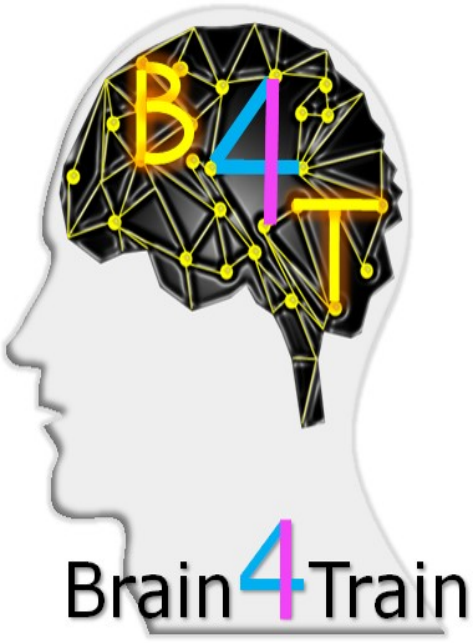

MODULE 1: INTRODUCTION TO STROKE REHABILITATION

Session 1. STROKE. CLINICAL CHARACTERISTICS, IMPAIRMENTS AND FUNCTIONAL ASSESSMENT FROM A COMPREHENSIVE PERSPECTIVE

Index

1. OBJECTIVES OF THE SESSION

At the end of this session, the student should have learnt:

- The etiopathogenic classification of STROKE and the differences based on its mechanism.
- The epidemiology of the different types of STROKE.
- The different subtypes according to the origin and location of STROKE.
- How to recognise the differences in the clinical characteristics and deficits caused by each subtype of STROKE.
- The main differences according to the type and subtype of STROKE in relation to the clinical progress, prognosis and functional impairment.
- The assessment methods and scales used to study all the disabilities that may occur in patients with STROKE.

2. STROKE AND ITS CHARACTERISATION

2.1. Pathophysiology and epidemiology of STROKE

Pathophysiology

In cerebrovascular diseases, ischaemia occurs due to a reduction in the cerebral blood flow. This decrease can be either total (global ischemia) or partial (focal ischemia). Depending on the duration of the focal ischaemic process, it will be a transient ischaemic attack (TIA) if it lasts less than 24 hours or a cerebral infarction or stroke if the ischaemic deficit persists for more than 24 hours. Another cause of stroke is haemorrhage, that is, the presence of blood, either in the parenchyma or inside the cerebral ventricles (cerebral haemorrhage), or in the subarachnoid space (subarachnoid haemorrhage), as explained by Díez-Tejedor E et al.

Stroke is associated with different causes based on its pathology. Cerebral infarction is usually caused by thrombosis/atheroma or embolism, but it can also be due to intraparenchymal haemorrhage or subarachnoid haemorrhage.

- Ischaemic atheromatous stroke is related to the formation of atheromatous plaques in medium and large arteries, caused by functional damage to the endothelium. These plaques grow over time, which results in a reduction in lumen and arterial flow. The arterial occlusion that occurs affects the complex process of self-regulation of the cerebral blood flow and the supply of oxygen and nutrients to the brain tissue. This is known as an ischaemic cascade, which leads to tissue death. Neuronal death occurs as a result of cell necrosis, the activation of inflammatory cells and release of cytokines, vascular damage and oedema. This process is dynamic and progresses over time. Initially,

there is a central area of infarction and peripheral areas of oligohaemia that are potentially salvageable; the recovery of this salvageable tissue or ischaemic penumbra will depend on the arterial recanalization and the presence of collaterals that can supply blood.

- The main cause of cardioembolic ischaemic stroke is atrial fibrillation. The emboli that may form enter arterial circulation and produce arterial occlusive phenomena at different locations.
- Lacunar ischaemic stroke affects arteries of small diameter such as the lenticulostriate, basilar and medullary arteries. The underlying phenomena are lipohyalinosis and microatheroma.
- Arterial hypertension is the major cause of haemorrhagic stroke. Other risk factors include age, smoking, cholesterol levels and the use of sympathomimetics and antithrombotic drugs. Haemorrhagic stroke may be deeply located in the cerebral hemispheres (intraparenchymal haemorrhage), and/or may spread to the cerebral ventricles (intraventricular haemorrhage), or to the subarachnoid space (subarachnoid haemorrhage). The tissue is directly damaged, and secondary damage occurs as a result of cerebral oedema, as described by Déniz Cáceres A et al.

