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Review Article

Principles of the New World Health Organization (WHO) Classification of Brain Tumors

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Introduction

A correct classification of intracranial tumors is still fundamental to create understanding between neurosurgeons and neurologists on the one hand and neuroradiologists and neuropathologists on the other. Neither epidemiological nor prognostic studies are relevant without an underlying classification which is equally understood by both groups. This has to be emphasized since an attempt was made with computed tomography (CT) to grade tumors on the basis of the CT appearance. The result has been a discrepancy between the morphological and the CT grading of gliomas [19]. For instance, in the astrocytoma group, grade I was usually applied to tumors which belong only partly to this group, namely the so-called pilocytic astrocytomas (whereas the bulk belong to grade II according to the neuropathologists).

It seems unnecessary to emphasize the 'Babylonic discrepancies' existing at present in the terminology [3, 4, 9, 11, 12, 13]. The classification used by us was the terminology of Bailey and Cushing somewhat modified according to the neurosurgical needs and the recommendations of various authorities [2, 7, 11, 20–25]. Our personal endeavors to unify the various classifications by an International Symposium in Cologne 1961 [30], following the classification meeting of the Spanish school in Santander [10] have failed. Even our attempts to expand an existing international system – namely the terminology of the Unio Internationalis Contra Cancrum (UICC) which had already been published [17, 18] – by our *Atlas of the Histology of Brain Tumors* [24] and also later by the *Atlas of Gross Neurosurgical Pathology* [25] similarly had no effect, because this classification of the UICC [18] was never used by pathologists. Meanwhile the development of CT has become a real and efficient tool in the hands of the neuroradiologist. His attempts not only to localize a tumor, but also to give some prognosis by grading [19] demanded a standard classification of tumors of the nervous system.

Fortunately at the same time the World Health Organization felt that among the prerequisites for comparative studies of cancer an international agreement on histological criteria for the classification of cancer types and a standardized nomenclature were necessary. Therefore study groups on the histological classification of cancer were selected for each tumor site and a tentative histopathological typing and classification was drawn up by groups of experts consisting of up to ten pathologists working in the field in question.

WHO has established 23 centers since 1958 covering tumors of most of the organ systems. Some of these centers have already completed the work and published the classifications.

For the study of the histological classification of tumors of the central nervous system (CNS) a reference center and a number of collaborating laboratories were then designated by WHO, and in 1970 L. J. Rubinstein and K. J. Zülch were asked to develop a preliminary classification of tumors of the CNS.

The center (Fig. 1) has distributed histological sections from 230 cases which were studied and reviewed. Comments were sent back to the reference center and then a final comment was made and returned to the collaborating centers. Thus a permanent feedback of opinions was guaranteed.

Meanwhile meetings of the study groups for the classification of tumors of the CNS were held in 1974 and 1976 and the preliminary classification discussed and improved in the light of the experience with the cases distributed.

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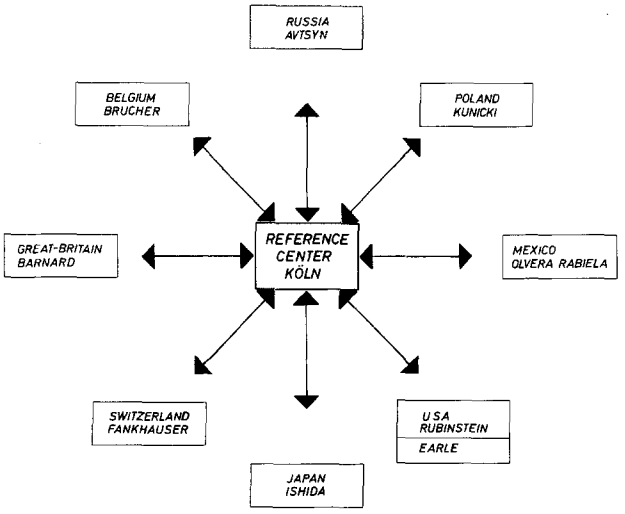

Fig. 1. Reference center and collaborating laboratories

Finally a report was submitted to the WHO for publication in the series *International Histological Classification of Tumors* (so-called 'Blue Books').

