case of sea-sickness, the attacks are sometimes incoercible. They are associated with vertigo; and in turn the vertigo may occur independently of either the headache or the vomiting. It is apt to occur at intervals, and is often chronic in character. After the symptoms which have just been enumerated have lasted for a variable length of time, the patient's gait becomes uncertain; he reels or staggers, or shows a tendency to fall forward or backward. This tendency sometimes increases until complete loss of equilibration renders the patient unable to stand, though he may be entirely free from paralysis. The muscles of one side of the face or of one arm begin to twitch, or even to be agitated by clonic spasms, which either may persist all the time, except during sleep, or else may recur in periodic paroxysms, followed by paresis, gradually increasing to paralysis in the same muscles or in others, *e.g.*, in the arm or leg, after twitching of the muscles of the face. The progress of the paralysis is apt to be interrupted by one or more convulsions, or by attacks of apoplexy or of loss of consciousness; or one of these may usher in the first signs of paralysis, which at the outset may be complete, facial, monoplegic, or hemiplegic. Paræsthesia or anæsthesia is next likely to manifest itself in the paralyzed limbs, or on the side of the face opposite to these. Afterward the symptoms succeed one another in about the following order: alternate paralysis of cranial nerves and extremities; deviations of the eyeballs, isolated or conjugate; dilatation of the pupils, ptosis, much more rarely appearance of Bell's paralysis; occurrence at this time of diplopia, hemiopia, or amblyopia, gradually increasing to complete amaurosis; much more rarely deafness or anosmia, and the discovery of choked disc before or after the development of ocular symptoms; progressively increasing modification of psychic character—at first marked irritability, then impairment of mental powers, loss of memory, apathy or hallucinations, maniacal excitement, and melancholic insanity; before or at the same time with the appearance of this mental change there will be lesions of speech, dysarthria, aphasia, or word-blindness, the two latter often suddenly developed, as after an embolus, the first proportioned to the degree of tongue paralysis and gradual. A patient presenting the foregoing assemblage of symptoms, all progressively increasing, has, with very great probability, a brain tumor. In addition, is to be noted the freedom from pyrexia, and usually from changes in the rhythm of either pulse or respiration. The gradual, sometimes rapid, emaciation, the fact that acute accidents, though often followed by an exacerbation of existing symptoms, or even by the first appearance of new ones, have nearly always been preceded by others which have established themselves insidiously, are circumstances important to the diagnosis.

This being the general picture of the disease, individual cases are framed by the special emphasis of one or more symptoms, or the obliteration of others. The individual peculiarities depend upon (1) the locality of the tumor, (2) upon its rate of growth, (3) upon its complications, and (4), only to a very slight extent, upon its nature.

Peculiarities due to Locality.—These may be divined approximately from such an analysis as has already been given of the symptoms proper to lesions of each given locality. The *a priori* judgment must, however, be modified in view of the tendency of tumors to encroach, in growing, upon territories adjoining their original seat, and also in view of the frequent diffusion of their influence beyond any situation which they may occupy.

The following summary of symptom groups is arranged in the order of characteristicness. It does not correspond to the order of frequency of locality, which, as indicated by the combined tables of Ladame and Bernhardt, would be as follows:

Centrum ovale	192 = 29	per cent.
Cerebellum	167 = 27	"
Cortex	74 = 11	"
Pons	56 = 8	"
Basal ganglia	36 = 5	"
Medulla	30 = 4	per cent.
Corpora quadrigemina	13 = 2	"
Cerebral peduncle	10 = 1	"
Extra-cerebral (including pituitary gland).	71 = 11	"
	649	

But if we consider localities in the order of distinctness with which a tumor in them may usually be recognized, the order would be as follows: cerebellum, pons, cerebral peduncles, cerebral cortex, basal ganglia, corpora quadrigemina, medulla.

Local Diagnosis of Tumors.—*Tumors of Cerebellum.*—The most characteristic symptoms occur when the tumor involves the middle lobe. Headache is early, severe, and prolonged, often occipital; vertigo and vomiting are prominent; they may be for a while the only symptoms; epileptiform convulsions of great violence, but not often repeated; choked disc occurs early, preceding amaurosis, but also followed by this; peculiar ataxia, resembling the gait of a drunkard; loss of equilibrium in standing, with tendency to fall forward or backward; often paralysis of one abducens combined with that of opposite rectus internus; absence of other motor paralysis or of general sensory symptoms; loss of patellar reflexes; the intelligence clear till toward the end, when apathy deepens gradually into coma. From pressure upon the pyramids and the cerebral nerves, alternate paralysis is frequent, as are cardiac and respiratory symptoms from pressure on the medulla. From the same cause, singultus, irresistible yawning, salivation. All the nerves at the base of the brain are liable to be irritated and subsequently paralyzed. Varied symptoms in the area of the trigeminal area; pains in the tongue, simulating a gouty neurosis; neuroparalytic keratitis; paralysis of the masticatory muscles; clonic spasms in the territory of the facial and vago-accessorius, in the larynx, soft palate, and pharynx. Unilateral paralysis of the tongue from pressure on the hypoglossal may be added to unilateral paralysis of the acoustic nerve.

