know practically nothing. This girl was definitely exposed to "fumes," as also were other cases of aplastic anæmia met with in the course of this investigation. J. E. showed little or no staining of the hands, but was sufficiently in contact with T.N.T. to have absorbed a poisonous dose through the skin.

A very similar case has recently occurred under the care of Dr. Christine Pillman, to whom I am indebted for the following account:—

A. P., a woman working in T.N.T., was admitted to the Royal Free Hospital on Feb. 28th, 1917, with toxic jaundice, and was discharged in April. On May 8th her conjunctivæ were still bile-tinged and she developed a well-marked purpuric eruption. On readmission to the Royal Free Hospital the following blood state was found:—

Red cells 2,800,000 per c.mm. | Colour index ... 0.8.
Hæmoglobin ... 50 per cent. | Leucocytes 4600 per c.mm.

The differential count showed—

Polynuclear neutrophils	24.6	Eosinophils	...	...	0.6
Lymphocytes	...	Mast cells	...	...	0.2
	74.6				

The case is evidently one of toxic jaundice followed by aplastic anæmia with purpura.¹³

The following is a summary of the conclusions to be drawn from these cases.

Four severe gastritis cases examined showed no blood changes of importance.

Toxic jaundice and anæmia appear to be separate and independent pathological states.

Anæmia may occur without jaundice and without liver necrosis.

About 17 per cent. of jaundice cases develop anæmia.

The incidence of toxic jaundice is probably overstated, both in medical certificates and in official reports.

In toxic jaundice the fragility of the red cells is altered as in ordinary obstructive or catarrhal jaundice.

A positive Wassermann reaction in a case of toxic jaundice is evidence of syphilitic infection.

Toxic jaundice proper is a long and serious illness, which may persist for nine months, leaving the patient less fit than formerly, and in all probability with a permanently damaged liver.

The jaundice is due to the action of the toxic substance upon the liver and not to hæmolytic.

The type of anæmia produced is that known as aplastic anæmia. It appears to follow destruction of the red marrow, and is to be differentiated from pernicious anæmia.

The latency of the blood changes may be even longer than the latency of the jaundice. The anæmia may develop so long as nine months after ceasing to work in T.N.T.

The anæmia is extremely fatal, and it is still doubtful if any cases recover from it.

The incidence of the anæmia among T.N.T. workers must be very small.

Purpura may develop with the anæmia and a case may first come under observation with hæmorrhage and a purpuric rash.

Finally, certain animal experiments were performed. Attempts were made to reproduce in animals the changes in the liver and other organs associated with jaundice and the blood changes found in human beings. The actual substance responsible for these changes and the mode by which it is introduced into the system is generally held to be trinitrotoluene itself, which is mainly absorbed through the skin. While Professor Benjamin Moore's work on this subject seems almost conclusive, it was felt that every possibility should be investigated in view of the importance of the subject, and bearing in mind the fact that the changes had not as yet been reproduced in animals by the administration of T.N.T. In these experiments T.N.T. was administered to rabbits through the skin by hypodermic inoculation, as also were D.N.B. and ammonium nitrate. Pure NO gas was administered to rabbits and white rats by inhalation over periods of time. It seemed possible that the spacing of the doses of T.N.T. might be of importance, that a considerable dose followed at the appropriate interval by a further dose might sensitise the animal and lead to poisoning, whereas similar daily doses might be tolerated. This point was investigated in these experiments.

The experimental work is not yet concluded, but it may be stated that the results are for the most part negative. Large doses, up to a gramme, of T.N.T. dissolved in toluol

can be given to rabbits without any serious effect. Injections of dinitrobenzol were similarly harmless. NO gas given to rabbits and white rats gave rise to cyanosis, drowsiness, and a yellow staining of the fur, but to no other ill-effects. If the percentage of NO gas in the fume-chamber was allowed to rise too high respiratory distress resulted, and in one or two instances dyspnoea remained for several days, but in no case was sufficient of the gas given to produce a fatal pulmonary complication. The animals, even with small quantities of the gas, showed cyanosis and gave a positive Haldane test in the blood. Neither jaundice nor anæmia was induced in any instance.