Short anouncements of the outlines of this classification were made in papers read at the meetings of the Italian [26] and German [27] Societies of Neurosurgery. The International Society News also published the information during the International Congress of Neuropathology in Washington in 1978. It is expected that the final issue will be available with Kodachrome transparencies by summer 1980 at the WHO Distribution an Sales Service, 1211 Geneva 27, Switzerland, and through outlets in other countries as listed by WHO.

It is hoped that an international agreement on the histological criteria for the classification may develop since the WHO is aware that at present pathologists use different terms for the same pathological entity and the same terms are sometimes applied to lesions of different types.

In what follows the discussion will be in two parts, classification and grading.

Classification

Before discussing in detail the various groups some remarks seem to be in order.

1. The classification can not solve all the unresolved problems of interpretation, such as, the correct position of some tumor types. In this particular case two classifications will be possible according to one's own scientific position.

2. It must be taken into account that tumors very often consist of a mixture of cells and yet, if possible, have to be classified according to the prevailing type of cell. Therefore, when classification is possible only with difficulty, some mixed groups are foreseen.

3. The process of malignant dedifferentiation is accounted for, in all groups where such changes occur, by the introduction of a higher grade which is called 'anaplastic'. The term 'anaplasia' includes all morphological features associated with malignant biological behavior: cellular pleomorphism, increased cellularity, greater mitotic activity, dedifferentiation, abnormal stroma reaction, vascular proliferation, and necroses with or without pseudopalisading of nuclei.

4. The terms preferred in the book are not always those which are in widest use although they seem to be the most correct from the scientific point of view. Synonyms are always given in brackets in order to make understanding easier.

5. It was felt necessary to give a prognosis of the tumor type by grading, the difficulties of which will be emphasized later.

There may be objections to the simplification of prognosis by grading, such as:

(a) the tissue sample may not be representative of the whole tumor;

(b) the cytological grading makes it difficult to interpret tumors with a mixed cell population correctly; and, last but not least,

(c) it must be emphasized that the clinical circumstances may influence the prognosis even more than the biological behavior of the new growth. The importance of the tumor location, with its influence on the cerebrospinal fluid pathway and vital centers, leads to the final prognosis of clinical malignancy.

In addition, the predilection of specific types of tumors for the roughly circumscribed age groups of childhood and adolescence, the middle decades of life, and the latter decades, is discussed and emphasized. Even the sex incidence of some tumor groups is noted in the text.

I. Tumors of Neuroepithelial Tissue

A. Astrocytic Tumors

1. Astrocytomas are subdivided into the well known three groups of fibrillary, protoplasmic, and gemistocytic tumors all of grade II.

2. The separation of a special subtype of *pilocytic astrocytoma* is new. This tumor corresponds to the older term polar spongioblastoma of Bailey and Cushing [3] and of our own former classification. However, it is separated in the WHO classification from the aforementioned three types of astrocytoma by better biological behavior (grade I!). It is characterized by fusiform cells, Rosenthal fibers and 'granular bodies'.

3. The ventricular tumor of tuberous sclerosis is included in the astrocytic group and is termed *subependymal giant cell astrocytoma.*

4. The term *astroblastoma* is still a matter of discussion. It was the feeling of the group that the diagnosis should be restricted to growths with astrocytic cells arranged in a perivascular pattern with thick processes radiating toward a central blood vessel. Since a similar pattern of processes may occur with glioblastomas and other groups the term 'astroblastoma' should be used only in the above defined sense and with great reluctance.

5. The malignant form of astrocytoma has long been well recognized and figures as the *anaplastic astrocytoma* (grade III).

B. Oligodendroglial tumors

1. The typical pattern of the *oligodendroglioma* is accepted widely (grade II).

2. Since not infrequently a conspicuous mixture of oligodendroglial cells and astrocytes occurs, the term *mixed oligoastrocytoma* is foreseen (grade II).

3. For the anaplastic variant of the oligodendroglioma (grade III) pleomorphism is characteristic. This tumor usually contains cellular pleomorphism in the form of multinucleated giant cells of the Langhans type and/or abundant necrotic zones with pseudopalisading, proliferation of vessels and other features of anaplasia.

