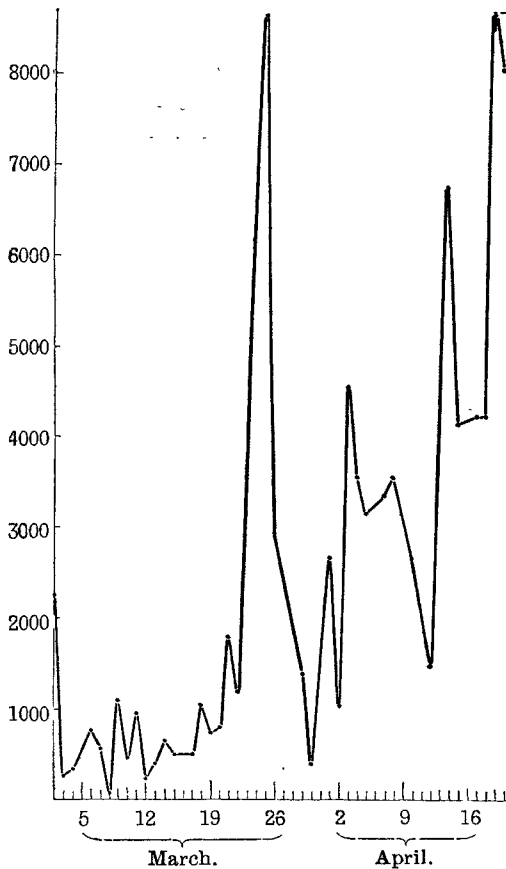
CASE 2.—This patient contracted dysentery when at the Dardanelles, and has been ill since Oct. 15th, 1915. At first he was in hospital at Alexandria, whence he was invalided

CHART 2.



on Dec. 14th, 1915. Before reaching the School of Tropical Medicine Hospital on Dec. 24th, he had received 22 injections of emetine. Ten stools per day were passed during the acute stage of the illness. When admitted to hospital the number of stools was up to four per day, and since then usually two or three motions have been passed daily. As with several of the other cases of lambliasis, constipated periods have occurred, and it has been necessary to have recourse to aperients. On April 5th, 1916, treatment by the administration

CHART 3.

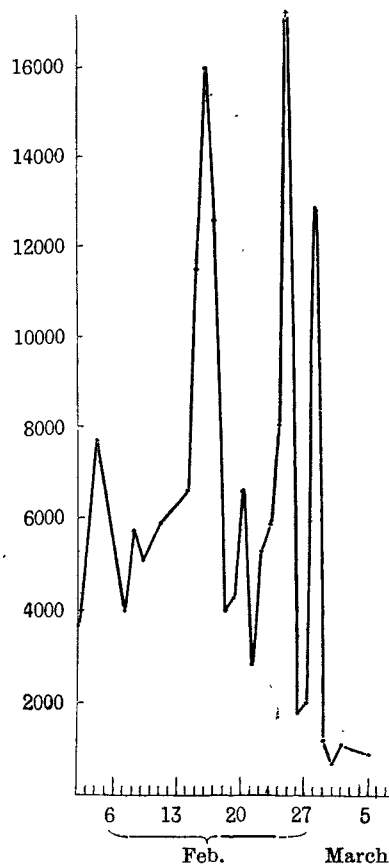


of a teaspoonful of bismuth salicylate three times daily was commenced. The cysts had disappeared from the stools by April 8, and have not since reappeared during treatment. (See Chart 2.)

CASE 3.—This patient from the Dardanelles had contracted dysentery on Oct. 26th, 1915. He was first sent to hospital in Malta, and was invalided to England on Jan. 25th, 1916. Twelve to 15 motions per day were passed during the acute stage of the malady. Prior to reaching the School of Tropical Medicine Hospital he had received 12 injections of emetine. When admitted on Feb. 10th one motion was passed daily, but since then two or three, or occasionally one, have been voided. Constipated periods have occurred when aperients had to be given. (See Chart 3.)

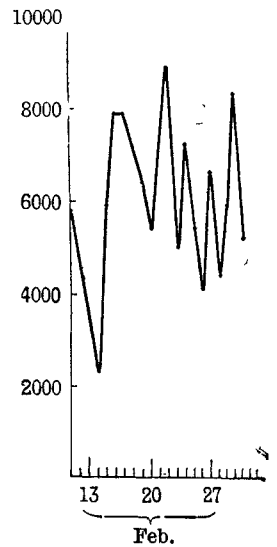
CASE 4.—This patient contracted dysentery when at Alexandria. No protozoal infections were then found in the stools. On admission to the School of Tropical Medicine Hospital on Dec. 7th, 1915, he passed one to two motions daily. No mucus was present in the stools. The early treatment of the patient from Dec. 22nd was by pulv. cret. arom. On Feb. 15th, 1916, β naphthol was administered three times daily. This was continued until the 23rd. On the 26th mist. terebinthinæ was ordered and a decrease in the number of lamblia cysts ultimately occurred, though the patient was not free from lamblia when discharged. (See Chart 4.)

CHART 4.



