

evacuated. Patton, in the case of his own son, aspirated on the twelfth day, removing twelve fluidrachms of blood. Result was good and Patton recommends it highly. For the external varieties, warm aromatic fomentations, cold spirit lotions, pressure, and setons have all had their day. As treatment in intracranial cephalocele has not yet been attempted; as the internal is almost always associated with the external variety, the latter being situated directly over the former, in the writer's opinion it would be advisable to trephine the skull to evacuate the tumor.

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CEPHALOCELE. See Brain.

CEPHALOMETRY; CRANIOMETRY. See Skull.

CEREBELLUM. See Brain.

CEREBRO-SPINAL INJURIES. (MEDICO-LEGAL.)
See Traumatic Affections. (Medico-Legal.)

CEREBRO-SPINAL MENINGITIS, EPIDEMIC.—DEFINITION.—Cerebro-spinal meningitis (*μηνιτις*, a membrane) is an acute infectious disease, with its main local expression, as the name indicates, in the membranes of the brain and spinal cord. Two sets of symptoms distinguish this disease: one common to all the acute infections, and characteristic of general poisoning of the blood: the other peculiar to the local lesion in the coverings of the brain and spinal cord. The combination of these two sets of symptoms and lesions individualizes the disease.

SYNONYMS.—No disease has received so many names, while there is not one against which valid objection may not be raised. Of *cerebro-spinal fever* (Royal College of Physicians) it may be said that while it recognizes the general infection it fails to indicate the part of the brain and cord affected. Cerebro-spinal fever is neither clear nor classic. It is a term "which may be pardoned when used by the laity, but which educated physicians ought not to tolerate" (Stillé). More glaringly faulty, though

with abundant recognition of the brain symptoms, are the designations of the older French authors: *Fièvre cérébrale*, *phrénésie*, *céphalalgie épidémique*, *meningite purulente épidémique*, with which may be cited also the German *Hirneuse*, and the old English terms *malignant meningitis* and *epidemic meningitis*. The early erroneous view of the disease as a variety of typhus fever is perpetuated in the names *cerebro-spinal typhus*, *typhus cerebri apoplecticus*, *typhus syncopalus*, *phrenitis typhodes*, *typhoid meningitis*.

The appearance of an hemorrhagic eruption, which characterizes the graver cases of nearly all the acute infections, has been more distinctly associated with this disease in the names *spotted fever* (Gallup), *petechial fever* (Wood), *malignant purpura* (McSwiney), *malignant purpuric fever* (Stokes), *pestilential purpura* (Banks), *febris nigra* (Lyons), and in its association in this connection again with typhus as a *typhus petechialis* (North), and with a neurosis, as *neuro-purpuric fever* (Mapother). Moreover, cerebro-spinal meningitis, on account of its eruption, has not escaped inclusion under the all-embracing title, *black death* (A. Smith). As was correctly remarked by Minet, nearly a century ago: "It is quite unfortunate that a single symptom—petechiæ—and one that is wanting in a great majority of cases, should have been seized upon to give it the odious and deceptive name of spotted fever, as that name has been applied by European writers to a very different kind of fever."

The opisthotonos, perhaps the most striking single symptom of the disease, which is, however, by no means universally present, has been selected by the Germans to name the disease a *Genieckkrampf*, *Genieckstarre*, *Nackentarre*; by the Swedes a *Nacksjucka*, *Dragsjucka*; and by the Italians a *torticollo*. Fancy has exercised its ingenuity in the title *cerebro-spinal arachnitis* (Mayne), a refinement totally unjustified in the morbid anatomy of the disease; and the limits of frenzy have been almost attained by the frantic efforts of Italian writers to cover the entire field of the disease with the names *tifo-apoplectico tetanico* and *febre-soporoso-convulsivo*. Terms as delusive and diffuse as spotted fever are the popular names *congestive fever*, *winter epidemic*, and *cold plague*.

From this array of titles, which is by no means exhausted, may be appreciated the difficulty of securing a proper name for a disease from its symptomatology or pathology. The name *cerebro-spinal meningitis* (Hughes, Law, Banks, Moore, and others) is at present the least of all objectionable, and has hence, in the course of time, come into common use, though it gives undue prominence to the local lesion to the exclusion of the infectious character of the disease. As was observed by Valleix, it is "begotten of anatomical bias and an incomplete appreciation of the facts." Gordon attempted to cut the knot of difficulty by calling the disease *cerebro-spinal fever*, with *cerebro-spinal meningitis*, a combination too bulky for practical use.