C. Ependymal and Choroid Plexus Tumors

1. The ependymal tumors comprise the typical mass *within* the ventricles with true ependymal rosettes, perivascular rosettes, blepharoplasts and ependymal canals (grade I) whereas the *extraventricular* tumors of younger age may be anaplastic (grades II and III; see below). The following variants are described:

(a) The *myxopapillary ependymoma* (grade I) occurs almost exclusively in the cauda equina. Here the stroma is highly vascular and mucin is often demonstrable. The stroma may be changed to such an amount that the original architecture is blurred.

(b) *Papillary ependymoma* exists as a rare papillary variant which, in places, may mimic the features of choroid plexus papilloma.

(c) *Subependymoma* may be a small or large intraventricular tumor composed of nests of uniform ependymal cells, situated in a stroma of dense acellular glial fibers. There tumors have also been termed *subependymal glomerate astrocytomas.* Typical ependymomas, particularly in the 4th ventricle, may also contain areas of subependymoma (grade I).

2. The rare form of *anaplastic ependymoma* may resemble glioblastoma or medulloblastoma, where features of ependymal differentiation can be recognized (grades II and III).

3. *Choroid plexuspapillomas* are composed of a papillary pattern of low columnar or cuboidal cells covering a delicate vascular connective tissue core (grade I). Some of these tumors are heavily calcified (usually in the temporal horn).

4. There may rarely be anaplastic forms (grade III) of this tumor with blurred architecture, pleomorphism, and mitoses.

D. Pineal Cell Tumors

These include the *pineocytoma,* a rare isomorphous tumor with uniform cytology and processes radiating toward the vascular stroma (grades I to III), and the *pineoblastoma,* a rare, highly cellular, malignant pineal tumor, very closely resembling the medulloblastoma (grade IV).

My interpretation of tumors of the pineal region differs from the rest of the group. I believe that the "two cell pineal tumor" consists of two entities: (a) a real tumor of the cells of the pineal parenchyma which has the typical cell processes with club-like expansions at their tips described by Del Rio Hortega [12], [8, Fig. 320], formerly called *anisomorphous pinealoma),* and

(b) the *germinoma,* a common tumor at this site, not originating in pineal epithelium, which will be discussed later in this classification.

My experience with the staining ability of these tumors was responsible for this distinction. The genuine pinealoma showed a negative stain by PAS and a positive impregnation by Girolami's silver method which is supposed to be specific for pineal parenchyma cells. The germinoma on the other hand showed the reverse tendency: positive stain by PAS and negative impregnation by Girolami's method.

E. Neuronal tumors

1. *Gangliocytoma* consists of mature ganglion cells and is well defined; a dysplastic variant of this tumor occurs in the cerebellum (grade I).
2. The gangliocytoma containing neoplastic glial cells, apart from mature ganglion cells, must be classified as *ganglioglioma* (grades I and II).
3. If the spectrum of neuronal cells is larger and immature neuroblasts occur in addition to ganglion cells, the term *ganglioneuroblastoma* (grade III) seems appropriate.
4. There are rare *anaplastic gangliocytomas* and *gangliogliomas* (grades II to IV) where the cells or the tissue may contain forms of anaplasia.
5. *Neuroblastoma* is a cerebral tumor composed of small darkly staining poorly differentiated cells with slender processes and a tendency to form pseudorosettes (grade IV). It is closely related to the retinoblastoma and sympathoblastoma.

F. Poorly Differentiated and Embryonal Tumors

1. The most prominent representative is *glioblastoma multiforme* with its variegated architecture of ne-

crosis, pseudopalisading, fistulous vessels, vascular endothelial proliferation and old and fresh hemorrhages (grade IV).

(a) If the stroma appears to consist of malignant transformed hyperplastic elements, the tumor may be classed as a *glioblastoma with sarcomatous component,* or *mixed glioblastoma and sarcoma* (grade IV).

(b) If on the other hand a glioblastoma has a predominance of bizarre, highly multinucleated (monstrous) giant cells, the term *giant cell glioblastoma* may be appropriate (grade IV). These tumors have also been interpreted as sarcomas (monstrocellular sarcomas, see below).