CASE 5.—This patient came from the Dardanelles, where he had contracted dysentery about Oct. 15th, 1915. During the acute stage of the malady 16 stools were

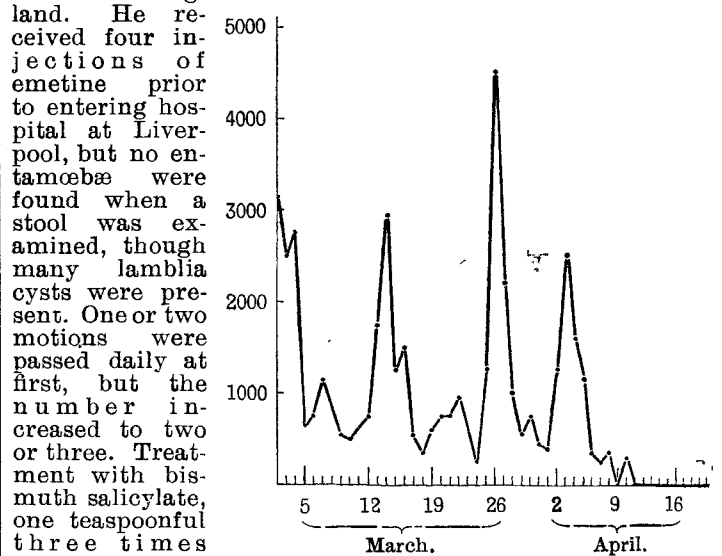
CHART 5.



passed daily. He received 15 injections of emetine before reaching England, whither he was invalided on Oct. 24th. When his stools were examined at the School of Tropical Medicine Hospital in February, 1916, no entamœbæ were found, but an abundance of lamblia cysts was present. No special treatment was administered in this case, and the patient was still infected when discharged, but the parasites were decreasing in numbers. (See Chart 5.)

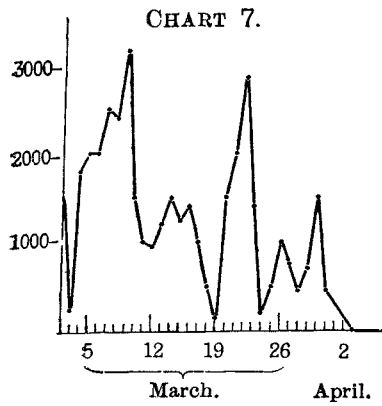
CASE 6.—This patient, when at the Dardanelles, became infected with dysentery on Nov. 14th, 1915. He was sent to Mudros and thence to England. He received four injections of emetine prior to entering hospital at Liverpool, but no entamœbæ were found when a stool was examined, though many lamblia cysts were present. One or two motions were passed daily at first, but the number increased to two or three. Treatment with bismuth salicylate, one teaspoonful three times daily, was ordered on April 4th, 1916. On the 6th, after the bismuth treatment had begun, the cysts decreased in number, and from the 11th to the time of writing have not reappeared. (See Chart 6.)

CHART 6.



CASE 7.—This patient had contracted dysentery on Dec. 7th, 1915, when in Gallipoli, and was sent to Malta. He was invalided thence on Jan 25th, 1916, and was admitted

to the School of Tropical Medicine Hospital on Feb. 2nd, 1916. During the acute period of the disease nine motions



were passed daily. Before reaching England he had received two injections of emetine. On admission one or two stools were passed daily, and they were almost always bulky and hard in character. On March 29th treatment with bismuth subnitrate, one teaspoonful three times daily, was ordered. The lamblia cysts decreased in numbers, and had disappeared on April 3rd, after which the man was discharged. (See Chart 7.)

The Volume of Lamblia-infected Stools and the Possible Number of Parasites Therein.

The daily examination of this series of stools has led to the conclusion that probably there is a greater uniformity of distribution of lamblia cysts in a diarrhœic stool than in a formed or hard one. The distribution of cysts in different parts of a stool, however, varies to some extent, but attempts were made to allow for this in the taking of the sample and in the making of the emulsion. As a rule, there appeared to be more parasites in a diarrhœic stool than in one of firmer consistency.

Determinations were made of the volume in cubic centimetres of some of the stools of patients infected with lamblia. The diet in Cases 1 and 2 at first was milk and fish. Later a chicken diet was prescribed. The remaining five patients were given an ordinary mixed diet. It was found that the volume or bulk of a normal stool from a man fed on a mixed diet varied from 130 to 180 c.c. per day. Pathological stools may vary in volume from about 500 to 1200 c.c. One of the patients observed (Case 1), who is an example of pure lamblia, had bulky stools varying from 175 to 500 c.c., volumes near the latter figure being the more common. On a few occasions the volume of this patient's stool has reached 950 c.c. Another patient (Case 2) at first had stools that were about normal in volume, averaging 150 c.c., but latterly they have been smaller, averaging 50 c.c. In yet a third patient (Case 3) the bulk of the stool was often 180 to 200 c.c., but latterly the volume has fallen to an average of 125 c.c. The possible number of cysts in a bulky infected stool, such as that of Case 1 on Feb. 22nd, when the volume was 950 c.c. and the number of lamblia cysts per c.mm. was 15,200, is:

$$15,200 \times 1000 \times 950 = 14,440,000,000.$$

The possible number of cysts in an infected stool of average volume, such as that of Case 3 on a day of moderate infection—for example, on March 21st, when the volume was 180 c.c. and 1800 lamblia cysts were found in 1 c.mm., is:

$$1800 \times 1000 \times 180 = 324,000,000.$$

The possible number of lamblia cysts in an infected stool of small bulk on a day when the infection is relatively low, such as that of Case 2 on April 6th, when the volume was 50 c.c. and the number of lamblia cysts per c.mm. was 200, is:

$$200 \times 1000 \times 50 = 10,000,000.$$

The above examples are sufficient to indicate that the number of lamblia cysts contained in an infected stool is counted in millions, and that every endeavour should be made to reduce and, as far as possible, to eliminate the organisms.

General Observations.

Certain points of general interest may now be mentioned. Examination of a large number of stools has shown that uniformity of distribution of lamblia cysts in a diarrhœic stool is more probable than in a formed or hard one. In general there are not so many parasites in a formed stool as in a diarrhœic one. The motions of some of the cases of lamblia were constipated at times.

Relapses of cases of lamblia may occur. Also, certain workers have considered that lamblia is harmless and have given no treatment for it. In other cases men known to be heavily infected with lamblia cysts, but free from dysentery-producing bacilli, have been discharged from hospital. Both

these classes of men may act as reservoirs of lamblia, and the infective cysts of the parasite may be shed promiscuously through the land, especially in country districts where sanitary arrangements may be somewhat primitive. There is, then, danger of outbreaks of lamblia diarrhœa, especially among infants and younger children. Outbreaks of flagellate diarrhœa have in the past been reported in certain parts of South America and in Italy. Also cases of lamblia have been recorded by several French workers from investigations conducted by them in Tonkin and other parts of Indo-China, and the infestation of the patients' houses by rats and mice has been noted. This observation is not without interest, as such rodents harbour species of lamblia in their intestines.

The danger arising from the presence of apparently healthy carriers of amœbic dysentery in a community is now well recognised. It is a matter of regret that seemingly so little consideration has been given to the problem of the carriers of lamblia cysts, who may be a source of considerable trouble in the future.

From Charts 1 to 7 it will be seen that the numerical distribution of lamblia cysts in a patient's stools varies from day to day. Cysts result from the rounding of the pear-shaped, suctorial flagellate forms. The cysts themselves are very difficult to eliminate and destroy by means of drugs. Every effort, therefore, should be made to attack the flagellate forms of lamblia—that is, the precursors of the cysts. Probably when cysts are few in the stool of a person suffering from lamblia, there are numerous flagellates in the duodenum and other parts of the intestine of the patient, and it would be well to try medicaments at such periods. Thus, it might be hoped that the flagellate organisms would be killed before they encysted, and the formation of a new "crop" of cysts be thereby prevented.

Again, from a study of the charts it will be seen that casual examinations of stools made at irregular intervals will result in a fallacious impression being obtained. It is necessary that regular examinations should be conducted, and should be continued over several months if possible.

The periodicity in the appearance of the maximum number of lamblia cysts appears to vary in the different cases. In some of the cases there seems to be a period of about a fortnight between the maximal crops of cysts (see Charts 1, 2, 6, 7), while in other cases it is somewhat less. By daily examinations of the stools of two other (uncharted) cases of lamblia, periods of 14 and of 10 days were found.

In conclusion, I have pleasure in thanking Professor J. W. W. Stephens, Captain L. A. Morgan, R.A.M.C. (T.F.), and Captain E. E. Glynn, R.A.M.C. (T.F.), for affording me facilities for obtaining material at the School of Tropical Medicine Auxiliary Hospital, Liverpool, and the sisters at the hospital for their cordial coöperation in securing the retention of the patients' stools needed for examination.

SPINAL ANÆSTHESIA :

WITH REFERENCE TO ITS USE IN THE TRENDELENBURG POSITION AND FOR THE PREVENTION OF SHOCK.

By H. M. PAGE, F.R.C.S. ENG.,

ANÆSTHETIST TO GUY'S AND THE WEST LONDON HOSPITALS, ETC.

With a Note by HAROLD CHAPPLE, M.C. Cantab., F.R.C.S. Eng., *Obstetric Surgeon to Guy's Hospital, &c.*

FOR all ordinary uncomplicated cases inhalation anæsthesia as improved at the present day is still the method of choice. Ether, if not contra-indicated, after a preliminary injection of atropine with or without opium, is rightly preferred, given by means of Clover's apparatus, with the addition, if possible, of oxygen, or by the open method, when a warmed vapour should be blown to the patient if the administration is anything more than a short one, which warming can be very simply effected by coiling an extra long delivery tube in a small receptacle for hot water or by the use of a thermos flask, as in the apparatus designed by my colleague, Dr. F. E. Shipway. There are also special cases where ether is best given by the intratracheal method, by Crile's tubes, or the rectum. Warmed nitrous oxide and oxygen with or without the addition of some ether vapour may be the method to choose, if available. There is also the intravenous route, which may have advantages under certain circumstances, though there are few cases that,