When a lateral lobe of the cerebellum is the seat of the tumor, the symptoms are apt to be complicated late in the disease by hemiplegia or hemianæsthesia or both, or by alternate paralysis. Cerebellar tumor is distinguished from pontine tumors by the marked ataxia which precedes the paralysis.

Tumor of Pons, Lower Half.—Uncertainty of gait, rather than ataxia, succeeded by isolated paralysis of third, or sixth, or seventh, or twelfth nerve, not preceded by symptoms of irritation in the muscle which it supplies; or else alternate paralysis, passing into incomplete paraplegia or general paralysis; permanent conjugate deviation of the eyes; amaurosis in a third, choked disc in a fifth, of the cases; entire absence of convulsions; headache, vomiting, and vertigo milder than in cerebellar tumor, or absent, but intelligence affected in half the cases.

Tumor of Upper Part of Pons.—Combination of symptoms proper to cerebellum and pons, as lobe of cerebellum is frequently compressed. Isolated rather than conjugate paralysis of the third nerve; paralysis of the facial on same side as hemiplegia; irritation of the trigeminus, sometimes of motor root, occasioning trismus; or of sensitive root, causing neuralgia on the side opposite to the hemiplegia. Sudden death is especially frequent in tumors of the pons.

In contrast with tumors of the cerebellum, sensory symptoms are manifold in tumors of the pons. The most common is a simple anæsthesia of the extremities on the side opposite the tumor; but sometimes without alteration of the cutaneous sensibility, the muscular and stereognostic senses are impaired. The tracts for the cutaneous sensibility and muscular sense are separated. Besides the Gubler form of alternate paralysis, when the facial is paralyzed on the side of the tumor, the hypoglossal, and extremities on the opposite side, there is occasionally seen a lesion of the trigeminus on the side of the tumor with hemiplegia on the opposite side. Lesion of the motor root causes paralysis of the masticatory muscles with atrophy and electrical degeneration; lesion of the

sensory root causes first neuralgia, later anæsthesia. Keratitis neuroparalytica also occurs.

Variations in the form of paralyses are frequent and liable to be misleading. There may be no paralysis of the extremities, but only of cranial nerves, especially the peculiar lesion determining permanent conjugate deviation of the eyes. Or an entirely cerebral form of hemiplegia may exist, or the lesion may limit itself to the nerve nuclei of the pons, paralyzing them without causing motor hemiplegia, but crossed anæsthesia or ataxia, or, through irritation of the pyramidal tracts, crossed intention tremor. Only for a short time does a pontine tumor remain unilateral, but soon it crosses the median line and occasions much complication of the symptoms. The cranial-nerve paralyses become bilateral. The conjugate deviation of the eyes to one side is neutralized by a second on the opposite side, so that the ocular bulbs remain rigidly fixed in the middle line. All four extremities and both hypoglossal nerves become paralyzed. Since the coronal fibres which pass through the pons from both cerebral hemispheres are injured, the medullary nerves dependent upon them—the glossopharyngeal, vagus, and accessorius—are paralyzed, a pseudo-bulbar paralysis results, with difficult deglutition, dysarthria, paralyses of the palate and pharynx, and disturbances of phonation.

As rarer symptoms may be mentioned albuminuria, polyuria, mellituria, and fever.

Tumors of the Cerebral Peduncle and Interpeduncular Space.—The characteristic symptom of this locality is an alternate paralysis in almost all cases (eighty per cent.). The limbs, the facial, and the hypoglossal nerve are paralyzed on the same side, the side opposite the tumor. The motor-oculi nerve is paralyzed by direct pressure on its trunk as it emerges into the interpeduncular space, and therefore on the same side as the tumor. The paralysis is usually total, so that there is unilateral dilatation of the pupil, ptosis from paralysis of the levator palpebræ, and divergent strabismus from paralysis of the internal rectus. Such alternate motor paralyses may exist alone, when the tumor is limited to the pes pedunculi; but if the lemniscus is involved, crossed sensory disturbance, crossed ataxia, or intention tremor from irritation of the fibres of the pyramid will be added to the symptomatology. These symptoms may exist alone without motor paralysis when the tumor begins in the lemniscus. As the tumor grows larger, it crosses the interpeduncular space, causing bilateral oculo-motor paralysis and paraplegia, often symptoms of the pseudo-bulbar paralysis. As in tumors springing from the base of the cranium, all the basal cranial nerves may ultimately be involved—trochlearis, abducens, trigeminus, and even facial. Vaso-motor symptoms occur when the substantia nigra is involved.