2. The second, also very frequent tumor in this group of the undifferentiated blastomas is *medulloblastoma* (grade IV), characterized by the poorly differentiated cells and a tendency to form pseudorosettes (Homer-Wright).

(a) *Desmoplastic medulloblastoma* is a variant in the architecture with abundant reticulin fibers in its stroma. This variant is supposed to occur in older patients and has a somewhat better prognosis than the typical form of medulloblastoma. It corresponds to what has been referred by some authors as a *circumscribed cerebellar arachnoidal sarcoma.* This is an undifferentiated tumor with a particular architecture containing lightly stained, reticulin-free islands in contrast to the very desmoplastic parts (grade IV).

(b) If the medulloblastoma contains striated or unstriped muscle fibers, the name *medullomyoblastoma* may be given. These are very rare tumors (grade IV).

3. *Medulloepithelioma* is also a very rare tumor of undifferentiated columnar cells with a characteristic tubular or papillary pattern which resembles primitive medullary epithelium (grade IV).

4. *Primitive polar spongioblastoma* is a very rare tumor of unipolar or bipolar glial cells with delicate processes, forming an unusual palisading pattern (grade IV).

5. *Gliomatosis cerebri* is a rare entity of diffusely spread glial cells resembling either spongioblasts, astrocytes or oligodendroglia. These diffuse cell populations infiltrate large parts of the cerebrum but may contain circumscribed foci resembling glioblastoma.

II. Tumors of Nerve Sheaths

A. Neurilemmomas are the well known tumors composed of Schwann cells (grade I).

B. Anaplastic neurilemmomas rarely occur (grade III).

C. Neurofibromas are localized or diffuse tumors consisting in a mixture of Schwann cells and fibroblasts with abundant collagen fibers and usually occur as a component of Recklinghausen's disease (grade I).

D. Anaplastic malignant neurofibroma is the malignant counterpart of the neurofibroma (grades III and IV). This malignant transformation is also described as a neurosarcoma. The term *neuroma* is not used for the above entities because this is a non-neoplastic overgrowth of nerve fibers and Schwann cells and other components of scar tissue.

III. Tumors of Meningeal and Related Tissues

A. In the *meningioma* group some of the traditional entities are foreseen as subgroups as well as some of the rarer forms.

1–4. The *meningiotheliomatous, fibrous, transitional* and *psammomatous* subgroups correspond to the well known traditional entities.

5–7. If a meningioma has predominantly vascular channels the term of *angiomatous meningioma* may be appropriate if it is indistinguishable from a hemangioblastoma, although encapsulated, and not invasive, it may be termed a *hemangioblastic* variant; the *hemangiopericytic* subgroup is indistinguishable from hemangiopericytoma elsewhere in the body, but is encapsulated and non-invasive.

Meningiomas correspond to grade I apart from the last mentioned which may have a poorer prognosis.

8. *Papillary meningioma* is a rare form with a worse prognosis.

9. The typical *anaplastic meningioma* can occur in many of the subgroups and displays anaplastic features, but its anaplastic changes are not yet as far developed as in the primary fibrosarcoma of the dura mater (grades II and III).

B. Meningeal Sarcomas

1. The *primary fibrosarcoma* of the dura mater is histologically well defined, invasive, yet fairly well circumscribed (grade II, IV).

2. *Polymorphic cell sarcoma* is rarely seen and has a larger variation of the cells in size and shape (grades III and IV).

3. *Primary meningeal sarcomatosis* is a diffuse sarcomatous neoplasia in the subarachnoid space (grade IV).

C. Xanthomatous Tumors

1–2. The *fibroxanthomas* and their malignant counterpart are rare forms. The xanthomatous component is prominent here.

D. Primary Melanotic Tumors

1–2. *Primary melanomas* as well as meningeal melanomatosis occur rarely in the central nervous system.

E. Others

All kinds of fibromas, chondromas, chondrosarcomas etc. are included in this group.

IV. Primary Malignant Lymphomas

This category includes reticulum cell sarcoma, microglioma, microgliomatosis, reticulosarcoma, periadventitial diffuse sarcoma and all other types of lymphoma which occur primarily in the central nervous system.

Since a special group has worked on the classification of the lymphomas in the system of the Blue Books of the WHO, details of the subgroups are not given in this volume.