In the first part of this investigation I received considerable assistance from Dr. Jenkins Oliver and in the latter part from Dr. R. Paddock. My colleague, Dr. S. K. Vaidya, has helped me throughout, and in particular with the routine blood examinations. Physicians at various general hospitals in charge of these patients have freely placed their notes and cases at my disposal. Dr. Jacob, at Nottingham, and Dr. M. G. Thackrah and Dr. J. A. Barnes, in London, have taken much trouble in finding suitable cases for me. Mr. Minter, the works manager of a factory, greatly simplified the work done on his premises. I am particularly indebted to Dr. W. J. O'Donovan for his assistance and advice. All expenses incurred in connexion with the investigation have been defrayed by the Ministry of Munitions and a grant has been further provided by the Medical Research Committee.

WAR SURGERY IN SERBIA:

PENETRATING WOUNDS OF THE ABDOMEN.

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THE object of this paper is to make a plea for operation in all cases of perforated intestine due to bullet wounds. Not only does this apply to cases received in the first 16 hours, but also to those received up to 40 hours after injury, and, in fact, to all cases where condition of patient will allow operation.

The cases mentioned were treated by me at Lady Paget's Hospital at Uskub, Serbia, and consisted of Serbians, Macedonians, and Bulgarians wounded during the Serbian retreat in 1915. The hospital was housed in two blocks and three pavilions. The two blocks were newly built cadet schools and in every way up-to-date buildings. The largest number of cases in hospital at one time was 1040. The conditions for operation were as perfect as possible in any Balkan military hospital, fully trained British sisters being in charge of the wards with Austrian and, later, Serbian prisoners acting as orderlies. The patients were all healthy Balkan soldiers, whose resistant power was second to none.

The conditions in the Balkans are such that comparison with surgery on the Western front is not justifiable, and the best comparison is with the South African War. A review of the literature of the first and second Balkan wars shows what a deplorable state of affairs existed.

The only writers mentioning abdominal cases in those wars are Girault and Laurens. Girault passed the month of November, 1912, at Uskub, where our hospital was situated. He states that the wounds were of about eight days' duration when seen at the ambulance after a long transport. Of 120 cases discharged, taken haphazard, he had not one wounded abdomen. At the Serbian Military Hospital installed at the Grad (a hospital which last year was run on English lines by the Wimborne Unit (2nd) of the Serbian Relief Fund) several hundred wounded were under treatment. Girault saw there only one case of wound of the abdomen, and that not a penetrating one. Thus one concludes that every case of abdominal wound causing perforation died. Laurens, having passed 11 months in the Balkans, has made analogous observations.

Treatment.

Medical treatment.—The cases not having operative treatment were placed in the sitting Fowler position. Subcutaneous saline was given by Lane's apparatus, as much as six pints in 24 hours in some cases. Pituitary extract and camphor in oil were given. No food, not even fluid, given by mouth for first three days. For restlessness hyoscine 1/150 gr., morphia 1/6 gr., repeated when necessary. Distension is very difficult to treat in general peritonitis; enemata of all kinds were tried, and a flatus tube was used; eserine salicylate hypodermically was found of no appreciable value.

¹³ This patient has since died (June 19th, 1917), and was found post-mortem by Dr. Spilsbury to have, in addition to a scarred and shrunken liver, the marrow changes of aplastic anæmia.

Surgical treatment: 1. *Laparotomy.*—On admission all patients with lesions of intestine were stimulated, for all were in profound shock from exposure on battlefield and delayed transport. After the case had been stripped and put in warm clothing saline was introduced by Lane's apparatus; hyoscine 1/150 gr., morphia 1/6 gr., were also given. In half an hour open ether was administered by the drop method. Never did I allow chloroform in these cases. Anaesthesia was easily produced, owing to state of patient and preliminary scopolomorphine injection.