Tumors of the Cerebral Cortex.—The symptoms vary so greatly, according to the precise part of the cortex which is affected, that each part must be considered separately.

Frontal Lobes.—Notwithstanding the important functions which doubtless pertain to the frontal lobes, a tumor in them not unfrequently remains latent. Bruns denies that psychic symptoms are particularly frequent in frontal tumors; but, according to our tables, they are present in forty-nine per cent. of the cases. One peculiar psychic symptom has been observed, namely, a tendency to crack jokes, the so-called "Witzelsucht" of Jastrowitz. Another characteristic symptom is the ataxia, which has been already mentioned as depending on paresis of the trunk muscles, and which simulates the better known cerebellar ataxia. Tonic cramps of the muscles of the trunk and neck are sometimes noticed,—sometimes a persistent rigidity of the neck. Many symptoms are due to pressure upon neighboring parts. Pressure on the central convolutions will lead to mono- or hemiplegia. Growth downward toward the base of the brain may bring a frontal tumor into direct or indirect contact with an optic nerve, or with the chiasma, resulting in a unilateral choked disc or unilateral nerve atrophy and blindness. Or there may be one-sided paralysis of the ocular muscles, especially the abducens; or a unilateral anosmia; or an exophthalmus if the tumor penetrates the orbit. To these symptoms may be added attacks of Jacksonian epilepsy; motor aphasia; circumscribed tenderness on percussion; lesser degree of headache, but greater tendency to stupor. These concomitant symptoms may serve to differentiate between a frontal ataxia and an ataxia due to cerebellar tumor.

Central Convolutions.—These contain the centres for all the voluntary movements of the body—centres, however, extending into several other areas. Thus the gyrus paracentralis; the posterior part of the first frontal convolution; the anterior part of the superior temporal, the gyrus marginalis (trunk muscles); the foot of third frontal convolution (motor-speech centre); second frontal convolution (centre for movements of head and eyes); neighborhood of facial and hypoglossal centres (movements of vocal chords and jaw muscles). Tumors in this extensive motor zone, therefore, are indicated by most characteristic symptoms of localized spasms and paralyses which occur early in their history. Horsley and Schäfer's experiments on the cortex have permitted further refinements of localization: for the thumb, in the posterior part of the anterior central convolution; for the foot and toe movements, in the posterior central convolution; and on the limits between the leg and arm centres, special centres for the movements of hip and knee. The larynx and the muscles of the trunk receive a double cortical innervation, and thus a unilateral tumor will cause muscular twitchings or Jacksonian convulsions on both sides of the body. As a second consequence of the double innervation, such regions as the eyes and larynx usually escape paralysis in hemiplegia.

According to the most modern view, the motor centres in the central convolutions are also centres for sensibility, and nevertheless sensory symptoms are usually lacking in tumors of the motor zone. Local muscular spasms are, however, frequently preceded by paræsthesias in the affected limbs, constituting a sensory aura. Sometimes the whole attack remains limited to the aura, constituting a sensory epilepsy. Or this again is replaced by a psychic equivalent, a feeling of fear or excessive anguish. When the sensory symptoms are primary, it may be inferred that the tumor occupies the posterior central convolution. The frequent absence of sensory paralyses is explained by a wider distribution of sensory mechanisms, of which a part escape injury in all but the most extensive lesions.

Parietal Lobes.—The symptoms differ on the right and left sides. A left-sided parietal tumor, touching upon the gyrus angularis, is liable to involve the association tracts which pass from the occipital to the left temporal lobe—hence to cause the peculiar disturbance of speech known as alexia. This symptom fails when the tumor is on the right side. From contact with the posterior part of the internal capsule tumors of the parietal region may cause hemianæsthesias; or the motor bundles of the internal capsule may be sufficiently irritated to occasion a hemiataxia.

When, directly or mediately through pressure from a distance, the angular gyrus and optic radiations are involved, there may be ptosis, limitation of the visual field, and homonymous hemianopsia. Loss of the stereognostic sense has been noted as a special symptom in tumors of the parietal lobes.

Temporal Lobes.—Sensory aphasia is the characteristic symptom of tumor of the left temporal lobe. Tumors in this region, on the right side, are apt to be latent. Each auditory centre is connected with both ears, so that deafness is rare; but auditory auræ preceding convulsive attacks, and occurring on the same side, are not uncommon. In tumors of the gyrus hippocampi, and especially of the uncus, epileptiform attacks or their equivalents may be ushered in by the auræ of a bad taste or frightful smell.