However, the spinal *epidural reticulosarcomas* or lymphosarcomas are well known to the neurosurgeon and neuroradiologist because they respond well to radiation treatment and therefore their prognosis is more favorable.

V. Tumors of Blood Vessel Origin

A. Among the tumors of blood vessel origin the *hemangioblastomas* of Lindau are well defined and known for long.

Semantically the Lindau syndrome is a combination of retinal and cerebellar tumors; von Hippel-Lindau's disease, in contrast, is an inherited form of this syndrome.

B. Monstrocellular sarcoma. This group has already been mentioned above in the differential diagnosis of giant cell glioblastoma. According to our concept these tumors seem to be relatively well demarcated, occur at any age and equally in the sexes, contain abundant reticulin stroma and are characterized by monstrous cells of enormous size and with many nuclei and inclusions (grade IV) and therefore are distinguished from glioblastoma.

VI. Germ Cell Tumors

The tumors in this group occur most often in the pineal region.

A. Germinomas are tumors composed of large primitive spheroidal cells indistinguishable from the testicular seminoma and the ovarian dysgerminoma. The "two cell type", a pattern with large epithelial and many lymphoid cells in its stroma, is the prominent feature. Multinuclear giant cells may be found. My concept has been mentioned in the discussion of pineal cell tumors.

According to prominent authorities germinomas are not only the most frequent tumors of the pineal region but are also encountered in the hypothalamic region as the so-called *ectopic pinealoma.* They are very sensitive to radiation (grade II and III).

B–C. Embryonal carcinomas and *choriocarcinomas* are rare tumors sufficiently defined in general pathology. The *teratomas* occur in many regions of the central nervous system (grade I).

VII. Other Malformative Tumors and Tumor-Like Lesions

A. Craniopharyngiomas are the most common tumors of childhood in the sellar region. They may be cystic and calcified (grade I).

B–D. Rathke's cleft cysts are intrasellar cysts whereas the *epidermoid* and *dermoid* – sufficiently defined by general pathology – occur usually in the cleft lines.

E. The *colloid cyst of the third ventricle* is most common at the foramen of Monro; synonyms are *paraphysial* or *neuroepithelial cysts.*

F. The *enterogenous cyst,* lined by mucin-secreting epithelium, may occur intraspinally.

G–K. Other cysts in the arachnoid or ependyma-lined systems may occur as well as *lipomas.* The latter, although benign, have a dangerous trend to grow into the stroma septa, as in the region of the spinal cord or corpus callosum.

Choristoma, pituicytoma or *granular cell myoblastoma* is found in the pars nervosa of the pituitary gland. The hypothalamic *neuronal hamartomas* are rare and of malformative origin, but may also grow and take on the features of a space occupying lesion. They are usually associated with precocious puberty, a rare entity of the *nasal glial heterotopias* or *nasal gliomas.*

VIII. Vascular Malformations

A–E. Vascular malformations contain the very well known entities of *capillary teleangiectasia, cavernous angiomas, arteriovenous malformations, venous malformations* and *Sturge-Weber's disease.*

IX. The Tumors of the Anterior Pituitary

The tumors of the anterior pituitary are only referred to by name since they are described in detail in *His-*

Degree of malignancy	Prognosis after 'total' removal	Tumors	
		Extracerebral	Intracerebral
Grade I benign *	Cure or at least survival time of 5 and more years	Neurinomas Meningeomas Pituitary adenomas Craniopharyngeomas	Gangliocytomas (temporo-basal) Ependymomas of the ventricles Plexuspapillomas Astrocytomas, pilocytic Angioblastoms (Lindau)
Grade II semi-benign **	Postoperative survival time: 3–5 years	Pituitary adenomas, (anaplastic)	Gangliocytomas of other location Ependymomas (cerebral) Astrocytomas, Oligodendrogliomas, isomorphous Pinealomas,
Grade III less malignant ***	Postoperative survival time: 2–3 years	Meningeomas, anaplastic Neurinomas, anaplastic	Gangliocytomas, anaplastic Ependymomas, anaplastic Plexuspapillomas, anaplastic Astrocytomas, anaplastic Oligodendrogliomas, anaplastic Pinealomas, anaplastic
Grade IV highly malignant ****	Postoperative survival time: 6–15 months	Sarcomas	Glioblastomas Medulloblastomas Primary sarcomas