Incision was through either right or left rectus, or in mid-line according to site of entrance wound. First I sought for the ileo-caecal valve and systematically followed the small intestine backwards, bringing each coil out of abdomen for visual examination. Each perforation was sutured with silk by the Czerny-Lembert method. No irrigation of peritoneal cavity. Dry gauze mops and gauze plugging were used to absorb blood and purulent fluid. The exposed coil of intestine was protected by abdominal pads wrung out of hot saline. No clamps were used; an assistant held the perforation on the stretch for suturing. In some cases I put in cigarette drains into peritoneal cavity—one into pouch of Douglas and the other down to most affected coil. The cases that recovered had no drainage-tubes in peritoneal cavity, and I am more and more inclined from results to discard intraperitoneal drainage altogether, except where one has a definite localised abscess. The abdomen was closed in layers with small cigarette drain left down to peritoneum. The wounds always suppurated; this is due to *Bacillus coli*, and so a certain number of antibodies get formed and have a beneficial influence on the underlying general peritonitis.

After-treatment is similar to that described under medical treatment. Most important is subcutaneous saline; it is well to change site of injection from pectoral region to inner surface of thigh alternately. I have given up rectal saline in war hospitals as I find the subcutaneous method much more efficient, and I have not had an abscess or cellulitis at site of needle introduction. Most patients leave the table in better condition than on admission, and cases with no pulse to be felt at commencement of operation have gone to the ward with distinctly perceptible pulse after ether saline stimulation in spite of an extensive operation.

2. *Murphy's operation.*—Murphy, of Chicago, has described excellent results obtained in general peritonitis by this operation, which I practised on one occasion.

Patient wounded 36 hours previously; unsafe to move him into theatre; operation done in bed. About 4 c.c. of 1 per cent. solution of novocain were injected in mid-line suprapubically. Incision 2 inches long through parietes and peritoneum. A rubber tube was then passed down into base of pouch of Douglas. The wound was firmly closed round circumference of tube, where it passed through the parietes, as it is essential not to have any extra-abdominal pressure here. Patient died in 2½ hours.

The intra-abdominal pressure is supposed to cause a free exit of purulent fluid in these cases of general peritonitis. This case is only mentioned as a method of surgical treatment of very bad cases.

Cases.

I. Laparotomy cases of abdominal wounds which showed no perforation of intestine. (Cases 1 and 2; both recovered.)

II. Laparotomy cases (Nos. 3-12) with multiple perforations of intestines of over 30 hours' duration. 7 deaths, 3 recoveries.

CASE 3.—Soldier wounded 32 hours before admission. Entrance and exit wounds showed that bullet had crossed abdomen from right iliac region to left loin. Patient collapsed, pulse imperceptible; abdomen soft and tender in all areas. Laparotomy after half an hour's stimulation by subcutaneous saline. Quantity of blood in peritoneal cavity. Appendix had been amputated by bullet. Eight perforations of small intestine; mesentery punctured in four places. The perforations were sutured and abdomen closed. Death in 14 hours.

An interesting feature of this case was a round worm (*Ascaris lumbricoides*) protruding an inch through a perforation.

CASE 4.—Soldier wounded 39 hours before admission. Entrance wound in left hypochondriac region, exit in left loin. Pulse imperceptible. Abdomen generally tender; no rigidity detected. Laparotomy; five perforations of ileum; general peritonitis marked. Perforations sutured and abdomen closed. Death in 24 hours.

CASE 5.—Soldier wounded 37 hours before admission. Bullet track and condition of patient similar to Case 4. On opening abdomen four perforations of ileum seen. A round worm was seen free in peritoneal cavity, and another had 1 inch of its body protruding through a perforation. Death 60 hours after operation.

CASE 6.—Soldier wounded 34 hours before admission. Entrance and exit wounds showed bullet had crossed abdomen. After saline stimulation immediate laparotomy. Six perforations of small intestine detected. Death on second day after operation.

CASE 7.—Soldier wounded 39 hours before admission. Entrance wound only was seen in umbilical region. Laparotomy; three perforations of small intestine, one of mesentery. Death 60 hours after operation.