HISTORY.—Epidemic cerebro-spinal meningitis is a disease of modern origin; perhaps it would be more strictly true to say of modern recognition, for previous to the nineteenth century there was no possible differentiation of this disease and forms of typhus fever, pernicious malarial fever, tetanus, and the various inflammations of the brain and cord, diseases known to be as old as the history of medicine. More recently Davis was justified in the statement that "in regard to the disease promiscuously styled 'spotted fever' and 'cerebro-spinal meningitis,' as reported in our literature, no less than three or four diseases have been confounded together" (Trans. Amer. Med. Assn., xvii., 1866). Hence the possibility is not to be excluded that cases, or even epidemics, of cerebro-spinal meningitis occurred in ancient times. Medical historians (Ozanam, Alpin) have made repeated endeavors to identify this disease with the *phrenitis* of Hippocrates, and with certain epidemics of ancient Egypt, or (Tourdes, Boudin) at least to find its most essential features in the later writings of Forestus, Ignassias, Felix Plater, and Saalman; but the references cited go further to show in-

terest and assiduity in antiquarian research than to confirm their views.

It is, however, not just to claim that there could have been no possible recognition of this disease before the fifteenth century, when the first dissections were made of the spinal cord, for diagnoses in ancient times were wholly based on symptoms; but it is unreasonable to assume the distinct recognition of a disease whose symptoms were not separated from other acute infections or from purely local lesions.

It is generally conceded of cerebro-spinal meningitis that it first attracted notice as a separate disease in Geneva, February, 1805. Perhaps this first notice is due to the fact that the cases occurred in the practice of Vieusseux, an observer as keen as he was frank. He called the malady a *fièvre cérébrale ataxique*, and admitted that neither he nor his colleagues had ever seen a similar disease. These first victims were a woman and three children, two of whom died within twenty-four hours. The disease extended gradually to neighboring houses, in one of which four out of five children were attacked, and died within fifteen hours. It was characterized by suddenness of attack, vomiting, excruciating headache, stiffness in the back of the neck, dysphagia, and convulsions (Laveran, "Dict. encyclop. des sc. med.," 2d ser., 5 to 6, p. 648). A young man in an adjoining house died on the same night of the attack, showing a violent discoloration of the whole body. Thirty-three persons fell victims to this first outbreak of the disease, which lasted until May. The post-mortem examinations made by Mathey upon some of these cases revealed gelatinous exudation covering the convex surface of the brain, yellow pus posteriorly and about the optic commissure, cerebellum, and medulla oblongata. It is remarked of this first attack that it remained quite strictly localized.

The next outbreak of the disease, with unmistakable signs, occurred in our own country, with the first cases at Medfield, Mass., March 1806. These cases formed the preface to a long chapter in the history of the disease, known then as "sinking typhus," ten years in duration, during which time it extended over, but remained confined to, the New England States. Meanwhile the disease made its first appearance in France, at Grenoble, where it prevailed during the months of the spring of 1814, remaining confined to the soldiers lately arrived from the army of Mont Blanc. Comte describes it as a malady characterized by stiffness of the neck, with headache and delirium among its prominent symptoms, with traces of inflammation in the brain and cord observed on autopsy among its lesions. During the next year, Rampon described four cases at Metz, distinguished by the same array of symptoms and lesions. With the exception of an extensive endemic in Vesoul, in 1822, which differed from previous attacks in its preference for the civil population, the disease did not show itself again in France until January, 1837, when it broke out with great virulence in the garrison at Bayonne, and rapidly extended to invade the neighboring barracks at Dax, Meignon, and Tartos, and to assume, later in the course of the year, epidemic proportions, reaching Bordeaux by December of the same year; Rochefort, January, 1838; and Nîmes and Avignon, in the interior, by the end of the year. It is remarked of this outbreak, at a place appropriately named Aigues-Mortes, where it first appeared in November, 1841, remaining confined to the civil population, and continuing until March, 1842, that it attacked 160 persons of whom 120 died.

The same regiment of light infantry which transported the disease from Bayonne to Rochefort conveyed it also to Versailles, where it appeared in February, 1839, six men inhabiting the same room being attacked within a period of a few days. Paris made its first acquaintance with the disease, after the lapse of several years, in December, 1847. It continued to prevail in Paris up to May, 1849, confined exclusively to the inmates of the garrison and the prisoners at La Force, in which latter place ten of the twelve persons attacked fell victims to the disease.

After France, Italy was invaded, the disease first appearing in the kingdom of Naples, in the winter of 1839-40, and spreading thence, in the following winter, to the lands of the church. In the same year (1839), the most eventful in the history of the disease, as that from which dates any exact knowledge concerning its nature and individuality, cerebro-spinal meningitis first showed itself in Algiers, where it continued to number victims with annual recurrence in various parts of the land up to 1847.

After the first recognized appearance of the disease, from 1805 to 1816, accounts of it cease for six years, when, in 1822, it reappeared at Vesoul, in France, and at Middletown, Conn., to which remotely separated places it remained quite strictly confined. Then, after an additional five years, it again showed itself, in 1828, in Trumbull County, Ohio; in 1830 in Sunderland, England, and in 1833 at Naples. In 1842, when the disease again visited the United States, it appeared almost at the same time in Louisville, Ky.; Rutherford County, Tenn.; and Montgomery County, Ala.

