to be identical with those cultivated by Staniwechevskaja. The organisms were Gram-positive, and gave a greyish film on agar and in gelatine, with a bluish tint by transmitted light. Subculture on agar from broth gave a growth which was quite unlike that of a *Staphylococcus aureus* or *albus*, and resembled that of *B. typhosus*. Gelatine began to liquefy in half the cases about the tenth day; in the remaining cases there was no liquefaction. The organisms fermented glycerine, galactose, maltose, laevulose, saccharose, mannite, dextrin, and lactose, but did not ferment sorbite, rhamnose, xylose, raffinose, arabinose, adonite, dulcitol, salicin, amygdalin, or inulin. They clotted litmus milk. Wilson also reported in one case the growth of an ovoid Gram-positive "diplobacillus," which behaved like the "diplococcal" organisms in every respect but that of fermenting glycerine and mannite. The agglutination of Wilson's organisms with typhus serum was in 13 cases five to twenty times that with normal serum. In 1913 Müller cultivated from the blood of 5 typhus patients "diplobacilli" and "diplococci," which he believes to be identical with the organisms described by M. Rabinowitsch in 1908 and by Fuerth and by Predjitschensky in 1893. The organisms were non-motile and appeared to be pleomorphic on subculture, cocco-bacillary forms being often seen. This appears to be the first record in the literature of the presence in typhus blood of pleomorphic organisms, with the exception of the large pleomorphic bacteria described by Fuerth and by Predjitschensky. In 1914 Gram-positive pleomorphic organisms were also recovered from typhus blood by Plötz, varying between 1 and 2 microns in length. There are in addition various other organisms, bacterial and quasi-protozoal, described by Gotschlich, Lewaschew, Thoinot and Calmette, and many others, and there is also a long list of observers who have failed to find in or cultivate from typhus blood organisms of any sort or description.

Perhaps the most striking fact brought out by a study of the literature is the large number of observers who have cultivated from the blood organisms of a diplococcal or diplobacillary nature.

Some of the observers quoted insist that the organism they describe is the *causa causans* of the disease. This is notably the case with the bacillus of Fuerth, restudied by Rabinowitsch, and again by Plötz. Analysis, however, of the evidence submitted is far from convincing, and the moderate view put forward by Wilson that both the *Diplococcus exanthematicus* and the diplobacillus are secondary organisms is one that appears to find more general acceptance. Moreover, as was shown by Hort and Ingram, the injection into monkeys of these large cocco-bacillary forms cultivated in citrated typhus blood consistently failed to produce a fever reaction. And there can be little doubt that, whether secondary invaders or not, they are not the primary cause of the disease. As a result of extensive observations in four different outbreaks of typhus in Ireland in 1914, Hort and Ingram found it difficult to believe that a theory of secondary invasion explains the frequency with which the organisms of Rabinowitsch, of Müller, of Fuerth, and of Plötz, organisms which appear to be identical, can be cultivated from typhus blood. They suggested therefore, as an alternative theory, that these organisms merely represent harmless phases in the life-history of organisms previously undescribed. This theory was based on the fact that they were able to demonstrate in, and cultivate from, fresh typhus blood, urine, and cerebro-spinal fluid a minute filter-passing organism which was proved to be infective to monkeys, from which the organism could be again recovered. This infective organism, both in film preparations of the fresh urine and cerebro-spinal fluid as well as in primary cultures in human blood, showed the same tendency to pleomorphism as the larger non infective forms. And there was some evidence that smaller forms still are present in the blood, urine, and cerebro-spinal fluid, but outside the range of vision, and that these smaller forms do not persist as such in artificial cultures. These results require repetition and confirmation by other observers, but there is little doubt but that a good case has been established for thorough investigation of the etiological claims of the organism in question.

PROGNOSIS.