Occipital Lobes.—The characteristic local symptom is a crossed homonymous hemianopsia. This symptom belongs to the entire optic tracts from the chiasma to the occipital lobes. In the left occipital, as already men-

tioned, alexia and optic aphasia are associated with the hemianopsia. Occipital hemianopsia is distinguished from that due to a lesion of a lower part of the optic tract by the absence of various symptoms. There are no hemianopsic pupillary rigidity, no lesion of the basal cerebral nerves, as the motor-oculi or trigeminus; no thalamic symptoms, as hemianæsthesia, hemiathetosis, chorea, or mimetic facial paralysis. Jacksonian epilepsy is usually absent. Cerebellar ataxia may be determined by pressure on the cerebellum, though this is usually protected by the tentorium.

Basal Ganglia or Lower Part of Centrum Ovale.—There is complete hemiplegia often followed by rigidity, thus closely resembling, except in its gradual development, the vulgar hemiplegia of hemorrhage. It is sometimes associated with complete permanent hemianæsthesia, when the tumor is in the posterior part of the hemisphere. It is often complicated late in the disease with symptoms of intraventricular effusion; then there are convulsions, retraction of the head, loss of consciousness, slow pulse, contracted pupils, as in acute hydrocephalus. Localized spasms and monoplegias sometimes occur and are difficult to explain.

When the tumor specially affects the *corpus caudatum*, the symptoms depend on the affection of the internal capsule at its anterior part; there is thus a pure hemiplegia with corresponding convulsions and without sensory symptoms. With tumors of the *thalamus*, hemiplegia is also usual, but is accompanied by hemianæsthesia, pains, ataxic, choreic, and athetosic movements of the extremity opposite the tumor; and finally hemianopsia. Frequently there is a crossed mydriasis, as the nuclei for the internal ocular muscles lie on the lateral wall of the posterior part of the thalamus. The mimetic paralysis of Bechterew—already mentioned as characteristic of thalamic lesions—is also present.

Corpora Quadrigemina.—The chief characteristic of tumors of the corpora quadrigemina is a combination of ocular paralyses with ataxia. This is particularly indicative of this special region when the ophthalmoplegia precedes the ataxia. If the ataxia appear first, there is an equal probability that the tumor is situated in the cerebellum, where tumors are much more frequent—twenty-seven per cent. of the whole number, as compared with two per cent. of tumors of the corpora. With the latter, convulsions are extremely rare; but the percentage of choked disc, amaurosis, psychical defect, is extremely high, and headache and vomiting are both frequent. Pressure on the external geniculate body may cause hemianopsia. Vaso-motor symptoms are uncommon. Scarcely to be separated from the foregoing are tumors of the *pineal gland*. Such tumors may be first manifested by a unilateral or bilateral paralysis of the trochlearis nerve.

Medulla Oblongata.—The symptoms depend on a paralysis of the cranial nerves from the eighth to the twelfth. There are therefore deafness, paralysis, and atrophy of the palate and pharynx, with dysphagia; paralysis of the vocal cords; paralysis and atrophy of the tongue with dysarthria; disturbance in the cardiac and respiratory rhythms. To these characteristic symptoms, due to lesions of nerve nuclei, will be added motor and sensory paralyses as the long cerebro-spinal tracts become involved.

Paralysis of the cranial nerves is almost always bilateral, as the tumor soon crosses the median line along which the nerve nuclei are situated. Acceleration of respiration is followed by dyspnœa, which passes over into Cheyne-Stokes respiration, and death often occurs suddenly through asphyxia. Toward the end of life singultus is frequent, and also a notable rise of temperature. Extensive vaso-motor disturbances occur—diabetes, polyuria. Through lesion of the cerebellar and olivary tracts a cerebellar type of ataxia often develops; and vertigo when the vestibular nerve is involved. Choked disc is not unfrequently absent. An emotional psychosis is not uncommon, and this, with the vagueness of other symptoms, has not seldom led to an erroneous diagnosis of hysteria. This seems still more plausible when the tumor penetrates the fourth ventricle, and causes intermittent symptoms of giddiness, fainting, headache, vomiting, and hysteriform convulsions.

Besides localities in the cerebrum which may be the seat of an intracranial growth, the clinician must always inquire whether the tumor whose existence is suspected does not spring from the cranial bones or the dura mater lining them. Tumors of the anterior, middle, and posterior cranial fossæ excite symptoms which approximately resemble those of the cerebral organs reposing in the same spaces, preceded by symptoms which result from the direct compression of cranial nerves. From distention of the very sensitive dura mater, the headache is peculiarly acute and violent.