Sweden was not reached by the disease until 1854, when it suddenly appeared in Gothenburg, extending thence in the course of the following year as far north as the city of Kalmar. Then, after a complete cessation of six months, it showed itself in a series of small epidemics extending a degree and a half farther north, and with this fitful, almost freakish appearance and disappearance, it hovered about that country for seven years, striking lightly in one place and like lightning in another, until it had killed in all 4,138 of its inhabitants. It was only during the last two years of this visitation of Sweden that the disease first showed itself in Norway (March, 1859), in very limited extent, but in such severe degree as to have carried off in the county of Opdal 14 of the 29 persons attacked.

Strange to relate, the first invasion of Germany did not occur until very late in the history of the disease. Disregarding as unauthentic the earlier communications of Würtemberg physicians, Hirsch feels compelled to accept the statements of Rinecker, who reports with due detail cases occurring in Würzburg, June, 1851, both in hospital and in private practice. But the first attack of any severity or extent was reserved for a later date and place, namely, for Silesia, Posen, and Pomerania, in 1864. Excepting Bamberg, anything like alarming proportions were not reached anywhere in Germany, though the disease prevailed with some severity at Erlangen, in July, 1864.

The comparative exemption of certain countries is another, and as yet inexplicable, feature of the disease, more especially of countries contiguous to and under the same general conditions as those severely visited. Thus while Ireland has suffered repeated attacks—a severe epidemic having occurred in Dublin, in 1866, wherein "the British forces suffered much in proportion to their average strength"—England has never had anything more than isolated cases, and Scotland, where the elements of crowd-poisoning are greatest, has never experienced an epidemic of the disease. And while epidemic proportions have been reached in Germany on the north, and in Italy on the south, Austria has remained almost entirely free from attack.

Our own country seems to have offered from the start a fertile soil for the development and spread of cerebro-spinal meningitis, and since the year 1842, when the disease began to make excursions over the various lands of Europe, it has become almost indigenous with us. Mention has been made already of the simultaneous occurrence of the disease in Alabama and Pennsylvania, in 1848. In the following year it made its first appearance in New Orleans, and during the following decade sporadic cases occurred over various parts of the country, as in North Carolina, in 1856, and Massachusetts, in 1857. Four years later (1861), more and more frequent cases are reported, from Connecticut, Indiana, Kentucky, and Missouri. Three years later still (1864), the disease again appeared in Pennsylvania, carrying off 400 children of the 6,000 inhabitants of Carbondale. It was during

the winter of these early sixties that the disease began to prevail in both armies of the rebellion, assuming a very malignant type in North Carolina, where it affected citizens and soldiers equally in the Union and Confederate armies alike (Stillé).

Epidemic recrudescences were observed in New York, 1872; Boston, 1874, and again in 1896-97; Cologne, 1885; Vienna, 1886 and 1897, and in Berlin, 1896.

The view that cerebro-spinal meningitis did not extend to or prevail in other continents than "North America and Europe, and the vicinity of the latter," has been quite abandoned, as epidemics have been authentically reported by Kotsionopulos, at Nauplia, in Greece, in 1868; by Höscheiman, in the Crimea, in 1868; by Diamantopulos, in Magnesia and Smyrna, in 1869-70; and by Sandreczky, in Jerusalem, in 1872.

Without attempting even to mention all the epidemics that have prevailed in various parts of the world, it may be stated that, though doubtful cases prevailed before this time, cerebro-spinal meningitis belongs to the nineteenth century, and that its history naturally falls into three periods, quite distinct: the first embracing the first cases of "ataxic cerebral fever," observed at Geneva, in 1805, and of "spotted fever," in Massachusetts, in 1806; the second commencing with the outbreak at Bayonne, in 1837, and extending over various parts of Europe and America up to the year 1866, gradually merging into the third or present period, when the disease has become more or less universal. Thus it may be said of this disease that it began in sporadic form, to become endemic in the course of the first observations; that on its second appearance it assumed the proportions of an epidemic in various lands, to finally overleap all barriers as a true pandemic disease.

GENERAL REMARKS.—Cerebro-spinal meningitis belongs among the rarest of epidemic diseases. Since the establishment of the disease as a pandemic affection, sporadic cases are of continual recurrence, but these cases remain isolated as a rule. The practitioner is often surprised at being confronted with a pronounced case of this disease in a crowded tenement house, in a palatial suburban residence, in a barrack or jail, in the ward of a hospital, in a distant farmhouse, when no similar case may have been reported, and probably no other case may show itself for years. So that individual cases, not distinctly marked, are apt to be overlooked for a time, or erroneously diagnosed, and numerous instances are recorded in which the diagnosis has been fully established only upon autopsy.

Now that the disease has made itself more familiar by frequent or constant appearance, much of the obscurity surrounding it is being dissipated, and cerebro-spinal meningitis is seen to take its orderly place among the acute infections, with its own specific cause, characteristic signs, and peculiar lesions. It has been stated already that two sets of symptoms distinguish this affection: one common to all the acute infections, and the other peculiar to the anatomical lesions of this particular disease. But, as in all the acute infections, either set of symptoms may assume prominence in an individual case. Niemeyer's statement, "I must again repeat that the symptoms and course of epidemic cerebro-spinal meningitis may be fully explained by the changes in the meninges of the brain and spine," covers only the cases of normal or protracted course, and will not apply to the foudroyant forms of "a disease in which," as Stillé remarks, "the septic element sometimes so far overrides the inflammatory as to destroy life before the latter has developed characteristic change." If this explanation is borne in mind it is seen that cerebro-spinal meningitis does not differ more widely from other acute infections than they do from each other.