The factors that can increase the risk of suffering a stroke include:

- Blood pressure over 120/80 (mm Hg)
- Hypercholesterolemia
- Diabetes Mellitus
- Sleep obstructive apnoea
- Cardiovascular disease
- Personal or family history of stroke, TIA or myocardial infarction

There are modifiable risk factors like:

- Obesity and overweight
- Physical inactivity
- Alcoholism and smoking
- Using drugs such as cocaine and methamphetamine

There are other non-modifiable risk factors associated with stroke like:

- Age over 55 years
- Male gender
- Hormones: treatment with hormones that includes oestrogens or an increase in the levels of oestrogens.

The consequences of stroke include physical limitations due to motor impairments, language and swallowing disorders, psychic disorders, cognitive deterioration or secondary epileptic seizures. These consequences and their severity depend on the duration of the ischaemia and on the anatomic location of the stroke. Several authors state that around 50% of the survivors have some degree of disability. Additionally, stroke is estimated to be the most important cause of disablement or long-term disability in adults.

The rehabilitation process helps to increase survival and to decrease disability in patients with cerebrovascular disease. As with any brain injury, the success of the treatment varies from person to person.

Epidemiology

Stroke is the second cause of death worldwide. Developed countries show a decrease in mortality. According to several authors, the incidence of stroke is estimated at around 200 new cases per 100,000 residents each year, with variations depending on different factors. The prevalence is estimated at around 6%, although it varies based on age groups (Déniz Cáceres A et al.). "Stroke is the primary cause of disability in most Western countries. Globally, the economic burden of stroke is very significant, with substantial resulting costs: the health budget of some countries is estimated at more than 5%" (Quinn T et al.). "Stroke is the third leading cause of mortality in Britain after coronary heart disease and cancer. Each year, approximately 140,000 people in Britain have a first-time stroke, and about 60,000 die from a stroke" (Hisham NF et al.). "In terms of economic burden, stroke costs including all direct costs (diagnosis, hospital and/or outpatient care), indirect costs (loss of income and social benefits for patients with stroke), and informal costs (home care for disabled survivors) amount to approximately 9 billion pounds per year in the United Kingdom (Hisham NF et al.). "Stroke, a highly prevalent condition, involves a significant social burden in the form of the "feared Ds": it is the main cause of chronic Disability, the second cause of Dementia, and the fourth cause of Death in the United States, where the prevalence of stroke is approximately 3% of the adult population (nearly 7 million people). Approximately 800,000 primary strokes (first-time) or secondary strokes (recurrent) occur each year in the US, most of them being primary strokes (approximately 600,000)" (Ovbiagele B et al.).

"Stroke is a heterogeneous pathology that includes ischaemic stroke, which accounts for around 80-85% of the total, and haemorrhagic stroke, which is responsible for 15-20%. It also encompasses cerebral venous thrombosis as well as subarachnoid and intraparenchymal haemorrhage. Additionally, stroke can affect the pathology of both small and large vessels and can be related to multiple etiologies" (Díez-Tejedor E et al). According to the Oxford Community Stroke Project, 81% of primary strokes are cerebral infarctions, 10% intraparenchymal haemorrhages, 5% subarachnoid haemorrhages and 5% are of an indeterminate type (Hisham NF et al.). Moreover, the data provided by the Stroke Data Bank of the National Institute of Neurological Disorders and Stroke and the Framingham study, using the TOAST classification show that 60% of ischaemic strokes can be attributed to embolism; 25% to the occlusion of small vessels (lacunar stroke), and 15% to atherothrombosis (Mant et al).

Study	Number of patients	LVD	MVD	Embolism	Infrequent causes	Undetermined causes	Hemorrhagic strokes
Narrving et al	1.054	616 (58%)	-	323 (30%)	-	-	111 (11%)
HCSR	694	233 (33%)	131 (19%)	215 (31%)	-	-	70 (10%)
LSR	1.000	427 (42%)	147 (15%)	204 (20%)	55 (6%)	58 (8%)	109 (11%)
NINCDS	1.805	182 (10%)	337 (19%)	246 (13%)	52 (3%)	508 (28%)	480 (26%)
HULPRI	1.222	322 (26,35%)	279 (22,83%)	290 (23,73%)	178 (14,52%)		153 (14,56%)

HCSR: *Harvard Cooperative Stroke Registry (1978)*; LSR: *Lausanne Stroke Registry* (1988); NINCDS: National Institute of Neurological and Communicative Disorders and Stroke (1989); HULPRI: Hospital Universitario La Paz, Registro de Ictus (1994-1996): LVD: Large Vessels Disease EPV: Microvascular Disease.
Modification of Diez-Tejedor E and Soler R (7)

Table 1. Extracted from the article by Díez-Tejedor E. "Clasificación de las enfermedades cerebrovasculares" [Classification of cerebrovascular diseases]. Sociedad Iberoamericana de Enfermedades Cerebrovasculares.