Anterior Fossa.—Tumors in this region may break through the roof of the orbit and cause the same symptoms as a primary orbital tumor, namely, unilateral amaurosis, ocular paralyses, trigeminal neuralgias. While the tumor remains limited to the anterior fossa, the olfactory nerve alone is exposed to pressure; and when the tumor compresses the basal part of the frontal lobes, the symptoms are usually vague. Tumors on the left side may press upon the speech centre sufficiently to cause motor aphasia. Frontal ataxia is absent, for the gyrus marginalis is too far removed. The psychic symptom of childishness has sometimes been particularly noted.

Middle Fossa.—The central part of this fossa contains the sella turcica with the pituitary gland. Lesions of the latter are often associated with the peculiar symptom complex known as acromegaly. Apart from this strange disease, the characteristic symptoms of tumor in the middle fossa are due to pressure upon the chiasma and the optic tracts. If the tumor be on the middle line, the optic fibres going to the inner half of each retina will be compressed, causing a bitemporal hemianopsia. This symptom sometimes occurs suddenly, lasts a short time, and vanishes. If the tumor involves one optic nerve in front of the chiasma, there is first unilateral amblyopia, then blindness of the same eye, then, as the tumor extends backward to the chiasma, temporal hemianopsia of the opposite eye, and finally complete blindness.

Yet with these marked visual symptoms choked disc is not unfrequently absent. The fact has been explained by supposing that the tumor obstructs the passage of lymph to the sheath of the optic nerve. Convulsions and vomiting are less severe or altogether absent. Motor and sensory paralyses occur only when the peduncles have become involved; thus after the chiasma symptoms already described, an order of evolution which is highly characteristic. Before the tumor reaches the cerebral peduncles, it will have invaded the lateral region of the sella turcica, and determined the rich assemblage of symptoms dependent on lesions of the motor-oculi and trigeminal nerves: ptosis, neuralgia, anæsthesia or anæsthesia dolorosa; trophic lesions of the skin and eyes; atrophic paralysis of the temporal, masseter, and pterygoid muscles; paralysis of the chorda tympani nerve and sense of taste. If the history of the case be exact the local diagnosis of tumors of the middle fossa can be made with much precision.

Posterior Fossæ.—Tumors of this region cannot with any certainty be distinguished from those of the medulla, pons, or lower segment of the cerebellum. Amaurosis or amblyopia exists in one-third of the cases, thus even more frequently than in tumors of the cerebellum. Through a bilateral compression of the cranial nerves or of the pons, tumors of the posterior fossa can determine the typical symptoms of bulbar paralysis, usually preceded by unilateral symptoms in the territory of the trigeminus or acusticus. When the tumor is situated directly over the foramen magnum, all the cranial nerves may escape pressure, but those supplying the four extremities be paralyzed.

Headache is as violent; choked disc as early a symptom as in tumors of the cerebellum.

Parts of Brain in which Tumors are most Frequently Latent.—Complete latency implies absence of

all symptoms; incomplete latency implies absence of focal symptoms only. The localities in which the latter condition is characteristically observed are also those in which tumors may most often be completely latent. These localities are: the temporal, occipital, or even, but less easily, the frontal lobes of the cerebral hemispheres, provided the central gyri are not indirectly affected; the parts of the centrum ovale corresponding to these regions, and hence untraversed by fibres from the pyramidal tract; the lateral lobes of the cerebellum, the thalamus opticus, and the lenticular nucleus. Finally, it is possible that in any portion of the brain a tumor may remain latent, providing it grow slowly enough.

Differential Diagnosis.—The epileptiform convulsions dependent upon cerebral tumor differ little or not at all from those of functional epilepsy. They are, however, often slighter, or at least the loss of consciousness is much less profound. The headache, on the contrary, is chiefly noticeable for its extreme intensity and persistence, in which respect it exceeds even nervous headaches.

The vomiting is also noticeable for its violence, and for the absence of any other symptoms of disordered digestion, such as furred tongue, epigastric uneasiness, etc. The diagnosis in regard to these symptoms ultimately depends on their combination, and on their association with paralysis or with psychical symptoms. Conversely, the psychical symptoms of tumor are distinguished from pure mental alienation chiefly by the existence of these physical signs; also by their greater vagueness, which renders precise psychiatric classification difficult or impossible.

It is by no means always easy to decide whether a patient with cerebral symptoms is suffering from a diffused or a focal disease; and in the diagnosis of tumor it is necessary to exclude meningo-encephalitis, progressive general paralysis, chronic basal meningitis, hydrocephalus, cerebro-spinal form of multiple sclerosis, brain abscess, locomotor ataxia.

