October 14th.—On admission he looked and felt ill, and had haemorrhagic herpes of small extent. His throat was slightly infected, but there were no further signs of diphtheria. A further swab was taken, and found to be negative.

October 16th.—He became jaundiced for the first time, and his urine contained bile. The same day, the sixth after the onset of the disease, his general condition became much worse, and he was delirious. He remained delirious for three days, and also developed profuse epistaxis and melaena.

October 18th.—The general condition was worse; the patient was still bleeding from the nasopharynx and violently delirious, after an extremely restless night. The same afternoon he was given 10 c.cm. of anti-leptospiral serum.

October 19th.—On this date, after an illness of nine days, he was very much better; and, save for a slight recurrent epistaxis and the jaundice, all the symptoms had disappeared.

October 20th.—The patient was transferred to University College Hospital. On admission there was marked jaundice, but, although weak, he felt perfectly well again; there was no sign of haemorrhage anywhere. The liver was palpable, but not tender; the spleen was not palpable. On October 25th the urine contained a trace of albumin, occasional leucocytes and epithelial cells, and very occasional red cells and granular casts. The subsequent course showed progressive improvement without recrudescences, the jaundice fading in about a month, and the patient steadily gained in strength. A blood count had shown a moderate degree of secondary anaemia, presumably accounted for by the rather severe haemorrhages, but this rapidly disappeared with large doses of iron.

LABORATORY INVESTIGATION

October 19th.—Two guinea-pigs were scarified and inoculated with the patient's blood. Neither of these animals developed any signs of disease. This can probably be accounted for by the fact that it was necessary to transport the blood from Acton, and thus some time inevitably elapsed between the drawing of the blood and the inoculation.

October 26th and 31st.—The patient's serum gave a positive adhesion test to the human strain of leptospira. This was positive even in extreme dilutions.

October 26th, November 1st and 2nd.—On each of these three dates two guinea-pigs were inoculated with centrifuged urine deposits. In the centrifuged specimen on November 1st six motionless, apparently dead, leptospira were seen. In the specimen on November 2nd there were large numbers of apparently dead leptospira. Before the two latter specimens were collected the urine had been rendered alkaline by sodium bicarbonate and potassium citrate given by mouth, as the leptospira are said to retain their vitality better in an alkaline medium. After a period of nine days one of the guinea-pigs inoculated on November 2nd died, with all the signs of leptospiral jaundice, verified by post-mortem examination, and numerous living, actively motile, leptospira were seen on direct examination of the liver. From this source further inoculations were made, and the organism was grown in pure culture and proved to be a typical human strain of leptospira icterohaemorrhagica.

December 13th.—The urine was free from leptospira. Several specimens during the month of November had all contained the organism, which was identified by direct examination of centrifugized deposits.

The incubation period has been stated by Schuffner to vary between seven to thirteen days, so it is reasonable to suggest that the infection may have been due to the injury to the hand contracted a week before the onset. This is also suggested by the presence of slime on the old brickwork. Virulent leptospira have been discovered living saphrophytically in the slime on the walls of Scottish coal mines by Buchanan.

I am much indebted to Major H. C. Brown of the Wellcome Bureau, who very kindly carried out the pathological investigations, and to Dr. D. I. Thomas of the Acton Fever Hospital for the account of the progress of the case while under his care.

BIBLIOGRAPHY

- Brown and Davis: *Brit. Journ. Exper. Path.*, 1927, viii, 397.
Brown, H. C.: *British Medical Journal*, 1935, i, 411.
Buchanan: *Ibid.*, 1924, ii, 990.
Schuffner: *Trans. Roy. Soc. Trop. Med. and Hyg.*, 1934, xxviii, 7.

SEPTICAEMIA DUE TO BRUCELLA ABORTUS FOLLOWING OPERATION

BY

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Much interest has been apparent in the last few years in the occurrence of an increasing number of cases of undulant fever in this country. That this increase is a matter of fact and not surmise is shown by reference to recorded cases: whereas in 1928 these numbered five, in 1930 they were twenty-eight, and in 1932 no fewer than fifty-seven.¹ The case here recorded, besides possessing unique features, raises several points of great interest, and we feel that no apology is needed for presenting it in detail. For the sake of clarity it seems best to describe the events in sequence, and to reserve comment until afterwards.

Case Report

A married woman, who had not lived with her husband for some years, consulted one of us in November, 1933, complaining of "irregular and excessive periods." She stated that for the previous two months she had only had intervals of from three to five days without menstrual loss, that she felt rather weak and tired in consequence, and that she had occasional backache and a sense of weight and bearing down. She is a well-built woman, rather florid in complexion, and at that time was 35 years old and weighed a little under 10 st. The previous history contained nothing of importance. She had had three children in six years, the youngest being 7 years of age; the last two confinements she described as being rather slow and followed by prolonged bleeding, which kept her in bed for six or eight weeks. Menstruation had always been regular but rather excessive.

