covered with old blankets and is weighted down with stones. Hooks and wires, on which to hang clothing, etc., are secured to the under surface.

Attention is particularly directed to the fifth kerosene oil drum which is situated outside the dugout and acts as the feeding drum for the other drums, by means of syphon action. This avoids the necessity of opening the steam box and so losing steam when adding water to the drums.

When a unit came out of the line, all the bedding and clothing was disinfected as a routine measure and in practice it was found easy to thoroughly disinfect the entire bedding and clothing of a platoon in one such disinfector in a day. Lice and nits were destroyed in twenty minutes, but forty minutes were usually allowed for the complete disinfection of any article. A disinfector of the size depicted could take twenty-five blankets or eighty shirts at one time.

Lecture.

ENCEPHALITIS LETHARGICA.[1]

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Early in the year 1918 an epidemic disease, characterized by unusual symptoms, appeared in the British Isles; these symptoms were so extraordinary that the attention of medical men and laity alike was engaged at once. When the frequently fatal issue and the complete failure of therapeutic measures became known, the interest in the disease, although increased, became less academic and more personal until it became evident that the contagiosity of the disease was very low, if, indeed, the disease could be regarded as contagious at all. Since then few diseases have received so much attention from medical and lay writers, and an enormous literature has sprung up, mostly dealing with one aspect of the disease, clinical, epidemological or pathological, but to a large extent dealing with the few or many cases observed by the authors.

The occurrence of several cases of this disease in the Rhine Forces, and the interest which they have aroused among the medical officers, is the reason for this paper, in which I am attempting to condense some of the recent literature.

History.

The present epidemic apparently originated in Austria early in 1917, and was described by Economo; shortly afterwards cases were noted in France, then in England and Australia. The first accounts of the disease in British literature appeared in the *Lancet* of April 20, 1918; then the disease was thought to be botulism, a general infection due to eating of food containing the *Bacillus botulismus*, or its toxins. This theory was shortly disproved, and as no known pathological agent could be discovered, it was thought that a new disease had appeared and many names were coined to fit the condition. By this time, however, the

[1] A lecture delivered to the medical officers of the Rhine Forces, March, 1920.

disease is generally known to medical men of all countries as encephalitis lethargica or epidemic encephalitis, and time is too short to enter into discussion of the suitability of the various names proposed.

Presumably influenced by the saying, "there is nothing new under the sun," search was made in the medical writings of the past, and it became obvious that the disease was far from new. Some of the older practitioners remembered that after the influenza pandemic of 1890, there appeared in Northern Italy and Dalmatia a new disease which was then known as nona, and its possible advent into France was regarded with fear: this disease was characterized by fever, somnolence, tremors and various paralyses, and without doubt was the disease under consideration. A Commission was formed to investigate the conditions, but it did not reach the locality until all the cases had died or recovered [1].

In 1712 Camerarius described an epidemic with similar symptoms at Tubingen and called it Schlafkrankheit. Towards the end of the 16th century Sydenham describes a fever accompanied by somnolence, and lasting several weeks. About the same time Albrecht of Hildesheim describes a case of febrile lethargy resulting in strabismus of both eyes. From this period to that of the ancients is a gap in the history. Galen wrote of the lethargy, and noted the persistence of mentality despite the apparent comatose condition of the patient. Celsus has a chapter on lethargy, but certainly also applied the term to what we would now call the typhoid state. Hippocrates describes the fever, tremors and somnolence, and even pointed out a method of treatment at present employed, for he observed that when an abscess developed the patient frequently recovered. (*v.* Note A.)

Thus the disease has long been known, but how are we to fill the gap in the history? Centuries may elapse without notice of cases. Either the disease is one which from time to time breaks out *de novo*, or it is one of the pandemic diseases with a long and variable epidemic periodicity, such as plague or cholera. The former conception is hardly justifiable, and the latter needs qualification, for an endemic focus is known for plague and cholera, whereas none is known for encephalitis, and it is hardly likely that so extraordinary a disease could exist and not attract notice. It therefore follows that the virus must exist in a non-virulent phase as a saprophyte, just as the meningococcus does, and like it, from time to time, acquires virulence and becomes pathogenic. If this conception be correct we should expect to find cases with greater frequency in the inter-epidemic interval, such cases being of a milder type than that of the epidemics. As the literature is more closely searched many of these cases should appear, and already several have been reported—thus Kinnier Wilson describes one case in 1907, and Walsh another in 1913 [2]. A third case is described in 1875 [3].

Ætiology.

Much work has been done to discover the pathogenic agent, and many theories as to its nature have already been made and disproved, many of these will be considered under the heading of differential diagnosis, and will be briefly noticed at present.