Attacks of the disease vary greatly in their severity in different epidemics. In Brill's disease, believed to be a

modified form of typhus, the death-rate is usually low. In severe epidemics the dominant factor as regards a fatal issue in previously healthy subjects is age. The very young and the very old frequently escape with a light attack, even in severe epidemics. Robust adults between the age of 30 and 70 are said by those who see most of the disease to suffer severely, and to give the largest number of fatalities. In individuals exhausted by privation, exposure, fatigue, or disease, as in epidemics of war, the outlook is grave. Cases with early delirium, or stupor without delirium, do badly, as a rule. Sir John Moore gives the following prognostic data as unfavourable: A presentiment of death; soft, rapid, and compressible pulse in adults; feeble first sound; hurried respiration, not accounted for by pulmonary lesions; insomnia and delirium, complete coma-vigil and pin-hole pupils, extreme prostration, convulsions, muscular tremors and hiccough, early paresis of sphincters, tympanites, cyanosis, abundant and dark rash, persistent high fever, early profuse sweating, haemorrhagic manifestations.

In no grave disease is recovery so rapid or so complete as it may be after an attack of typhus.

TREATMENT.

The general treatment of typhus is that of any acute infective disease, and should be carried out whenever possible on open-air lines, due regard being paid to the avoidance of exposure.

Owing to the fact that previous to 1914 no satisfactory evidence was available as to the nature of the causative agent of the disease, specific treatment by vaccines or by antisera has not been possible for typhus. It is, however, not unreasonable to hope that confirmation of the etiological relationship to typhus of the organism described by Hort and Ingram will lead to the establishment of efficient protective, and possibly curative, methods of specific treatment.

[By permission of the Editor translations of this paper into French, Russian, and Serbian are being sent by the British Red Cross Society to Serbia and Russia.]

EPIDEMIC CEREBRO-SPINAL FEVER.

A NOTE ON PLEOMORPHISM OF THE RESPONSIBLE MICRO-ORGANISM.

BY FLEET-SURGEON E. A. SHAW, R.N., M.D. CANTAB.

IN connexion with the hypothesis as to the above put forward by Drs. Hort, Lakin, and Benians in the BRITISH MEDICAL JOURNAL for March 27th, I would like to contribute a few bacteriological notes on a case from a small epidemic I have been recently investigating, which appears both to support and to be explained by their hypothesis.

M. H., a youth of 18, became sick on March 14th with what appeared to be "rubella," but after twenty-four hours in an observation ward, had become so clinically pronounced a case of cerebro-spinal fever as to cause his prompt removal to the ward set apart for this disease.

On March 16th a throat swab was plated on nasagar, and cerebro-spinal fluid was drawn off aseptically, from which ascitic broth, nasagar slopes, and Petri dishes were inoculated. This fluid was decidedly turbid, and microscopically showed marked leucocytosis, but no micro-organisms of any sort.

On March 18th, after forty-eight hours' incubation at 37°, all the slopes, Petri dishes, and broth were sterile; there had been no growth at all. Lumbar puncture was repeated, turbid cerebro-spinal fluid was obtained under pressure. The case was now clinically as complete a case of cerebro-spinal fever as could be imagined; every sign and symptom was present, the only thing lacking was the bacteriological confirmation of the diagnosis. The same inoculation of slopes, etc., was repeated. Microscopically, this fresh specimen of cerebro-spinal fluid showed again marked leucocytosis, but again absolutely no micro-organisms.

On March 20th there was again no growth; everything was sterile. Lumbar puncture was repeated, and again decidedly turbid cerebro-spinal fluid was obtained. Nasagar slopes and plates were inoculated, and this time 1 c.cm. of cerebro-spinal fluid was added to each of two 10 c.cm. ascitic 2 per cent. glucose litmus broth tubes. Yet again, microscopically, leucocytosis was seen, but no micro-organisms.

On March 21st there was again no growth, and everything was returned to incubator: 8 c.cm. of blood were taken aseptically from the median cephalic vein, added to 50 c.cm. of ascitic broth, and incubated. I did not expect much from this, for the blood of previous cases had very rarely yielded the meningococcus of Weichselbaum.

On March 22nd there was no growth on the slopes or plates of March 20th; the ascitic glucose litmus broth contained a few

Gram-negative diplococci in each loopful examined. Subcultures were made from these broth tubes. The blood broth appeared to be sterile. Lumbar puncture was repeated and further inoculations made. Microscopically the cerebro-spinal fluid showed no micro-organisms.