The view that cerebro-spinal meningitis is a cerebral variety or form of typhus fever had advocacy enough in the earlier history of the disease to have fixed the name of typhus in connection with it. This view, which was ably supported by Boudin, Murchison, Upham, Baltzell, and others, was based upon a seeming analogy of symp-

toms—suddenness of attack, petechial eruption, brain symptoms—in the two diseases, and an occasional coincident prevalence. But more extensive observation has proven beyond doubt that there is nothing more in common between these diseases, to use the language of Burdon Sanderson, "except so far as each was due to a specific poison." Holmes writes graphically upon this question: "That a disease which is sometimes almost as sudden in its invasion as a stroke of lightning; which is rarely suspected of being contagious; which gives us a solitary case in a ship of war, a single case in a boarding-school, two cases only in an almshouse; which in civil practice affects the villages and isolated farmhouses of the interior (where typhus running the ordinary course is unknown) as much at least as the larger cities; which in a great majority of cases is fatal in a few days, or even hours; the mortality of which is very variable—such a disease presents so many points of difference, when compared with British typhus, that we should hesitate before pronouncing the two identical." Clymer quotes Tourdes, Levy, Lebert, Niemeyer, Stokes, Gordon, and Hirsch, in protest against this view, citing from Hirsch the statement: "Apart from its very obscure pathological essence there is hardly anything in its symptoms or lesions which brings epidemic meningitis within that comprehensive and elastic term—typhus." Differing as they do in all essential particulars, Radcliffe says, "doubt can only arise when the two diseases prevail together."

Any connection of this disease with malaria has been disproved in the same way. Such fluctuations occur in the course of certain cases of cerebro-spinal meningitis as to simulate to some extent the periodicities of malaria, and the "intermittent" is recognized as one of the forms of the disease. But the geographical study of the two affections reveals the fact that cerebro-spinal meningitis does not visit malarious countries with special frequency or virulence; that it attacks regions entirely exempt from malaria—the high, dry, and sandy plateaus of Central Franconia, for instance; that it shows preference for the winter rather than for the autumnal season; that the two diseases have, in short, different spatial and temporal relations, or, if they should coincide, the symptoms of meningitis do not show increased virulence. Ziemssen quotes in this connection from Bonsaing, who noticed that the epidemic of meningitis at Pola "did not seek out the notoriously malarious parts of the city"; and that "during the epidemic, and after its disappearance, malarial fevers were almost entirely absent." If further proof were wanting to establish the non-identity of these affections it could be found in the absence in meningitis of enlargement of the spleen and liver, and of the melanæmia, so characteristic of malarial affections, in the age of the victims of the two diseases, in the total inefficacy of quinine in controlling the disease, and above all in the examination of the blood for the plasmodium malarie, the specific cause of malaria, which is never found in pure cases of cerebro-spinal meningitis. These observations, which establish the independence of cerebro-spinal meningitis, meet with striking confirmation at the hands of Diamantopulos, in his account of the epidemic in Asia Minor in September, 1870. Any connection with typhus or malaria is, this author states, "positively to be denied, as during the entire prevalence of meningitis in Magnesia, no case of either of these diseases occurred" (*Schmidt's Jahrbücher*, 196, p. 239, 1882). However, typhus fever or malaria may coexist with cerebro-spinal meningitis.

Lastly, it is claimed that cerebro-spinal meningitis is not confined to man, but that characteristic symptoms and lesions have been observed in some of the lower animals. Gallup observed of the epidemic in Vermont in 1811 that "even the foxes seemed to be affected, so that they were killed in numbers near the dwellings of the inhabitants"; and Smith remarks of the outbreak in New York, in 1871, that "it was common and fatal in the large stables of the city car and stage lines, while among the people the epidemic did not properly commence until January, 1872" (Stillé). Clymer quotes from Law, of Dublin, who writes, in reporting several sporadic cases

of the disease in 1865: "It is a fact worthy of recording that at the time we were attending this lady, nine rabbits out of eleven, which her son had, died all in the same way; their limbs seemed to fail them, they fell on their sides, and then worked in convulsions, and died. Two hens fell lifeless from their roost." Statements of this kind must, however, be taken with much allowance, as the symptoms cited by no means identify the disease, and the lesions found upon the bodies of three of the rabbits examined—"congestion of the vessels at the base of the brain" in two, and in the other "vasculature of the membranes of the spinal marrow"—are too vague and indefinite for a diagnosis. The same reservations must also be made in the case of the so-called epizootic of meningitis among the domestic fowl in Algeria in 1846, among the dogs and hogs preceding the epidemic in Ireland in 1868 (Collins and Ferguson), and more markedly still of the disease among the artillery horses in Grenoble, 1814, and the livery-stable horses in Paris, 1844 (Villatte), where post-mortem examinations were not made at all.