At the outset the disease was thought to be botulism, and many other types of food poisoning were considered as possible factors—thus solanin poisoning, from changes occurring in badly stored potatoes; that it might be due to the

benzine employed in the manufacture of oleomargarine; [4] that it might be a deficiency disease, somewhat of the nature of beri-beri or pellagra, conditioned by a war diet; however, the disease also appeared in countries where food was abundant and of good quality, as in Queensland and the United States, and some of the theories were no longer tenable. A favourite theory for some time that the disease was merely an unusual type of Heine-Medin's disease, or poliomyelitis, was introduced by Crookshank [5] and supported by Osler and others. The possibility of the disease being of influenzal origin, especially in view of its appearance amongst the epidemics of influenza, was very soon considered, especially by the laity; this belief was strengthened when the epidemic of nona, after the 1890 influenza was remembered. That the disease is distinct from influenza cannot be doubted, for the symptomatology as well as the histological findings are quite distinct. But, though the exciting cause of encephalitis is not that of influenza, yet it is possible that the general reduction of the health of the community occasioned by the previous epidemics of influenza, was one of the predisposing causes.

As pathological investigation proceeded speculation diminished, for it was quickly realized that a definite infection was present. In 1917 von Wiesner investigated a series of Economo's cases, and claimed to have cultivated a Gram-positive diplococcus from the tissues of a monkey inoculated with brain from a case of encephalitis; this diplococcus reproduced the disease in other monkeys.

Other investigations failed to confirm this result [6].

In February, 1919, Bradford, Bashford, and Wilson described the presence of a filterable virus in encephalitis and some other diseases; they showed that the disease could be transmitted to monkeys by the injection of brain and other tissues. Also they claimed to be able to culture the virus by the Noguchi method [7].

Morse and Crump, 1920, isolated an organism which appeared to be a staphylococcus from six consecutive cases of the disease; it was culturable, and cultures injected into rabbits reproduced the disease; filtered cultures were also lethal, but this they regarded as being due to extracellular toxin [8].

McIntosh and Turnbull, in 1920, confirmed the presence of a filterable virus and transmitted the disease to monkeys [9].

Levaditi and Harvier conveyed the infection to animals by intraocular injection and by scarification of the nasal mucosa. They also showed that animals immune to poliomyelitis were not immune to encephalitis and vice versa [10].

Strauss, Loewe and Hirshfield have also cultured the virus by the Noguchi method, and demonstrated that it was a filter passer, also that though it is somewhat like the virus of poliomyelitis yet there are distinguishing features [11].

Maggiora, Mantovani and Tombolata are reported to have isolated from broth cultures of blood a small Gram-positive diplococcus, which was agglutinated by the serum of patients and convalescents up to dilutions of 1 in 100 [12].

It is thus seen that the investigations have led to some confusion, but some of this may be due to the employment of varying methods, for in the investigation of poliomyelitis Rosenow and Wheeler found a pleomorphic coccus in the brain and other tissues; this when cultured aerobically appeared as a diplococcus, but in anaerobic culture it became much smaller, was filterable and resembled the Flexner bodies noted in the tissues of poliomyelitis [13].

Quite recently de Fano [14] has described the presence of minute intracellular bodies in the nerve cells of the brain and the epithelial cells of the salivary glands. These appear to be minute coccoid bodies surrounded by a clear area somewhat resembling a capsule, but possibly due to hyaline degeneration of the protoplasm brought about by diffusion of toxin (Note B). We may therefore conclude that the disease is caused by a specific virus, probably filterable or with a filterable phase. Marinesco [15] is of opinion that this virus obtains entry into the body from the throat or nasopharynx, from whence it is conveyed to the brain via the lymphatics. As to the contagiosity of the disease there is very little real knowledge: though most of the recorded cases have been treated in the wards of general hospitals I have not heard of other patients in the same wards acquiring the disease. Netter says that contagion is rarely evident even where every opportunity for infection is present. He attributes this to the lethargy itself, and points out that a patient who is lethargic does not cough or talk, and it is the spray of infected mucus which accompanies these actions, which is the chief source of infection [16]. Flexner, however, suggests that it is the abortive and ambulant cases which spread the infection [17] (v. Note C).

Age and sex appear to have no influence on immunity or infectability; the sexes are equally affected and no age appears to be immune—infants, children, adults and the aged may all acquire the disease.

Seasonal Influence.

The disease is more frequent during the winter months, another difference from poliomyelitis, which is a summer disease.

Morbid Anatomy.

With the exception of the recent findings of de Fano there is general agreement as to the histological findings.

The central nervous system being excluded, there is little or nothing to be found peculiar to the disease: the changes in heart, lungs and other viscera, noted up to the present, are those usually met with in death from secondary infective processes—of which the most frequent are broncho-pneumonia and bed sores.

Brain may or may not show some apparent shrinkage with increase of fluid in the cisternæ. The dura mater shows no obvious changes: the pia-arachnoid is congested, and milky areas, due to infiltration of round cells, and small hæmorrhages, are frequently noted. On section, beyond congestion and the variable presence of small hæmorrhages, there is nothing noteworthy in the macroscopic examination. However, on microscopic examination definite changes are revealed and are most prominent in that part of the brain which produced the localizing symptoms: these changes are not present to the same degree in any other disease.

The lesions found are as follows:—

(i) Infiltration of the walls of the small arteries and veins with small round cells, chiefly lymphocytes and plasma cells: a few neutrophil cells and also eosinophil cells were noted by Marinesco and Draper—but McIntosh noted no neutrophil cells. The endothelium and fibroblasts may take part in the process. A hyaline degeneration (immediately external to the endothelium)

probably a later stage, was noted by Bashford and is present in the sections demonstrated [18].