2.2. Types and subtypes of STROKE. General classification

Strokes can be classified into two large groups according to their mechanism:

- Cerebral ischaemia or ischaemic stroke. A distinction can be made between focal cerebral ischaemia, which affects only one area of the encephalon, and global cerebral ischemia, which affects the brain diffusely.
- Intracranial haemorrhage or haemorrhagic stroke. They are divided into deep and cortical, in addition to subarachnoid haemorrhage.

Based on the duration of the ischaemic process, two types of focal cerebral ischemia are distinguished: Transient Ischaemic Attack (TIA), defined as an episode of focal or monocular cerebral ischaemia that lasts less than 24 hours, and cerebral infarction, which causes a neurological deficit that persists for more than 24 hours, and indicates the presence of tissue necrosis.

They can also be classified according to the underlying cause. The TOAST trial classification distinguishes several clinical categories of cerebrovascular disease:

- Atheromatous disease, which can affect the carotid or vertebral arteries extracranially located, as well as the main intracranial arteries.
- Cardioembolic strokes, associated with a cardiac source of emboli.
- Another fundamental etiological alternative is the lacunar pathology or small arterial vessel.
- The rest of the etiologies encompass less frequent conditions such as dissections, neoplasia, vasculitis, and many other including genetic causes.

Stroke can also be classified from a topographic point of view, based on the affected vessel. Because of its wide dissemination, the classification proposed in 1991 by the Oxfordshire Community Stroke Project is included below. The singularity of this classification lies in the fact that it exclusively uses clinical criteria:

- TACI (Total Anterior Cerebral Infarction). They account for 15% of cerebral infarctions. The cause is more commonly embolic.
- PACI (Partial Anterior Cerebral Infarction). It is the most frequent infarction (35%). The two most common causes are cardioembolism and atherosclerosis in a similar proportion.
- LACI (Lacunar Infarction). They represent 25% of cerebral infarctions. The most common cause is lipohyalinosis associated with arterial hypertension, as well as microatheromas.
- POCI (Posterior Circulation Infarction). Their frequency is also 25%. The most common cause is atherosclerosis.

Extracted from Diaz-Tejedor et al.

2.3. Clinical characteristics of STROKE and its prognosis

CLINICAL CHARACTERISTICS

The clinical presentation of stroke is normally acute and will depend on the etiology and the topography of the lesion. Although the clinical symptoms of ischaemic and haemorrhagic strokes are very similar, impaired consciousness, intracranial hypertension and intense headache are more common in haemorrhagic strokes.

In other cases, the vascular disease can be subclinical and may be revealed in a study performed for a different reason. It is not uncommon to find a carotid stenosis, ischaemic lesions or even microhaemorrhages that were asymptomatic.

The clinical presentation of stroke will depend on the anatomical location and the extent of the lesion (the duration of the ischaemia and the volume of bleeding determine the severity of the injury), as well as on the ability of the collateral circulation to compensate through the Willis polygon, which can palliate the lack of blood supply to an area by increasing the flow through an alternative route (Déniz Cáceres et al).

Symptoms and signs according to the location

Depending on the affected arterial territory, the symptoms of stroke will be different. Likewise, infarctions secondary to cerebral venous thrombosis will have a different clinical translation based on the area of the brain affected. The clinical presentations or neurovascular syndromes are described according to the arteries involved.

- Internal carotid artery

  If there is adequate intracranial collateral flow, the occlusion of this artery may not show any symptoms. The consequences of insufficient blood flow range from a TIA to a large infarction in the ipsilateral hemisphere.
  The neurological presentation ranges from monoparesis, to contralateral hemiparesis with or without a homonymous defect in vision, speech or language impairment, various types of agnosia, and partial or total contralateral sensory defects.
  Amaurosis fugax is characteristically associated with stenosis of the internal carotid artery. The anterior choroidal artery syndrome is also within the territory of the internal carotid artery; this syndrome may be accompanied by contralateral hemiparesis, hemianesthesia and contralateral homonymous hemianopsia, which is a cardinal symptom of this topography.