Tuberculous meningo-encephalitis, which not unfrequently lasts as much as three months, has then a duration not inferior to that of many tumors, and many of the symptoms are identical: violent headache, convulsions, vomiting, neuritis optica, changes of character, monoplegic paralysis, and spasms. In the diffused inflammation, however, these paralyses are transient and variable, a condition sometimes, but rarely, seen in tumor. The disease, moreover, is always attended by more or less fever, by more marked variations in the pupils, by a slow, hard pulse, by obstinate constipation, by retraction of the abdomen, and by vaso-motor symptoms. When a tuberculous tumor is associated with diffused inflammation, it is masked by the symptoms characteristic of the latter.

The appearance of spinal symptoms may decide the diagnosis, which could be still further confirmed by means of a lumbar puncture, and the discovery of pus or tubercle bacilli in the fluid.

A tumor of the medulla may especially simulate *progressive general paralysis* by producing a diffused paresis without distinct paralysis, embarrassment of speech, depression of mental power, headache, and unequal dilatation of the pupils. A tumor, however, is indicated by the occurrence of amaurosis, convulsions, vomiting, localized paralyses; while the diffused disease is characterized by the outbreak of ambitious delirium, and by the peculiar trembling of the lips. There is no choked disc, but rigidity of the pupils and peculiar disturbance of speech.

Tumors of the sella turcica may be closely simulated by *chronic basal meningitis*, which is most frequently situated in exactly the same locality and involves the same nerves. It is distinguished by the occurrence of descending optic neuritis, unattended by symptoms of intracranial pressure. In young children premature closure of the fontanels with blindness would point to meningitis: enlargement of the head to tumor.

Hydrocephalus may also have choked disc, and is usually associated with depressed mental capacity. Slow enlargement of the head in young children belongs either to this disease or to tumor. The rolling down of the eyes and subsequent retraction of the head point to an effusion. Ventricular effusions are not infrequent complications of tumor, especially of tuberculous tumor. General symptoms then predominate over focal symptoms. Bruns and Oppenheim agree that it is impossible to make a positive diagnosis between tumor and acquired hydrocephalus in childhood.

Multiple cerebro-spinal sclerosis may for a time simulate tumor, the disease being characterized by headache, vertigo, disturbances of speech and of vision (diplopia and amblyopia), and by the occurrence of apoplectiform attacks, followed by incomplete hemiplegia. The latter, however, are rare in tumor, but are apt to be frequently repeated in sclerosis. In sclerosis, on the other hand, there is an absence of convulsions and of motor paralyses, except after apoplectiform attacks. Instead, there is a diffused loss of power, with muscular rigidity, absence of vomiting and of choked disc. There are the positive symptoms of nystagmus, scanning or explosive speech, staggering gait and giddiness, spasmodic paralysis of the arms and especially of the legs, finally the characteristic intention tremor of the limbs. Yet tumors of the cerebellum, pons, corpora quadrigemina, and the peduncles may all cause intention tremor through irritation of the pyramidal tracts. In tumors of these localities (except the cerebellum), choked disc is for a long time absent. The difficulties of diagnosis are greatest with children. Extension of the symptoms to the territory of the spinal cord speaks in favor of multiple sclerosis, while a distinctly alternate hemiplegia speaks in favor of tumor. The course of multiple sclerosis is slowly progressive, extending over several years, or is marked by acute attacks separated by intermissions. A modified choked disc may occur for a time, but subsides, and normal vision is preserved, even when optic atrophy is considerable.

Locomotor Ataxia.—It may occasionally be difficult to distinguish the ataxia of cerebellar tumor from that of tabes spinalis. But in the tumor the patient has a staggering or reeling gait, like that of a drunken man, and there is no sign of ataxia in either upper or lower extremities when the patient is in a horizontal position (Althaus). The alterations of sensibility, characteristic of tabes, are absent in tumor, and most of the positive symptoms of tumors are absent in tabes.

Abscess of the Brain.—The symptoms can be quite identical with those of tumor. General pressure symptoms, including choked disc, are less intense with abscess, because this directly destroys brain tissue. Headache, however, is about equally violent in the two cases. Local symptoms are less marked with abscess; one reason is that abscesses are most frequently situated in the latent regions of the brain. If specific regions are affected, characteristic specific symptoms will develop; thus sensory asphasia and hemianopsia in abscesses of the temporal lobe from purulent otitis, or motor paralyses from lesions of the central convolutions after traumatisms.

Fever and chills, when present, are important indications of abscess; but these signs are often absent, and subnormal temperature is rather frequently observed.

The course of brain abscess is usually rapid. But the most important element of differential diagnosis lies in the etiology, for a focus of pus in the brain is never primary, but always secondary to pus elsewhere.

The evolution of abscess is habitually much more rapid, and its progression much more regular than that of tumor. An abscess is always to be suspected when localized cerebral symptoms develop in the course of an otitis media. Extremely chronic cases of this aural affection sometimes pass into an acute exacerbation, during which the cerebral membranes become infected through the roof of the tympanum, through the fenestræ, or through the auditory canal.