ETIOLOGY.—Every attempt to connect cerebro-spinal meningitis with any special climate has turned out a signal failure. The disease has ranged, almost at will, from Gibraltar in the south of Spain, and from Algiers in Africa, to the most northerly towns and villages in Norway and Sweden. And in our own country cases have been reported from Maine to Mexico. The inter-tropical regions proper have as yet remained exempt from the disease, but the prevalence of it elsewhere, in seasons of extreme heat and humidity, would indicate this exemption to be an accident of time rather than of space.

Equally futile has been the endeavor to fix the disease in connection with any special soil. The coast of France, the valley of the Rhine, the hills and mountains of Calabria and Algiers, up to an elevation of a thousand feet and more, the marshy banks of the Garonne at Bordeaux, the recently inundated fields at Avignon and Aigues-Mortes, the wet camping-grounds at Newbern, N. C., the rocky sides of Gibraltar, and the dry, sandy plateaus of Franconia, have all offered equally fertile soil for the development and dissemination of the disease. Subsequent writers subscribe with unanimity to the statement of Hirsch that "conditions of the soil seem to be in every respect irrelevant to the occurrence of the disease."

But the *season of the year* has more to do with the dissemination of this disease. Perhaps the most striking fact apparent in the study of the etiology of this affection is the frequency of its occurrence during the colder months of the year. Thus, of 52 epidemics in France and Switzerland, 23 occurred in winter, 13 in winter and spring, and but 2 in the midst of summer; while of 16 epidemics in our own country, 6 occurred in winter and 5 in winter and spring. The epidemics of Sweden and Norway, Denmark, Spain, and the Netherlands all occurred in winter. Various explanations have been offered to account for this preference of the colder season. That cold alone, or mere reduction of temperature, will not account for the genesis of the disease is proven by the fact that epidemics have occurred in the midst of summer, even in hot countries, as in Italy, the South of France, and the Southern States of our own country. Moreover, many cold countries—North Russia, Siberia—have never known the disease at all. Obernier attributes the preference for the colder months of the year to the fact that people are more confined to houses at this season, are subjected longer to the evils pertaining to the "house climate."

Leaving for the present extrinsic considerations, some attention must now be paid to those that are intrinsic; and first, concerning *age*.

While it is acknowledged of cerebro-spinal meningitis that an almost freakish variation has occurred in its attack of individuals, it is generally conceded that it shows predilection for the period of youth. Thus, it is stated by Hirsch that of 1,267 fatal cases in Sweden in the years 1855-60, where the age was stated, 889 were under fifteen years, 328 from sixteen to forty years, and 50 over forty

years of age. But some qualification must be made of these statistics, from the fact that cerebro-spinal meningitis is notoriously much more fatal in the early years of life. Stillé quotes from Schweitzer to the effect that in 1866, in the Kronach district (Germany), of 115 cases, 75 occurred under the seventh year, 22 between the seventh and twelfth years, and 10 between the thirteenth and twentieth years; and from J. L. Smith, from the "Reports of the Board of Health of the City of New York," who found that of 975 cases, 771 occurred in persons under fifteen years of age, and 336 in children under five years of age. In some epidemics children have been the only victims of the disease. This was the case at Conshohocken, 1863 (Reid); Neustettin, 1865 (Litten); Westchester, N. Y., 1872 (Rodenstein); and at the Pettiburg Colony, 1848 (Ferrus). In other cases the disease attacked children first and adults later, as at Polzin, 1864 (Lehmann); Forchheim, 1864-65 (Seggel); Hanover, 1865 (Neynaber), and Jerusalem, 1872 (Sandreczky). Emminghaus, who reports these data in his article on this disease ("Handbuch der Kinderkrankheiten," 2, 483) makes the collective statement, from over fifty extensive observers, that of 1,435 cases, 1,133 were under fifteen years of age. All authors agree concerning this, as of all the acute affections, that the period of earliest childhood (suckling) is not affected in like degree. Smith found the proportion of liability to attack at the ages of under five years as 461; five to ten, 204; ten to fifteen, 106. Niemeyer's figures for the first two quinquennial periods are as 54 and 40, and Mende's as 47 and 29. On the other hand, in Berlin, the disease was wholly confined to adults.

It is definitely ascertained, regarding the period of childhood, that sex makes no difference whatever, and though different results have been reported in different epidemics affecting adults, it is probable that the average number of each sex attacked remains about the same.

It is commonly stated that individuals of robust, vigorous constitution furnish the greatest contingent of cases. Hirsch remarks that statements to this effect were made to him by relatives and medical men, and Pfeiffer and Heiberg corroborate these statements from their own observations. Yet all such statements of individual observations must be taken with some allowance. We may recall how universally prevalent was this same idea regarding pneumonia but a few years ago, whereas it is now conceded that the very reverse is true. At any rate it has been remarked by Leyden, of cerebro-spinal meningitis, how often weakly children are attacked, and by Ziemssen how frequently the victims of this disease were subjects of chronic brain affections.