- Middle cerebral artery

  The middle cerebral artery begins at the bifurcation of the internal carotid artery. The occlusion of the first portion of the middle cerebral artery is usually caused by emboli, although atheromatous stenosis may also exist. The occlusion of the first part of this artery can cause a serious deficit that includes contralateral hemiplegia, contralateral hemihypoaesthesia, homonymous hemianopsia, paresis of the contralateral gaze and, if the infarction occurs in the dominant hemisphere, aphasia. The occlusion of the trunk of the middle cerebral artery can cause motor impairments due to the isolated involvement of the deep territory.

- Anterior cerebral artery

  The occlusion in the proximal part is usually compensated by the collateral flow through the anterior communicating artery. The obstruction of the distal part causes weakness of the contralateral lower limb, which is generally more acute in its distal part and is sometimes associated with weakness in the proximal muscles of the contralateral upper limb. There may be sensory involvement of the same areas. Apraxia (mainly in gait), apathy, oculocephalic deviation, behavioural disorders, contralateral paratonia, frontal release reflexes, and urinary incontinence may also occur (Díaz Tejedor E et al.).

- Boundary syndromes

  In these conditions, the lesion occurs in the area between two arterial territories, like between the anterior and the middle cerebral arteries. In this case, there may be transcortical motor aphasia (decreased fluency with normal repetition and echolalia) and predominantly proximal paresis that does not normally involve the face. In the posterior boundary territory between the middle and the posterior cerebral arteries, the symptoms include sensory aphasia, visual impairment, hemi-inattention, and in the case of bilateral infarction, cortical blindness.

- Vertebrobasilar system

  The vertebrobasilar system supplies the cerebellum, medulla, pons, midbrain, thalamus, occipital lobe, and even portions of the temporal-occipital and parietal-occipital junctions. Three main arteries are identified:
  Vertebral artery. The occlusion of a vertebral artery or posterior inferior cerebellar artery can cause a lateral bulbar infarction. This Wallenberg syndrome is characterised by the sudden onset of severe vertigo, nausea, vomiting, dysphagia, ipsilateral cerebellar ataxia, ipsilateral Horner syndrome, as well loss of sensitivity to pain and temperature in the ipsilateral hemiface and the contralateral hemi-body.
  Basilar artery. The basilar artery has branches that supply the brain stem, which occlusion can cause the infarction of the brain stem. The syndromes that cause the involvement of these branches can affect the motor function or the sensitivity of one side of the face and the contralateral hemi-body. Vertigo is a significant symptom, and nystagmus frequently occurs. The “top of the basilar artery” is a characteristic syndrome in which the occlusion of the distal part of the artery results in a very severe infarction of all the distal territories. The basilar artery thrombosis is a syndrome typically progressive and associated with a poor prognosis.
  Posterior cerebral artery. The basilar artery bifurcates into two posterior cerebral arteries. The occlusion is often due to emboli and causes a homolateral visual defect, as well as other more complex phenomena like palinopsia, diplopia, metamorphopsia, telescopic vision, prosopagnosia, etc. It can also lead to dyslexia and dyscalculia, which occur due to the involvement of the dominant hemisphere. When both posterior cerebral arteries become occluded, cortical blindness and frequent behavioural abnormalities occur (Díaz Tejedor E. et al.).

Typs of Isquemic stroke	Signs and symptoms	Location	Causes
Lacunar Infarction (LACI)	Pure motor syndrome Pure sensory loss Sensorimotor syndrome Ataxia-hemiparesis Dysarthria-clumsy hand syndrome	Basal ganglia Protuberancia	Lipohialinosis Microatheroma
Total Anterior Cerebral Infarction (TACI)	Brain cortical dysfunction (aphasia, acalculia, visual-spatial perception disorders) Homonymous hemianopsia. Motor and-or sensory impairment, at least in two areas (face, upper or lower limb)	Superficial and deep territory of middle and anterior cerebral artery . Superficial and deep territory of middle cerebral artery .	Embolism Thrombosis
Partial Anterior Cerebral Infarction (PACI)	Two or three components of TACI: Brain cortical dysfunction . Less extended sensorimotor impairment than in LACI (f.e. monoparesis)	Posterior and inferior territory of Anterior Cerebral Artery.	Embolism Thrombosis
Posterior Circulation Infarction (POCI)	Ipsilateral dysfunction of one or more cranial nerves and contralateral motor and/or sensory impairment (Conjugate gaze disorders). Nuclear or internuclear motor ocular disorders. Cerebellar stroke syndrome. Homonymous hemianopsia uni or bilateral	Vertebrobasilar territory Cerebellum Encephalic trunk Occipital lobe	Embolism Thrombosis

Bamford et al 1991. OCSP: *Oxfordshire Community Stroke Project.*

Table 2. Extracted from the article by Díez-Tejedor E. "Clasificación de las enfermedades cerebrovasculares" [Classification of cerebrovascular diseases]. Sociedad Iberoamericana de Enfermedades Cerebrovasculares.