Cerebral Hemorrhage.—The onset of the paralysis is sudden, instead of being slow and insidious, and the paralysis is usually at once complete. But the cranial nerves

are rarely affected, with the exception of the facial; vomiting, headache, vertigo, and choked disc are absent, as are also mental symptoms after recovery from the apoplectiform shock. Hemorrhage into the meninges, which scarcely ever occurs except in children and old people, does not resemble tumor in any of its symptoms with the exception of convulsions.

Softening.—The diagnosis from tumor is often extremely difficult when the softening is from the beginning chronic in character. Lesions of special senses are much less frequent in softening, and choked disc is rare; so also are lesions of cranial nerves, vomiting, and convulsions; while the headache is less circumscribed and intense. Contractures of paralyzed limbs are more frequent. Psychic alterations are marked, but are of a different character from those of tumor. There is emotional instability instead of irritability, dementia rather than the depression and apathy of tumor.

A diagnosis of the nature of the tumor can rarely be made.

Carcinoma is often indicated by the rapid progress of the symptoms, and by signs of multiple foci successively developing. Perforating tumors are almost invariably malignant—carcinoma, sarcoma, or osteo-sarcoma. The tumor is nearly always primary, and destroys life before it has occasioned cachexia.

Tuberculous tumor often complicates tuberculous meningitis, or is complicated by it. In either case the focal symptoms are much obscured by those of the diffuse disease. When isolated, a tuberculous tumor may be suspected from the youth or scrofulous constitution of the patient.

Gummata.—Their diagnosis principally depends upon the presence of other signs of syphilis. The evolution is relatively rapid, and the invasion of drowsiness and coma may be hastened by the coexistence of diffused endarteritis.

Glioma.—This remains the most probable when the diathetic tumors have been excluded. It not infrequently develops after a blow on the head, and then seems to result from chronic inflammation of the neuroglia.

Intracranial aneurisms occasion symptoms which are indistinguishable from those of neoplasms proper. It is the basilar artery which is most often affected, and the symptoms then resemble those of tumors of the pons.

But all the arteries are liable to be the seat of this lesion. It is said that headache is more diffuse and more intense than with other tumors, while vomiting is less frequent. Sudden attacks of loss of consciousness often occur, due undoubtedly to inequalities in the distention of the tumor and consequent variations in the brain pressure.

Aneurisms of the posterior communicating artery occasion symptoms of motor-oculi paralysis (ptosis, external strabismus, fixed dilatation of the pupil), and finally—the effect spreading to the corpora quadrigemina—amblyopia. When the aneurism is seated on the internal carotid, the sensitive root of the trigeminus may be affected; hence neuralgias or anæsthesia. Aneurisms of the carotid which communicate with the cavernous sinus are characterized by exophthalmia, and a susurrus which is heard when the stethoscope is applied over the eyeball (case Gruening).

The termination of aneurismal tumors is peculiar, being always by rupture and sudden death, with the symptoms of intracranial hemorrhage.

In addition to these various forms of definite brain lesion, a preliminary diagnosis is required between any brain lesion and certain general diseases: arteriosclerosis; neurasthenia, hysteria, idiopathic epilepsy, uræmia, migraine. Choked disc is the most valuable single symptom for the positive decision in favor of tumor, amidst the mass of symptoms which confuse the diagnosis by being common to tumor and to these functional diseases. Bruns claims to have made twenty-two correct diagnoses of the existence and precise locality of a brain tumor; but they were all in one of two groups. First, the central convolutions, posterior and middle fossæ, or the pons. Second, the speech region, the cerebellum, medulla oblongata, corpora quadrigemina, left occipital lobe, occasionally the frontal lobe. Bruns advises to rest satisfied with the diagnosis of the posterior fossa, and only under very favorable circumstances to try to distinguish between the pons, cerebellum, corpora quadrigemina, or base of the cranium.

Rarely is it possible to distinguish between a cortical and subcortical tumor, unless in the cases of alexia due to lesion of the association tracts between the occipital and first temporal convolutions. Collins claims that in a cortical tumor of the motor-speech region, the mental conception of words is destroyed, which is not the case when the tumor is subcortical and destroys only the centrifugal speech mechanisms.