Individual epidemics have been frequently noticed to have been distinctly connected with different social states. The selection of *soldiers* as exclusive victims has made this disease a familiar guest in army life. The recent conscripts and new recruits have been often the sole victims of the disease. Pfeiffer says the disease "prefers winter, soldiers, and children." At times the disease has remained strictly confined to certain corps or companies. On the other hand, other epidemics have spared the garisons and camps to attack, as at Leipsic, the civil population. During the War of the Rebellion citizens and soldiers suffered alike, and the colored race was not spared, whereas during the outbreak in Texas there was not an instance of the disease occurring among negroes.

The same caprice has been exhibited in different epidemics with regard to the inhabitants of cities and towns. As a rule the rural population has suffered most. In this connection Stillé says of the disease: "It has passed by large cities reeking with all the corruptions of a soil saturated with ordure and populations begrimed with filth, as Vienna, Berlin, Paris, London, and New York, to devastate clean and salubrious villages and the families of substantial farmers inhabiting isolated spots." Roth remarks of the 42 deaf-mutes attacked at Bamberg that 38 were from rural districts, while only 4 were from the city itself. What made this circumstance the more remarkable was the fact that the disease prevailed in Bamberg in unusual severity.

A strict localization of the disease to certain houses, flats, or stories has often been observed. Prisons, work-houses, orphan asylums, constitute at times breeding-places of cerebro-spinal meningitis. The epidemic in Ireland, 1846, was strictly confined to the prisons, and the disease broke out with the same seclusion in the orphan asylums in Philadelphia and Vienna in 1863, Washington in 1869, and Jerusalem in 1872. Keene reports a similar outbreak in the Naval School at Newport in 1863.

Fatigue of the body (Bollet), exposure to cold and rain (Mannkopf), traumata (Leyden), sunstroke (Schweitzer), the pre-existence of other acute infectious disease (Immerman and Heller) have all been cited as accidental predisposing causes in individual cases, but no one now would claim that any of these factors stands in any direct relation to the disease. The same remarks apply to the alleged psychical causes of the disease, as fright from a peal of thunder (Ziemssen), mental strain, etc. The frequency with which the disease has broken out in school has the same significance as attacks at night in bed.

The preference for the colder season and the predilection for the age of childhood are factors which are universally acknowledged, but so many exceptions have been noticed to these rules as to deprive them of the force of laws governing the disease.

The mode of onset of the disease, the symptoms presented during its course, and the characteristic lesions encountered in the internal organs, assign the disease unmistakably, in its nosological relations, with the acute infections. Examples of infection by contagion have been reported by Ziemssen, Prew, Neynaber, and others, and instances have been reported by Niemeyer and Fraentzel of transportation of the disease by detached troops. Hence search was made for something characteristic in the way of micro-organisms. Schweningen (*Schmidt's Jahrbücher*, xcvi., p. 130, 1882) speaks of having found enormous accumulations of germs (*massenhafte Pilze*) in the brain in cerebro-spinal meningitis. Leyden (1883) found in the exudation and in the tissue of the pia mater of a sporadic case the diplococci, formerly described by Eberth and Klebs, of oval form, united in short chains of two or three members, and assuming color with fuchsin and methylene blue. Marchiafava and Celli (*Gaz. degli Ospitali*, 8, 1884) made the same examination in two cases of epidemic meningitis, discovering constantly in preparations colored with a weak alcoholic solution of methylene blue, oval micrococci isolated or united as in diplococci. The micrococci were partly free and partly embedded in the protoplasm of the white blood corpuscles, rarely in the endothelial cells. Anything approaching chain-like formations were not observed. The tissue of the pia mater contained the same structures as the exudation, but blood from the right heart and splenic pulp proved entirely free. Ughetti (*Deutsche med. Wochenschrift*, June 19th, 1884) reports, also, of examinations made in one of twenty-one cases of the disease, at Ulsterbianco (Italy), the presence of numerous spherical micrococci, partly isolated and partly grouped in pairs, in the sero-purulent fluid from the ventricles of the brain. The author injected a syringe-ful of this fluid under the skin of the back or abdomen in four rabbits, with entirely negative results. In another case the blood drawn by cups along the spinal column contained "innumerable micrococci" of exactly the same appearance as those from the ventricular fluid. This blood injected into three rabbits by the hypodermic method produced likewise no symptoms worthy of note. Aufrecht (*Deutsche med. Wochenschrift*, vi., 4, January 24th, 1885) found micrococci floating free in the serum, and embedded in the pus corpuscles; further, in miliary deposits in the liver, lung, and kidney, as well as in the splenic pulp and blood from the heart. They could be colored with fuchsin, and were endowed with active motion. Many other observers, among them Leichtenstern (1885) and Rovsing (1886) reported finding bacteria in meningitis.