CASE 8.—Soldier wounded 35-37 hours before admission. Entrance wound in left lumbar region, exit in right loin. On opening abdomen six perforations of small intestine were detected. Death 14 hours after operation.

CASE 9.—Soldier wounded 32 hours before admission. Entrance wound in left lumbar region, exit to left of third lumbar vertebra. On opening abdomen five perforations of ileum were found. Death in 12 hours.

CASE 10.—Serbian soldier wounded 35 hours before admission by bullet at about 400 yards range. Entrance wound midway between pubes and umbilicus, exit in left loin. On admission patient in profound shock; had walked 12 kilometres and been conveyed 13 in Balkan carriage. Pulse imperceptible. Abdomen slightly distended; very slight tenderness on pressure, but no special area tender; recti not rigid. Laparotomy after preliminary stimulation for half an hour by saline subcutaneously. General peritonitis; four perforations in third foot of ileum (two double perforations about 5 inches apart). On manipulation contents began to escape. The perforations were rapidly sutured, peritoneal cavity closed, and small cigarette drain inserted in parietes. Uneventful recovery, except that parietal wound became septic. Three months later the patient, who had been taken prisoner in hospital by the Bulgarians, was sent to prisoners' compound.

CASE 11.—Soldier admitted 36 hours after wound. Bullet had crossed abdomen antero-posteriorly from left anterior lumbar region. Condition of patient similar to Case 10. Laparotomy; three perforations of small intestine. Perforations sutured and wound closed as in Case 10. Uneventful recovery, except that for three weeks T. was intermittent, as high as 104° at times. It gradually fell, and three months later patient was ready for discharge.

CASE 12.—Soldier admitted 34 hours after bullet wound of abdomen. range unknown. Entrance wound was a fine perforation situated on right linea semilunaris on line joining anterior superior spine and umbilicus; exit wound an inch to left of mid-line posteriorly. Abdomen slightly distended; definite tenderness over right iliac region. General condition of patient bad, but better than in Cases 10 and 11. Pulse felt, but 135 in rate. Complete paralysis of right leg. Laparotomy; two perforations of caecum in same plane; bullet had entered on anterior and passed out on inner surface. Some weak adhesions present in neighbourhood. The perforations were sutured. No perforations of small intestine discovered. Abdomen closed with tube to parietal peritoneum. Good recovery, although wound suppurated badly. Paralysis of right leg passed off, and 2½ months after operation patient was discharged for convalescence.

In all the above ten cases I believe death would have occurred had there been no interference. The pulse was perceptible on admission in only one case (No. 12). All had suffered from exposure on battle-field and in transport for over 30 hours.

III. Cases (Nos. 13-19) of over 30 hours' duration, due to a bullet wound, treated by abstention treatment. 7 cases, 7 deaths. These cases were consecutive, and were taken as a control to test the abstention treatment as compared with the laparotomy cases, also consecutive.

IV. Case (No. 20) of over 30 hours' duration, treated by Murphy's operation. One case; death in 2½ hours.

V. Two autopsies (Cases 21-22) to demonstrate death due to hæmorrhage.

CASE 21.—Wound received over 30 hours previously. Died in receiving-room in 10 minutes. Autopsy: Bullet had passed through right gastro-epiploic artery of stomach; abdomen filled with blood. Also perforation of stomach at point where artery had been severed. Undoubtedly had this case been operated on within 25 hours of receiving the wound, he would have lived.

VI. Three cases (Nos. 23-25) illustrating rigidity of recti due to injury of diaphragm; all recovered.

VII. One case (No. 26) of abdominal wound, cured spontaneously at home. In this case obviously the bullet had missed the intestine. It is mentioned as a case which the abstentionists would probably have classed as a cure.

Comments.

Out of several thousand wounded all cases of penetrating wounds of abdomen were sent to our hospital, so it is correct to state that all such cases not sent to us died on the battlefield.