Prognosis.—The prognosis of cerebral tumor is not modified by the diagnosis of either the seat or the nature of the tumor, unless the latter can be shown to be syphilitic. Gummatous tumors sometimes yield with remarkable rapidity to the mixed treatment for syphilis. All others are invariably fatal, but after a longer or shorter lapse of time, and with somewhat different modes of termination. Thus, as has been said, aneurisms terminate by rupture, and death occurs with all the symptoms of cerebral hemorrhage. In the majority of cases the patients die in coma, gradually developed from a condition of apathy and drowsiness. These states are associated with continually increasing brain pressure, which often results in œdema. Sudden death is not uncommon, and is dependent upon inhibition of the cardiac centre. This sudden death may occur as an accident after the most variable duration of the disease; but even the mode of death, which seems to indicate the natural evolution of the morbid process, leaves a most variable time for this to be accomplished. The patient sometimes dies as early as ten or even eight weeks from the appearance of the first symptoms; in other cases these have been prolonged for ten years.

Pathological Anatomy.—The histological structure of many cerebral neoplasms, including aneurisms, does not differ from that of the same growths in any part of the body. Tuberculous tumors, like miliary tubercles, always start from the lymphatic sheaths of the blood-vessels, beginning in a local accumulation of adenoid elements. Gliomata are a species of sarcomatous tumors which are peculiar to the brain. They were described as neuromata, until Virchow demonstrated that they contained no nerve elements, but developed from the neuroglia. The glioma may consist almost exclusively of cells, and is then called a medullary glioma; or it may contain a large amount of connective tissue, which either remains soft and of the myxoma type (myxoglioma), or becomes hard, fibrous, or even cartilaginous (fibrous glioma). Finally, some among these tumors are so rich in vessels as to have acquired the name telangiectatic gliomata. All develop from the neuroglia. The tumor appears as a grayish mass, becoming pink or red as vessels develop in it. If these are numerous, apoplexies may take place into the substance of the tumor. The three forms of malignant tumor of the brain are sarcomata, carcinomata, and melanoid tumors. The first are closely related to the gliomata, arising like the medullary variety of the latter; the chief difference consisting in the greater size of the cells and the larger amount of intercellular substance. Cancer of the brain is nearly always encephaloid, primary, and not infrequently congenital. The growth is rapid, and the size ultimately attained by the tumor is in inverse proportion to the vital importance of the part of the brain in which it is seated. Enucleation of the tumor is impossible. Cancer of the upper part of the cerebral hemispheres not infrequently perforates the dura mater, and even the skull. Conversely, cancer of the eyeball, usually melanotic, constantly tends to penetrate the brain.

Melanoid tumors are forms of carcinoma in which the tissue is infiltrated with pigment. Their most frequent seat is the eyeball, the pigment being derived from that of the choroid.

Hydatid cysts are found in the brain, but they usually remain latent, especially if small and multiple. Other varieties of cyst are not infrequently formed by hemorrhagic effusion, by softening of brain tissue from extensive necrobiosis, or by the softening of myxomatous tumors.

Complicating Lesions.—With glioma, congestion and hemorrhage in the vicinity of the tumor are the most frequent complications, the latter often being the cause of death. The tissue around the tumor is often the seat of an inflammatory softening. Effusion into the ventricles is often caused by compression of vessels which return blood from the choroid plexus. Such effusion is common with tubercle, and then may depend on granular thickening of the ependyma.

A zone of non-inflammatory softening surrounds most tumors. It depends upon necrobiosis of nerve tissue, from localized obstruction to the circulation and œdema. When this softening is extensive, functional regions quite different from those actually occupied by the tumor become involved. This circumstance, as has often been shown, by complicating the symptoms often materially obscures the diagnosis.

When the fibres of the pyramidal tract have been affected by the tumor, descending degeneration or secondary sclerosis may set in, and even reach the lateral columns of the cord. This is, however, much less common than after hemorrhage; and, correlatively, late rigidity is correspondingly rare. Conversely, the appearance of rigidity in limbs paralyzed from the effects of a cerebral tumor often indicates that hemorrhage has been excited in its vicinity.

Treatment.—There is no radical medical treatment except for gummata, and for these the mixed treatment sometimes yields brilliant results.

In 1884 an epoch-making event occurred. Two English surgeons, Bennett and Godlee, attempted to remove a cerebral tumor by a bold surgical operation. Between 1884 and 1893 this operation was performed eighty-five times. These eighty-five cases are recorded and analyzed in a table published in the Supplement to the Reference Handbook in 1894, to which, for details, the reader is referred. Out of the eighty-five operations twenty-four resulted in recovery, about one-thirteenth. Between 1893 and 1899 many new cases of operation are recorded in tables published by Starr (Trans. Med. Soc. New York, 1896) and also by Knapp (Boston *Med. and Surg. Journ.*, October 12th, 1899). These collections are included in the list tabulated below, but to them have been added a number derived from other sources. The total number of cases in which the operation has been performed since 1893 is one hundred and thirty-eight. These new cases have not been analyzed, but the model for their analyses is offered on pp. 122 *et seq.* of the Supplement (vol. ix.).

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