Examination confirmed a diagnosis of early prolapse, accompanied, and probably caused, by subinvolution, and expectant treatment with tonics, ergot, and tampons of glycerin and alum was persevered with for some weeks. Temporary improvement not being maintained, however, she was seen by Dr. J. W. A. Hunter of Manchester, who wrote confirming the diagnosis as follows:

The . . . vaginal walls are healthy but are definitely relaxed, and she has a fairly pronounced cystocele and a rather smaller rectocele. The cervix shows slight hypertrophy and is definitely lacerated and catarrhal, which would account for the long history of leucorrhoea. The uterus itself shows a fairly pronounced degree of subinvolution . . . she had a definitely prolonged puerperium after her last confinement and I think the subinvolution in all probability dates from this . . . there is some definite thickening in the left broad ligament between the ovary and the pelvic colon, probably as the result of a mild degree of infection from the colon. She suffers from some chronic left-sided pain, and this is accounted for by this condition. For treatment I would advise . . . a curettage to remove the thickened hypertrophied endometrium associated with the subinvolution in order to relieve her menorrhagia, a small amputation of the catarrhal cervix, and also an anterior and posterior colporrhaphy. . . .

Operation was performed as suggested by Dr. Hunter at the Buxton and District Hospital on June 13th, 1934, without incident, and recovery was rapid and uneventful until the eighth day, when the patient had a sudden haemorrhage. This was controlled by an injection of morphine, but recurred again at midnight the following night to a more alarming extent. As an injection of morphine failed to control the bleeding the vagina was packed with sterile gauze under light general anaesthesia, the pack being removed after fifteen hours. There was no further haemorrhage, but, as would be expected, there was a rise in temperature to 99.8°; this fell to normal the following morning.

ONSET OF SEVERE RIGORS

That afternoon, the eleventh after the operation, she had a smart rigor, which was repeated on the two succeeding days, the last being accompanied by a rise in temperature to 106.4° . Two injections of anti-streptococcal serum were given and a blood culture taken. As the serum seemed to have no effect non-specific immunization was attempted by injections into the buttock on alternate days of 10 c.cm. of whole blood (from her sister). This procedure had no apparent effect in reducing the temperature or controlling the rigors, so it was abandoned after four injections. During this phase, which lasted about a week, the patient, apart from the rigors, appeared quite comfortable, but the temperature remained at a fairly high level. The result of the blood culture, investigated by Dr. G. J. Griffiths, pathologist to the Devonshire Royal Hospital, showed a growth of a non-motile Gram-negative cocci-bacillus, fermenting glucose with gas production; subculture was negative. Agglutination tests with a large series of organisms proved positive to the *Brucella abortus* up to a titre of 1 in 640. (Note.—A positive test in blood serum from humans is not always proof of active infection. Many individuals have *Brucella* agglutinins in their blood from a past infection or from recent exposure to infective materials. As a rule a high agglutinin titre 1 in 500 or over is evidence of active infection.²)

The course of the disease now entered upon a more dramatic phase, with terrific changes in temperature and shattering rigors occurring daily, occasionally twice a day. Some of these were almost unbelievable in severity, the patient being quite convulsed and the whole bed shaking; during the later stages the rigors were accompanied by delirium and were followed by slight confusion. They lasted usually about three hours and in each case were followed by profuse sweating, but in the intervals the patient was composed and cheerful and complained of no discomfort whatever, taking nourishment well and sleeping normally. In comparison with the prostration which usually occurs after a "bout of malaria," the attacks were followed by surprisingly little exhaustion. Treatment for the time being consisted of excess of fluids, with occasional salines, glucose, and quinine, and large doses of iron (ferri et ammon. cit.), which were well tolerated.

During the course of the illness the patient had no fewer than fifty-nine rigors, the temperature recorded (in the mouth) reaching 105° or over on twelve occasions, 106° or over on five, and 107° or over on seven: the highest reading being 107.8° . Cyanosis and dyspnoea were marked features, occasionally necessitating the use of oxygen. About a month from the commencement of the fever the patient began to show signs of cardiac distress, and became profoundly anaemic. A blood count taken on July 22nd showed a red cell count well under two million per c.mm., and haemoglobin 36 per cent. The white count was also low, but showed a marked relative leucocytosis (91 per cent.). Blood transfusion was performed on July 23rd and repeated on August 2nd, in each case being followed by a distinct clinical improvement. There were ten rigors in the succeeding week, and the average daily swing in temperature was 7.5° ; after this the average height of the temperature subsided and the rigors became less intense.