Netter, Fränkel, and Foà and Uffreduzzi (1886), study-

ing independently cases of cerebro-spinal meningitis, reported finding an encapsulated coccus resembling the *Micrococcus pneumoniae crouposa* of Sternberg (*pneumococcus*). The micro-organism was found in the cerebro-spinal fluid in cases of meningitis independent of pneumonia. The same micro-organism was found during the following year, by Weichselbaum and a number of other observers, in cases of meningitis secondary to pneumonia. Both Netter and Weichselbaum observed that the injection of the pneumococcus into the cranial cavity would produce meningitis.

Weichselbaum (1887) isolated from six cases of cerebro-spinal meningitis a micro-organism which he called the *Diplococcus intracellularis meningitidis*. The presence of this diplococcus, which is also known as the meningococcus, in cerebro-spinal meningitis has been confirmed by many investigators. Netter believes that the meningococcus may be a degenerated form of the pneumococcus, but this opinion is not generally accepted. Osler would give to the cases caused by the pneumococcus the dignity of a special place in nosology as a pneumococcal meningitis, and would ascribe cerebro-spinal meningitis, both sporadic and epidemic, to infection by the *Diplococcus intracellularis meningitidis*.

Bonome (1889), in six cases of cerebro-spinal meningitis, found a micro-organism which he named the *Streptococcus capsulatus meningitidis*. Netter regards this organism as a variety of the pneumococcus, a view which is shared by Foà and Uffreduzzi but opposed by Bonome.

To account for the ingress of micro-organisms into the recesses of the brain and spinal cord Eichhorst invokes the action of the lymph vessels in conveying the excitants of inflammation from neighboring structures, and Weigert calls attention to the destructive suppurative changes which he has encountered in the upper cavities of the nose. In this connection Strümpell calls attention to the remarkable loss of the sense of smell, and to the prefatory coryza or nasal catarrh which he has repeatedly seen in this disease. Sears (*Boston Medical and Surgical Journal*, August 9th, 1888) noted the frequency of pharyngitis during epidemics of cerebro-spinal meningitis.

A case of intra-uterine meningitis has been reported by Gradwohl (*Phil. Med. Jour.*, vol. iv., p. 445). The mother died at the seventh month of pregnancy, without aborting. Cultures of the diplococcus intracellularis meningitidis were obtained from the meninges of both mother and fetus, and both showed the meningeal lesions of meningitis.

One attack of cerebro-spinal meningitis confers the immunity common to most of the acute infections. Second attacks are rare. One such case is reported to have occurred in an individual named Lacon, who left the hospital cured, February, 1841, to return February 4th, 1842, affected with the same disease, which proved fatal on the following day (Companyo: "Essai sur la mén. cérébro-spinale," p. 76, Paris, 1847).

PATHOLOGY.—The disease begins with the aspect of an acute infectious malady, and maintains it throughout its course. As a rule the onset is sudden, with the impress of profound toxæmia. A chill comes on in the midst of apparent health, with vomiting, excruciating headache, and rapid prostration. Tenderness and stiffness in the back of the neck supervene in the course of a few hours. The face is pale, the expression anxious and strange, the extremities are stiff and tremulous. The slightest motion intensifies the pain in the whole body, the act of vomiting makes it atrocious. A sense of formication with hyperæsthesia is felt first, as a rule, in the lower extremities, to which it may remain confined, or it may extend over the whole body. The special senses of sight and hearing become likewise supersensitive. A flare of light, the slam of a door, the rumble of wheels in the street, a touch of the bed, produce a condition of agony. Even the approach of an attendant with the gentlest ministrations is watched with apprehension. Temporary relief of this distress is secured during a state of sopor or stupor which may occur, from which the patient awakens or is aroused—children often

with a *cri hydrocephalique*,—with a renewal of the same symptoms in greater or less degree.

In the course of a few days, often during the same day of attack, the stiffness of the neck increases to rigidity, or extends to constitute the characteristic opisthotonos. Convulsive twitchings of the face, or clonic spasms in the muscles of the extremities, may now occur, with delirium or outbursts of maniacal excitement under the slightest provocation.

Soon various eruptions, especially herpes and petechiæ, more rarely erythema nodosum, ecthyma, and pemphigus, begin to make their appearance, at first, as a rule, on the face, to extend later over large tracts of the body, or over the whole body (spotted fever).

The temperature curve of the disease distinguishes itself by its irregularity. As a rule, it rises quickly at first to 102° F., or even 104° F., to fall in the course of a few days, or to undergo fluctuations in extreme degree, sinking at times below the normal (Laveran). An extreme hyperpyrexia not infrequently precedes a fatal termination, which is usually attended, however, with a reduction to correspond with the marble coldness of the skin.

The pulse increases out of all proportion to the temperature, to experience, later on in the attack, greater fluctuation in frequency, volume, and tone than in almost any other disease. The same variations are noticed also in the acts of respiration, which are often quick and slow in the course of the same hour of the day.

The tongue is usually dry and red, in bad cases fissured and fuliginous, and sordes in these cases cover the teeth and gums.