Hæmorrhage is the most frequent cause of death in penetrating wounds of the abdomen in the first hours. Cases 21 and 22 are remarkable examples of hæmorrhage from larger vessels (gastro-epiploic and hæmorrhoidal veins) surviving 30 hours.

The round worm (*Ascaris lumbricoides*) was present in Cases 3 and 5. I have not been able to find any reference to such an occurrence. It is a question whether the worm in Case 5 escaped through the perforation during the operation. If it were in the peritoneal cavity immediately after the wound occurred it would constitute a method of spread of peritonitis. It could break down any weak adhesions during its exit, and also it could carry *Bacilli coli* and so inoculate distal parts of the peritoneum. This is pure conjecture, and the opinion of a helminthologist would be interesting. Most people in the Balkans suffer from these parasites, and the matter is therefore of importance.

Intermittent rigidity of the recti muscles is an important sign of an injured diaphragm (Cases 23, 24, and 25). In all, the wounds were such as to coincide with a wound of the diaphragm, and the question arose whether in addition there was any visceral lesion. The cases, seen soon after injury, exhibited an "intermittent rigidity" of both recti lasting

for several minutes, and then the recti would become flaccid for about an hour. This sign passed off after about 36 hours. It is not to be confounded with the rigidity of peritonitis.

Many cases of spontaneous recovery of penetrating wounds of the abdomen have not had a perforation of the intestine. A bullet can cross the abdomen without causing any material damage to the viscera (Cases 1 and 2). The correct treatment of penetrating wounds of the abdomen due to bullet wounds is immediate laparotomy after preliminary stimulation with saline. This treatment ought to be carried out in all cases and at all stages after injury, for recovery may result in the worst cases, even of over 30 hours' duration (Cases 10, 11, and 12). Operation can only be performed successfully in a favourable surgical locale, and each division ought to have a mobile ambulance where such cases can be treated without passing through the various other stations.

Note.—Since writing above I have had the pleasure of seeing the motor operating theatre to be presented to the Italian Army by the Wounded Allies Relief Committee. I was very pleased to hear from Sir William Collins, the designer, that another was being built for the Belgian Army.

SOME OBSERVATIONS ON TRENCH FEVER.

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MY attention was called insistently to the nature of this disease by having six bouts in two separate attacks of trench fever (hereafter called "T.F.") in May and August of 1916. I had seen some hundreds of cases previously. I observed at that time that it appeared to be infectious, four cases occurring in a single dug-out containing five men, and no cases occurring, so far as I can remember, among the remainder of the men belonging to a group of batteries at that time. Just before my first attack there were a number of cases of catarrhal influenza in the headquarters' mess to which I at first attributed my condition. I was, however, speedily disillusioned by the temperature chart (three days fever, three days no fever) and by the absence of catarrhal symptoms.

At this time, from previous experience, I was of opinion that 90 per cent. of cases of aches and pains in the back and lower limbs with temperature in officers were influenza and 10 per cent. trench fever, while among N.C.O.'s and men the converse ratio obtained. This, of course, was based on the rough provisional diagnosis which a battalion M.O. may well make after seeing a large number of cases. From a subsequent experience I am of opinion that many of the influenza cases were really T.F., while influenza did exist on the Western front. About a month after my first attack I had breathlessness and tachycardia on exertion. For instance, my pulse ran up to 240 after playing a set of tennis, exerting oneself as little as possible. True dilatation was not present and the cardiac condition appeared to both a specialist and myself to be purely nervous in origin. I succeeded, however, in assisting, in the French sense, at the battle of the Somme for two months, being fortunate enough to have the use of a motor cycle or a car for half this period. I became infected again with T.F., and as I found it impossible to walk 20 yards over rough ground without breathlessness I was evacuated to England.

On one matter I held from experience a very clear and firm opinion. With such a heart it is essential to walk slowly and without impedimenta, even a 10 lb. haversack rapidly causing distress, while as long as one walked slowly no ill-effects were felt.