Fig. 2. Definition of grading according to Zülch

tological Classification of Endocrine Tumors. These subgroups have now to be defined by their endocrine neurological properties and are therefore not discussed here in detail. However, the *acidophil, basophil, mixed acidophil-basophil* and the *chromophobe* subgroups are mentioned in this volume as well as the malignant form of the *pituitary adenocarcinoma.*

X. Local Extensions from Regional Tumors

A–G. Among the local extensions from regional tumors into the cranial cavity the glomus jugulare tumor (chemodectoma), the chordoma, chondroma and chondrosarcoma, the rare olfactory neuroblastoma and the not infrequent *adenoid cystic carcinoma (cylindroma)* have to be mentioned apart from other entities projecting about the brain and/or spinal cord.

XI–XII. Metastatic tumors and unclassified tumors do not need any description. Some of the intracranial tumors still may remain unclassified, when they can not be placed in any of the above categories with sufficient certainty.

In order to prevent unnecessary criticism it may be remarked that the descriptions in this volume of the WHO are short, concise, and, according to the opinion of the group, sufficiently clear to make differential diagnosis possible.

This issue may be supplemented by larger books in the world literature such as those of Russell and Rubinstein [15], of Rubinstein [14], of Barnard [5], of Arendt [1], of Schiffer and Fabian [16] and by our *Atlas of the histology of brain tumors* [24] and a revised and enlarged edition of the smaller volume *Brain Tumors. Their biology and pathology* [23] which will appear in 1980.

Grading

One of the great advantages of this forthcoming book is that every one of these tumor entities expresses its usual biological behavior in growth by grades of malignancy. They are based on the experience of the many prominent members of the WHO group in their collaboration with neurosurgeons. However, definitions were not given but only the designation *benign* (grade I), *semi-benign* (grade II), *less malignant* (grade III), and *highly malignant* (grade IV).

The personal interpretation of the grades of malignancy (Fig. 2), published in 1968 [29] is, however, not an official statement of the World Health Organization. Yet, it must be emphasized that it is far more difficult to give a prognostic evaluation of an intracranial or intraspinal neoplasm than in other regions of the human body. Within the confines of the skull a space-occupying and expanding lesion, be it benign or malignant, will lead to a fatal outcome if not operated or if the intracranial pressure is not relieved. This expresses its "clinical malignancy".

Therefore the clinical malignancy of an intracranial mass has to be considered. Here, apart from the space-occupying volume, the local pressure of an intracranial tumor may act on vital neural structures irrespective of its histological nature. And, moreover, secondary occlusive hydrocephalus can be produced by a growing tumor hence the final malignancy of a tumor is the sum of the clinical and morphological characteristics of growth and capacity to spread, i. e. to metastasize [24, 25, 28, 29, 30].

In conclusion I believe that the World Health Organization has created an excellent work, which, as a manual, is a good tool to provide the neurosurgeon, neurologist, neuropathologist, general pathologist und particularly the neuroradiologist with a classification which we hope will be accepted worldwide and may create a better understanding among the clinically oriented members of the neurosciences.

Appendix

New Histological Classification of Tumors of the Central Nervous System (World Health Organization)