The abdomen is sunken and retracted, often to such a degree as to show the outlines of the bodies of the vertebrae, or make distinctly apparent the crests and prominences of the iliac bones. Constipation is present, as a rule. The urine flows scantily and slowly from a parietic bladder, or in the worst cases is voided unconsciously in bed. Trismus, singultus, delirium, and coma, with ecchymoses and meteorism of the abdomen, mark the speedy advent of the close of the disease; or relaxation of the opisthotonos, relief of the pain in the head, with critical sweats or enuresis, indicate a favorable resolution.

Although different epidemics exhibit great variations in the degree and number of the symptoms cited, cerebro-spinal meningitis usually shows itself besides, in the typical cases mentioned, in one of three distinct forms or types, namely: the abortive, the intermittent, and the siderant or foudroyant.

The abortive form exhibits all its symptoms in the lightest grade. The headache is slight, the stiffness of the neck trivial or temporary, and vomiting may not occur, or may not recur after the first attack. Such cases often entirely escape recognition, or are diagnosed only because of the prevalence of an epidemic of the disease.

The intermittent form is noticed more especially in certain epidemics, though such cases are wont to occur in any extensive outbreak of the disease. Not infrequently isolated sporadic cases assume this form, to the great embarrassment of the practitioner. Quotidian and tertian intermissions or remissions occur in all the symptoms of the disease, leading often for a time to erroneous prognostications. The intermissions are by no means as distinct, as a rule, as the periodicities of malarial disease, yet they prove exceedingly deceptive to superficial observation. The exacerbations correspond undoubtedly to the irregular invasions or advances of the disease.

The foudroyant is the fulminant form, in which the patient is often killed by the force of the poison before permanent local lesions have time to develop. These are the cases which destroy life in the course of from six to thirty-six hours. The patients in these cases are often suddenly stricken with unconsciousness and convulsions, sometimes preceded for an hour or two with vomiting and pain in the head, in which condition they are carried

home, pallid, cold, or lightly cyanotic, showing no reaction to the most powerful stimulants, to sink into coma and speedily succumb.

Cerebro-spinal meningitis is particularly prone to a number of grave complications and sequela, prominent among which may be mentioned paralysis and paresis of various organs and members, and profound, often permanent, lesions of the eye and ear.

MORBID ANATOMY.—The external appearance of the body in cerebro-spinal meningitis varies with the duration of the disease. Rapid or foudroyant cases exhibit no change, but cases of longer duration show an emaciation which in protracted illness simulates that of cancer and tuberculosis. No trace of eruption is discoverable, as a rule, though occasionally the surface remains covered with petechiæ. Suggillations form quickly and in quantity over the body, and post-mortem rigidity sets in soon. Moreover, decomposition begins unusually early in rapid cases, as in other acute infections. In the most chronic forms, with extreme emaciation, bed-sores are common and extensive.

The muscular tissue is, in the foudroyant cases, brown and fragile, in cases of average duration more pale from loss of blood. The molecular change of fatty degeneration invades its structure, and gives it the appearance, which is especially remarked of the heart, of being strewn with sand.

The condition of the spleen varies greatly. It is usually found swollen, in fulminant forms, with deeply darkened pulp, but not infrequently it is shrunk to such degree as to show a wrinkled capsule. In average cases it is rather the rule to find this organ of diminished size. As might have been expected, the intermittent forms show no enlargement of the spleen. The cloudy swelling, fatty and granular degeneration of the kidney and liver, ecchymotic state of the mucosæ, œdema of the lungs, effusions in the serous sacs, post-mortem softening of the stomach, swollen condition of the mesenteric glands, dark color and altered consistence of the blood, are changes which belong to all the acute infections, and are especially marked in this disease.

The characteristic lesions are encountered at the anatomical seat of the disease, in the membranes of the brain and cord. But, as already stated, in the fulminant forms these changes may be absent altogether, and Woodward claims that cases of even more protracted course may be marked in this way. There were two classes of cases observed, he says, in the War of the Rebellion. "In the first the autopsy disclosed grave anatomical lesions of the cerebro-spinal axis, accumulations of serum, sero-pus, or tough yellow lymph, especially in the ventricles about the base of the brain and in the upper part of the spinal canal. In the second class of cases no perceptible anatomical lesion in the cerebro-spinal axis was observable." The author further observes: "These two classes of cases rest upon equally reliable evidence, and are not to be disposed of on the supposition that the latter represent merely an early stage of the former, since it is to be remarked that both anatomical conditions appear to have been found indifferently in protracted cases as well as in those which proved suddenly fatal" (Clymer, Aitkens: "Sc. and Pract.," 1872). Considering the difficulty of making sections of the vertebral column and of establishing an accurate diagnosis between this disease and pernicious malaria without it, we may still look with some degree of scepticism upon the protracted cases without lesions. Most of us who form our own observations in civil practice with the greater leisure for investigation, will still agree with Valleix, who remarked, long ago, "that when there is more or less absence of the meningeal changes, it is among those who have been struck down by the disease as by a thunderbolt." Light lesions are easily overlooked. Thus in the two rapid cases reported by Levick, with unappreciable change, Parkes calls attention to the omission of stating whether or not there was opalescence or unnatural dryness of the membranes. We are not to forget, also, how quickly even intense hyperæmia fade away entirely in the short interval be-