On March 24th the subinoculations from the two ascitic glucose litmus broth tubes of March 20th, which on March 22nd contained Gram-negative diplococci, had not grown; presumably the broth growth had died or metamorphosed before the subinoculations were made. The nasagar plates inoculated from fresh cerebro-spinal fluid on March 20th showed a typical growth, afterwards verified, of the meningococcus of Weichselbaum, and microscopically films from the blood broth of March 21st showed a Gram-negative diplococcus. Subcultures from this blood broth were made.

On March 26th the subcultures from the blood broth of March 21st only showed eleven very minute colonies on the two slopes, and were returned to the incubator, and fresh subcultures made from the blood broth of March 21st.

On March 27th the eleven minute colonies of the previous day had scarcely increased in size at all, but the slopes freshly inoculated from the blood sown in ascitic broth, which had then had five days' incubation, showed a thin, apparently homogeneous, greyish translucent film of growth, which, examined with a pocket lens, appeared punctate, and, with a low power of the microscope, as myriads of small colonies, some round, some oval, and all of fairly regular outline, moist and coalescing when touched by platinum wire, and emulsifying very readily. Slide films prepared from these, stained by Gram and counter-stained with Bismarck brown, were very surprising, for I fully expected the usual Gram-negative diplococci alone, instead of which I found micrococci singly, in pairs, and some in tetrads; some of the pairs were typical-looking diplococci, others were pairs simply by juxtaposition. There were other somewhat larger cocci with a tendency to staphylyl grouping, and there were small bacilli and larger bacilli up to the size of a typhoid bacillus; some of each, both cocci and bacilli, were Gram-positive and others Gram-negative; in fact, every form was present described in the conjoint paper referred to as found in a single colony obtained from the urine, except Gram-positive diplococci.

In addition to these forms, there were others intermediate between cocci and bacilli, of the type spoken of by the French school as *cocco-bacille*, and also "club" forms, the largest of all, the enlarged end of which took Gram stain most deeply.

This composite picture made me suspect my Gram stain, which I at once tested on recent cultures of *Staphylococcus pyogenes aureus* and *B. typhosus*, only to find it was quite right. The "club" forms made one think of involution forms, but this growth was only twenty-four hours old.

A subculture made from this slope on to another that day, and examined the next showed very similar features, but many fewer "club" forms. A film was stained with heated carbol-fuchsin, decolorized with 30 per cent. sulphuric acid, counter-stained with methylene blue, and examined for acid-fast forms, but none were found; the bulbous ends of the "club" forms took the counter-stain very deeply indeed. Further investigation is proceeding.

The possibility indicated by the preliminary note of Drs. Hort, Lakin, and Benians, that in cerebro-spinal fever we have to deal with a causative organism which is not only polymorphic, but in some phases ultramicroscopic and capable of passing the filter, would explain the earlier fruitless efforts in this case, and the later microscopical appearances of the growth ultimately isolated, which I have found only in this one case, but it means a vastly increased burden for the bacteriologist.

It is pleasant to be able to add, in conclusion, that the patient in this case is now convalescent, with a most healthy appetite.

ACUTE INVERSION OF THE UTERUS FOLLOWING LABOUR ON TWO OCCASIONS.

By N. STUART CARRUTHERS, M.R.C.S.ENG.,
L.R.C.P.LOND.,

LATE ASSISTANT HOUSE SURGEON, GUY'S HOSPITAL, LONDON; LATE
CLINICAL ASSISTANT, CHELSEA HOSPITAL FOR WOMEN.

INVERSION of the uterus is one of the rarest complications of labour. Statistics show that it is only met with in from 1 in 180,000 to 1 in 200,000 confinements. As I have seen two instances in the same woman at consecutive labours the circumstances are, perhaps, worth recording.

In textbooks of midwifery three degrees of inversion are described: The first, in which the fundus is depressed, and bulges into the interior of the uterus; the second, in which the fundus protrudes through the external os, and is felt in the vagina; and the third, in which the entire uterus and vagina protrude through the vulva. In the

following case the inversion was of the third degree at the first confinement, and of the second degree at the second.