	Grade Malignancy:
I. Tumors of neuroepithelial tissue	
A. Astrocytic tumors	
1. Astrocytoma	II
a. fibrillary	
b. protoplasmic	
c. gemistocytic	
2. Pilocytic astrocytoma	I
3. Subependymal giant cell astrocytoma (ventricular tumor of tuberous sclerosis)	I
4. Astroblastoma	II–IV?
5. Anaplastic (malignant) astrocytoma	III
B. Oligodendroglial tumors	
1. Oligodendroglioma	II
2. Mixed oligoastrocytoma	II
3. Anaplastic (malignant) oligodendroglioma	III
C. Ependymal and choroid plexus tumors	
1. Ependymoma	I
Variants:	
a. Myxopapillary ependymoma	I, II
b. Papillary ependymoma	I
c. Subependymoma	I
2. Anaplastic (malignant) ependymoma	III, IV
3. Choroid plexus papilloma	I
4. Anaplastic (malignant) choroid plexus papilloma	III, IV
D. Pineal cell tumors	
1. Pineocytoma (pinealocytoma) isomorphous	I–III
2. Pineoblastoma (pinealoblastoma)	IV
	Grade
E. Neuronal tumors	
1. Gangliocytoma	I
2. Ganglioglioma	I, II
3. Ganglioneuroblastoma	III
4. Anaplastic (malignant) gangliocytoma and ganglioglioma	III, IV
5. Neuroblastoma	IV
F. Poorly differentiated and embryonal tumors	
1. Glioblastoma	IV
Variants:	
a. Glioblastoma with sarcomatous component (mixed glioblastoma and sarcoma)	
b. Giant cell glioblastoma	
2. Medulloblastoma	IV
Variants:	
a. Desmoplastic	III, IV
b. Medullomyoblastoma	III, IV
3. Medulloepithelioma	IV
4. Primitive polar spongioblastoma	IV
5. Gliomatosis cerebri	?
II. Tumors of nerve sheath cells	
A. Neurilemmoma (schwannoma, neurinoma)	I
B. Anaplastic (malignant) neurilemmoma (schwannoma, neurinoma)	III
C. Neurofibroma	I
D. Anaplastic (malignant) neurofibroma (neurofibrosarcoma, neurogenic sarcoma)	III, IV
III. Tumors of meningeal and related tissues	
A. Meningioma	I
1. Meningotheliomatous (endotheliomatous, syncytial, arachnotheliomatous)	
2. Fibrous (fibroblastic)	
3. Transitional (mixed)	
4. Psammomatous	
5. Angiomatous	
6. Hemangioblastic	II
7. Hemangiopericytic	II
8. Papillary	II, III
9. Anaplastic (malignant) meningioma	II, III
B. Meningeal sarcomas	
1. Fibrosarcoma	III, IV
2. Polymorphic cell sarcoma	III, IV
3. Primary meningeal sarcomatosis	IV
C. Xanthomatous tumors	
1. Fibroxanthoma	?
2. Xanthosarcoma (malignant fibroxanthoma	?
D. Primary melanotic tumors	
1. Melanoma	IV
2. Meningeal melanomatosis	IV
E. Others	
IV. Primary malignant lymphomas	III, IV
V. Tumors of blood vessel origin	
A. Hemangioblastoma (capillary hemangioblastoma)	I
B. Monstrocellular sarcoma	IV
VI. Germ cell tumors	
A. Germinoma	II, III
B. Embryonal carcinoma	IV
C. Choriocarcinoma	IV
D. Teratoma	I
VII. Other malformative tumors and tumor-like lesions	
A. Craniopharyngioma	I
B. Rathke's cleft cyst	I?
C. Epidermoid cyst	
D. Dermoid cyst	
E. Colloid cyst of the third ventricle	
F. Enterogenous cyst	
G. Other cysts	
H. Lipoma	
I. Choristoma (pituicytoma, granular cell "myoblastoma")	
J. Hypothalamic neuronal hamartoma	
K. Nasal glial heterotopia (nasal glioma)	
VIII. Vascular malformations	I?
A. Capillary telangiectasia	
B. Cavernous angioma	
C. Arteriovenous malformation	
D. Venous malformation	
E. Sturge-Weber disease (cerebrofacial or cerebrotrigeminal angiomatosis)	
IX. Tumors of the anterior pituitary	
A. Pituitary adenomas	
1. Acidophil	I

2. Basophil (mucoid cell)	I
3. Mixed acidophil-basophil	I
4. Chromophobe	I
B. Pituitary adenocarcinoma	III
X. Local extensions from regional tumors	
A. Glomus jugulare tumor (chemodectoma, paraganglioma)	?
B. Chordoma	See similar tumors elsewhere in the body
C. Chondroma	
D. Chondrosarcoma	
E. Olfactory neuroblastoma (esthesioneuroblastoma)	
F. Adenoid cystic carcinoma (cylindroma)	
G. Others	
XI. Metastatic tumors	
XII. Unclassified tumors	

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