The patient's condition, however, began to give rise to serious anxiety, dyspnoea and tachycardia persisting during the apyrexial intervals, albumin appearing in the urine, and oedema in both ankles. On August 27th another 400 c.cm. of blood was given by transfusion, and this seemed to mark the turning-point in the infection, there being only two more slight rigors, and within three days the temperature had returned to normal, where it remained, the pulse rate taking a few days longer to reach normal levels. The duration of the fever was ten weeks. A blood count a fortnight later showed red corpuscles 2,500,000 per c.mm. and haemoglobin 48 per cent. The blood serum tested against the *Brucella abortus* showed agglutination up to 1 in 160. (Note.—If the serum agglutination titre of an individual is found to be slowly decreasing as shown by a repetition of tests at intervals of thirty to sixty days, it is evidence of recovery from infection.²)

The patient was discharged from hospital sixteen and a half weeks after operation, free from symptoms, and weighing $8\frac{1}{2}$ st. A blood count showed red cells 4,180,000 per c.mm. and haemoglobin 68 per cent. Since discharge she has had

signs of subacute arthritis, but after the extraction of several teeth under general anaesthesia this has quite cleared up; the dental operation was unaccompanied by any form of reaction. She is now, after six months, quite well and strong, and weighs 10 st.; incidentally the symptoms for which she originally sought advice are cured!

Discussion

Infection by *Brucella abortus* in man resembles infection by the *Brucella melitensis*, but is generally supposed to be milder in type, though severe and fatal cases are not unknown. Hughes describes three types of melitensis infection (Malta fever), the common form lasting two or three months and characterized by irregular attacks of pyrexia, sweating, anaemia, and rheumatic pains, giving to the disease its name of undulant fever. He also describes a mild type and a malignant type, the latter associated with profound toxæmia and hyperpyrexia with death in a few days. Bassett Smith adds two further varieties: an ambulatory or carrier type, and an intermittent type causing severe illness characterized by hectic temperature, profuse sweating, and wasting.³ One is justified, we think, in dividing the case described above into two phases corresponding to Bassett Smith's ambulatory and intermittent types: a stage associated with a localized infection without constitutional reaction and of indefinite duration; and a septicaemic stage, the outstanding features of which were the hectic temperature and succession of rigors, and the absence of toxæmia, rheumatic pains, anorexia, and depression that are usually prominent symptoms.³

Dalrymple-Champneys,¹ describing the condition, states:

"It is almost certain that infection resulting in immunity can occur without recognizable clinical disease; there is a possibility that the majority of bovine strains in this country have a low pathogenicity for man. Finally there is the possibility that a lowering of the individual's resistance due to some other cause opens the door to infection."

These suppositions, particularly the last, are amply borne out in this instance, where a general dissemination and septicaemia superseded a localized infection as a result of the lowered resistance following operation.

In this connexion it is perhaps justifiable to assume that, since the exact time of operation and the time of the onset of symptoms indicating generalized infection are known, the incubation period of *Brucella abortus* infection in man is about eight to ten days. There is little or no evidence on this point, and opinions vary as to the incubation period of *B. melitensis* infection, some putting it at eight to ten days, others at fourteen to fifteen days, and in the laboratory it is found to be as low as five to six days.³ Huddleson² writes as follows: "The length of time between exposure and the first onset of symptoms in undulant fever may vary from seven to twenty days."

ORIGIN OF INFECTION

We have no direct proof as to the origin of infection in this case, but there can be little doubt that it was milk-borne. We have circumstantial evidence of an outbreak of epidemic abortion in the herd from which the milk supply was obtained, but as this was some years ago, and we have no knowledge of any recent tests, it is unlikely that it has any connexion with the case. A further difficulty arises since the patient for several months before her illness had worked at a place some miles from her home, necessitating a daily journey by train. The area of possible sources is thereby widened considerably, and we are not aware of any other cases where the diagnosis has been confirmed by which the field of search for a probable source of infection could be narrowed.