On returning to the front in December, and joining a battalion about the middle of January, with which I remained two months, I observed five cases of T.F. (considering as such the various types otherwise described as X disease, P.U.O., &c.) which occurred in a single dug-out holding eight men, within 16 days, the sixth man having had it previously. Every case had a heart affected similarly to my own, but in less degree.

I suggested provisionally that T.F. should be considered as infectious, early notification, isolation, and, in view of the supposed association with lice, that energetic de-lousing methods should be proceeded with. Major Hurst's paper in the *Journal of the Royal Army Medical Corps* of February, 1916,

had not then been published, nor did I see this until the end of March. Owing to the exigencies of the military situation radical measures could not be proceeded with, and I found it necessary to keep a number of T.F. cases in a sick dug-out.

For the first month my records are not as complete as they might be, but on appointing a clerk who was both capable, reliable, and understood scientific and statistical methods, results were obtained which appear to be of some importance. At the end of the first month I found that 40 per cent. of my hospital evacuations were trench fever. We came across then in THE LANCET the record of a single experiment showing that a louse could transmit T.F., the incubation period being 14 or 15 days. Taking this as provisionally probable I set to work to get records of all the men with whom each case coming to me with T.F. symptoms had slept for a month previously. This, owing to battalion arrangements, and owing to the fact that cases grouped themselves markedly in platoons, was easier than was expected, and the evidence of unreliable men could frequently be checked by that of those more reliable.

On March 10th I reported that there was practically no sickness of any importance in the battalion from a military standpoint, with the exception of T.F. and a few cases of diarrhoea. T.F. had by this time so increased that it was now 66 per cent. of all cases (excluding eyes and teeth) coming sick to me.

Trench fever is stated to have been known to the Belgians before trenches formed an unhappy feature of the landscape; it was known to at least one doctor in Serbia in one of the Balkan wars—and, as far as I can discover, at that time was undiagnosed; it was recognised, as Major Hurst records, at Salonica, and known to Austrian troops in the Tyrol and to Germans on the Eastern front. With regard to the general diagnosis I agree with practically all of Major Hurst's conclusions. The essential point to remember, which I verified by subsequent observation in about a hundred cases, is that when a man comes complaining of aches and pains confined to the lower parts of the body, more particularly in the small of the back, and almost certainly down the legs, probably, but not necessarily, in the shins (deep in the bone), with a fairly high temperature at night, looking well, though flushed, with clear eyes, and probably with a tongue which I shall describe later, a history of sudden onset and of more acute pain in the night than in the morning, when trench fever is known to be in the battalion or unit—then the chances against this patient suffering from T.F. are remote in the extreme. As an instance I showed to my C.O. before making an examination a man with an exceptionally healthy appearance, a normal temperature, a smile as he described his agonies of the night before, and his pain in the back resembling the lumbago of unenthusiastic soldiers, and I pointed out how that man might easily be mistaken for a malingerer; but I stated also that he might quite well have a temperature of 103° at night, which actually occurred. The secret of the prophecy lay in the fact that he had a fast pulse, which differed from the malingerer's pulse by remaining fast when his attention was distracted from his ailments.

When I was leaving my battalion, Private Norman Graves, undeterred by either the enemy, or, what was worse, the cold, or, what was worse still, trench fever, with a temperature of 103°, carried the major portion of the work which follows almost to its conclusion.

About one quarter of the trench strength of the battalion suffered from T.F. within approximately two months; about one-half of these were studied carefully, exact records of each being taken in shorthand, and charts showing the time distribution, the platoon distribution, and the bedmate distribution were made, with, in addition, graphs of frequency. Among the companies in the line all had within 22 days practically the same number of cases, with the exception of one company with about 30 per cent. less. This company, curiously enough, differed from the rest in allowing men to sleep, not necessarily in the same groups (which in other companies remained more or less permanent), but more or less as they pleased. As, however, I cannot state to what extent this company had suffered previously owing to the deficiency in the earlier records, nor the extent of the constant redistribution of the men no accurate deduction can be drawn. I believe, however, that the company had suffered previously badly, and, in fact, worse than the others. When