On February 12th, 1913, I was called in to see a healthy woman, aged 26, who had passed through one previous and perfectly natural confinement. Her pregnancy on the present occasion was normal, complicated by nothing worse than morning sickness. Violent labour pains, I noted, came on every four or five minutes; the presentation was left occipito-anterior and the os was rather more than half way dilated. As the patient was in great pain, crying out for relief, I gave her a hypodermic injection of morphine sulphate and hyoscin hydrobromide. The pain ceased and the uterine contractions were reduced to three or four in the hour, labour progressed slowly, and the patient remained semi-conscious throughout the day. Towards night the uterus contracted only at long intervals, and as the os was fully dilated I delivered with the forceps just twenty-two hours after the commencement of labour, without difficulty. Massage was then applied to the uterus, which could be felt to contract at intervals of ten to fifteen minutes. With each contraction a small indentation could be felt on the highest part of the fundus, somewhat anteriorly. It gradually increased, until it seemed deep enough to lodge a small egg. At this stage the patient moved vigorously about as if in great pain, and much bright red blood escaped from the vagina. Almost immediately the placenta was expelled through the vagina, but on endeavouring to remove it, I found that something more was protruding. On placing a hand on the abdomen no fundus could be felt, and the diagnosis became obvious. The patient was now extremely pale, with a small, thready pulse, only just palpable at the wrist. Her skin was clammy and cold, especially in the extremities. With a little difficulty the firmly adherent placenta was detached from the womb. The area of adhesion, about an inch and a half in diameter, corresponded to that part of the fundus where the dimple had been felt. The bleeding from the denuded surface consisted only of a general oozing, except at a few points, where some vessels spurting feebly.

The fundus was taken in the palm of the right hand, pressure was made upwards, and the vaginal displacement reduced. The hand was then passed through the vulva, the fist closed, and the inversion gradually undone by pressing the knuckles against the inverted fundus. Ergotinine citrate gr. $\frac{3}{4}$ and strychnine gr. $\frac{1}{4}$ were injected into the gluteal muscles. Vigorous rubbing was applied to the limbs and massage to the uterus. A hot intrauterine lysol douche was also given, and by these means contractions of the womb were induced. As the woman's condition was extremely critical, it was decided to infuse at once. I inserted a cannula into the axilla through the pectoral muscles; it was connected to a large funnel by a short length of tubing. In this way a pint and a half of saline was given. I had not a proper infusion apparatus with me, and the patient lived in a country cottage many miles from my surgery, so that this contrivance was the best that could be arranged in the circumstances. In spite of the fact that the saline was made from warm water which had not been boiled and salt out of the family salt-cellar, and the apparatus unsterilized, no sepsis occurred.

For several days the patient was in a very grave condition, and the uterus was exceedingly tender when touched. The temperature did not rise above 100° F., neither was the lochia excessive nor offensive in smell.

On the twelfth day a large vein in the left leg near the knee became thrombosed, but by the end of seven weeks the patient was able to be moved to a couch. Nine days after the confinement the womb was still rather large, but otherwise there was nothing to suggest that such a serious disaster had happened.

Complete inversion might, no doubt, have been prevented had the exact significance of the depression been grasped and the placenta promptly removed, but the third stage of inversion followed so rapidly upon the first that it had taken place before such a possibility was suspected. On the next occasion complete inversion was successfully arrested by early removal of the placenta.

On July 8th, 1914, I was again called to attend the same patient. Labour was normal and the pains strong and frequent. Nothing was given to allay her suffering, and in due course the child was born. During the third stage of labour the uterine contractions continued to be strong. After five or six pains a depression appeared in precisely the same situation as at the last labour, and with each pain became larger, so that even between them it could be distinctly felt by laying the hand flat on the fundus. Only the most gentle massage had been applied during this stage of labour. As the inversion was getting much more advanced, and the placenta showed no sign of separating, I thought it wise to remove it manually. On passing the hand into the vagina the greater part of the placenta was felt to be already detached, but one portion was firmly adherent and had pulled the fundus into the body of the uterus and past the external os. The placenta was detached and the inversion pushed out again. Recovery was uneventful. At the present time the woman enjoys good health and both children are alive and healthy.

It is interesting to speculate as to the cause of the inversion in this woman. According to Eden's *Manual of*