There is no positive evidence that *B. abortus* infection can cause abortion in women, but it must be regarded as a possibility. Reference to the literature suggests that the cause of abortion in cattle is a pathological change entirely confined to the placenta; and that the animals only abort once, which is unlikely were the uterus the seat of a chronic infection.³ In guinea-pigs examined after experimental *Brucella* infection "macroscopic lesions in the female genital organs are so rare that they are of no importance for routine diagnosis."²

Although a considerable number of post-mortem examinations have been made on fatal cases of undulant fever (presumably *melitensis* infection), few gross changes, with the exception of an enlarged spleen and superficial lymph glands, have been attributed directly to invasion of *Brucella*.² In the case under discussion there was no palpable enlargement of the spleen or lymph glands, and one may assume that the intermenstrual bleeding was the result of a chronic endometritis due to *B. abortus* infection. There is, of course, no means of proving this, and, as Dr. Hunter's letter (vide supra) points out very clearly, every symptom and sign could be accounted for by a diagnosis of subinvolution. On the other hand, the time factor, the rather sudden onset of symptoms, and the presence of a localized parametritis "probably as the result of a mild degree of infection from the colon," and lastly the onset of acute symptoms following trauma to the cervix and vaginal vault, support the former view. Until corroborative evidence is forthcoming one would hardly dogmatize on this point; it may be that in the textbooks of the future, among the many causes of menorrhagia will be numbered "infection by *Brucella abortus*."

One would like to think that blood transfusion had in this case been the means of conferring a passive immunity, but here again it is impossible to dogmatize. We are, however, satisfied that it saved the patient's life by supporting the failing circulation, on which the brunt of the effects of the infection fell. In spite of the usual assumption that "the treatment coincident with recovery gets all the credit," there is no doubt at all that, clinically, the improvement after each transfusion was very definite and out of all proportion to the change in the blood picture. The significant fall in the agglutination titre is also suggestive, and with the evidence afforded by the chart is in our view conclusive.

Summary

From a consideration of the case above recorded one is justified in assuming:

1. That infection by the *B. abortus* does occur without recognizable clinical symptoms and may remain latent for an indefinite period.
2. That the incubation period in acute infections is probably eight to ten days.
3. That the *B. abortus* may cause localized chronic inflammatory lesions in man.
4. That blood transfusion may be the means of conferring a non-specific passive immunity (complement) in septicæmic infection.

In conclusion, we should like to record our appreciation of the help of Dr. G. J. Griffiths, pathologist to the Devonshire Royal Hospital, to whose willing efforts the successful issue was largely due; and to thank Drs. J. W. A. Hunter and T. H. Oliver of Manchester for their interest and co-operation.

REFERENCES

- ¹ Dalrymple-Champneys, Sir W.: *Lancet*, 1934, i, 95.
- ² Huddleson, I. F.: *Brucella Infections in Animals and Man*, 1934.
- ³ Dalrymple-Champneys, Sir W.: *Undulant Fever*, Ministry of Health Reports on Public Health and Medical Subjects, No. 56, 1929.

WEIGHT-BEARING INSTRUMENTS FOR WALKING

BY

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In another paper¹ I have described an instrument which is designed to relieve one of the lower limbs of the strain of weight-bearing in standing and walking. The apparatus provides a saddle upon which the patient sits firmly whilst taking a step with his sound limb. It may be of some interest to contrast the apparatus with the well-known and widely used "calliper" splint, which is a modification of Thomas's knee appliance for walking.

Weight-bearing

The centre of gravity of the body in the erect position lies in the mid-sagittal plane or thereabouts. When a person with normal lower limbs stands with his weight evenly distributed on both he is in a state of stable

FIG. 1.

FIG. 2.

FIG. 1.—Diagram to show the distribution of the lines of force when the subject's weight is evenly distributed between the two lower limbs, as seen from behind. The centre of gravity of the body lies approximately in the mid-sagittal plane. The down-pointing arrow represents the resultant of the forces bearing downwards on the femoral heads, which are widely spaced and effectually prevent any rotation of the pelvis in the coronal plane. The muscles passing vertically from the ilium to the great trochanter are not called into play.

FIG. 2.—Diagram to show the lines of force when the subject stands on his left leg, as seen from behind. The body weight centres over the left foot. The head of the left femur supports the body weight, and acts as a fulcrum. The pelvis is prevented from rotating round this fulcrum by the contraction of muscles passing from the iliac wing to the great trochanter and fascia lata of the thigh. Note that the right side of the pelvis is held higher up than the left.

equilibrium in the coronal plane, and little muscular effort is necessary to preserve this state (Fig. 1). When he lifts his right leg from the ground he will fall to the same side unless, consciously or unconsciously, he alters his position so as to bring his centre of gravity over his left foot, and brings into play muscles which oppose the tendency of the pelvis to rotate round the head of the left femur in such a way that the right ilium falls and the left rises. It is well known that when a normal person stands on his left leg the right side of the pelvis rises higher than the left, and vice versa. This is brought about largely by the contraction of muscles passing more or less vertically between the wing of the ilium on the one hand and the great trochanter and fascia lata on the other, on the weight-bearing side (Fig. 2). The

¹ "A Saddle Appliance for Bearing the Body Weight," *Australian and New Zealand Journal of Surgery*, 1934, iii, 270.