(ii) There are also foci of interstitial inflammation—small accumulations of cells of a lymphoid type and occasional polymorphonuclear cells, and increase of the neuroglial cells.

(iii) The lesions of the nerve cells consist of dissolution of the Nissl bodies, more or less pronounced: reduction in size of the cellular body, and the number of processes with eccentricity of the nucleus, or even disappearance of the nucleus and vacuolation of the cytoplasm. The intracellular inclusions noted by de Fano are mentioned in the section dealing with ætiology.

(iv) Foci of hæmorrhage around the small vessels: the older hæmorrhages being represented by masses of fibrin and pigment.

Certain differences between the findings of encephalitis and other diseases may be dealt with here. In poliomyelitis the ganglion cells are much more markedly affected, many have disappeared and their places are occupied by phagocytes—whereas neuronophagia, though noted by Marinesco and McIntosh [19], is observed rarely in encephalitis. The perivascular infiltration consists of more polymorphonuclear cells and fewer plasma cells. The lesions of poliomyelitis are usually much more marked in the spinal cord. However, Mott, Marinesco and Draper are in agreement that the differences between the lesions of encephalitis and especially the ponto-bulbar form of poliomyelitis are more of degree than kind. In *botulism* there is no inflammatory reaction around the small vessels and no hæmorrhages—the lesion is more of the nature of a degeneration of the nerve cell itself. In influenzal encephalitis the perivascular infiltration is wanting, and the most marked change is the presence of hæmorrhages—presumably due to a lesion of the vascular endothelium.

Symptoms.

The *incubation period* is not definitely known, but is probably variable like that of poliomyelitis. Experimentally, in monkeys, the incubation period was found to be eleven to thirteen days (Bashford) [20], and thirteen to forty-six days (McIntosh) [21]. The whole brain or any part of it may be invaded by the virus; moreover, in any affected nerve cell the virus or its toxins may lead to irritation, with increase of function and one set of symptoms, or cell death with cessation of function and a different set of symptoms. In any given centre for a definite nervous action, that is in any specialized nerve cell group, both sets of symptoms may be combined. It is thus seen that the symptomatology of encephalitis lethargica will not be simple, and the probability of finding even two cases exactly alike is very small—for the symptoms of any described nervous disease may be present. As a result many clinical types have been described, and names, chiefly indicative of the presenting symptom, have been applied to these so-called types, leading to some confusion, for it has been frequently observed that the type did not remain true throughout the illness. Walshe [22] therefore, advised that such a symptomatic classification should no longer be employed and suggested a classification on the lines which will be followed in this paper.

It is usual to recognize a prodromal period or stage of invasion, a stage of the declared disease and a stage of regression; these stages certainly exist and can be appreciated in any given case—but as there is no symptom of the stage of invasion

which may not also be present in the stage of the declared disease in a different case further attention will not be recorded here.

Symptoms may be discussed as follows:—

(1) General symptoms and signs probably due to the general infection.

(2) Nervous symptoms—due to local action of the virus on the central nervous system.

(1) *General Symptoms.*

Fever is usually present at some stage of the disease. It is irregular as to degree and type—usually irregularly remittent or intermittent; a constant type of pyrexia for a few days may occur. The fever is probably the first sign of the disease, and may occur some days before symptoms of a diagnostic character appear. The onset of a remission or a relapse is usually accompanied by return of the pyrexia. Shivering may accompany the fever. Later in the course of the disease a fever of the hectic type may develop, due to the presence of secondary infections.

The *pulse* rate is proportional to the height of the pyrexia—and is not increased or slowed in the apyretic periods. In the later stages of some cases rapidity or slowing may occur, and death from "asystole" is not uncommon. The presence of the normal pulse-temperature ratio is a point of some importance—for in tubercular meningitis characteristic alterations are found—undue rapidity and irregularity of the pulse.

Catarrhal Affections.—An early conjunctivitis is frequently present, and occurred in all the cases of any severity which I have seen. Later in the disease, conjunctivitis may reappear and is then probably due to loss of the blinking reflex. Slight pharyngitis—due to mouth breathing is frequently noted. Boveri [25] insists on the absence of bronchitis in the early stages, and points out that this differentiates the condition from the encephalitis of influenza, where an initial bronchitis is frequent.

Headache.—Whether or no the frequency is as great, at any rate complaint of headache is more frequently made in the early stages. It is at times one of the presenting symptoms. Where the lethargy is pronounced patients rarely complain of headache except to a leading question. General aches and pains are a feature of the early stages of the disease; more frequently still there is malaise.

Gastro-intestinal symptoms are frequently noted, but there is nothing characteristic of the disease noteworthy. Nausea, vomiting, and anorexia are often present, but these do not persist. Diarrhœa or constipation are frequently met with—often alternating. The mouth is generally dry and the tongue heavily coated, unless salivation is abnormally active.

Circulatory disturbances are noted with some frequency, but only in the later stage where there is local action on the cardiac centres or toxin action on the heart muscle itself.

(To be continued.)