PROGNOSIS

When trying to establish a prognosis in stroke, several factors must be considered. Some interesting information for prognostic purposes is included below:

- Prognosis after stroke can be described in terms of survival, risk of a second stroke (recurrence) or degree of long-term disability. The prognostic factors are different for each of them.
- It is important to highlight three major predictors of the rehabilitation results after stroke: degree of the initial severity of the stroke, topography of the lesion, and etiology of the lesion.
- Depending on the initial severity of the stroke, different recovery profiles can be defined. In strokes with a severe initial disability, the greatest recovery occurs between the first and the third month and lasts up to six months.
- The recovery of the motor deficit is basically related to its initial severity. Most patients who have a severe and persistent motor deficit three weeks after stroke still show a severe level of paresis six months after stroke. Regaining proximal movement in the upper limb during the first four weeks is not itself associated with the return of the

function; however, if voluntary hand grip is detected, the return of an at least poor function can be expected after a period of several months.

- The age of the patient is also determinant in the vital and functional prognosis after stroke: young patients have an inherently greater potential for survival and functional results than older patients.
- The etiology of stroke is important for the prognosis (see Table 2) and from a clinical perspective because there are some differences in the acute treatment of patients with intracerebral haemorrhage and cerebral infarction. Etiology is a very important predictor of disability and participation restrictions, and these are major determinants of health care needs both in the near future and in the long run.
- The prognosis of haemorrhagic stroke is worse in terms of disability and mortality; it is influenced by the volume of the haematoma, which correlates with the intracranial hypertension and the decrease in cerebral perfusion.

Stroke type	Mortality at one month (95% CI)	Mortality at one year (95% CI)
Cerebral infarction	10% (7–13)	23% (19–27)
Primary intracerebral haemorrhage	50% (38–62)	62% (43–81)
Sub-arachnoid haemorrhage	46% (29–63)	48% (24–72)
Uncertain type	77% (46–100)	84% (52–100)
All	19% (16–22)	31% (27–35)

Table 3. Extracted from chapter Mant J, Wade D, Winner S. Stroke. In: Stevens A, Raftery J, Mant J, Simpson S. Health care needs assessment.

- Depending on the anatomical location of the lesion, a TACI is associated with high mortality and significant disability in most survivors, a PACI is associated with an increased risk of early stroke recurrence, a patient with a POCI is the most likely to have good recovery, whereas patients with a LACI have the best chance to survive. For lacunar strokes, the relationship between the clinical classification and the anatomical site may not be accurate (Mant J et al.).

	Case fatality (%)			Functionally dependent (Rankin 3–5) (%)			Dead or dependent		
	1 month	6 mths	1 year	1 month	6 mths	1 year	1 month	6 mths	1 year
LACI	2	7	11	36	26	28	38	34	40
TACI	39	56	60	56	39	36	96	96	96
PACI	4	10	16	39	34	29	44	45	45
POCI	7	14	19	31	18	19	38	32	38
All	10	18	23	39	29	28	50	48	51

Table 4. Extracted from chapter Mant J, Wade D, Winner S. Stroke. In: Stevens A, Raftery J, Mant J, Simpson S. Health care needs assessment.

- We have argued that, in order to predict how an individual will be affected by a stroke, we must first understand and control multiple factors that can influence whether a specific function is affected and to what extent. Controlling as many sources of inter-patient variability as possible should reveal consistent injury-result associations for some locations of the injury even if other locations show more variable results (Price CJ et al.).

- "Substituting some or all the treatments of a standard rehabilitation regime with VRBR provides greater benefits in walking speed, balance and mobility in people with stroke. Although the benefits are small, the extra cost of applying virtual reality to standard rehabilitation is also small, especially when spread over many patients in a clinic. Adding extra VRBR time to standard rehabilitation also provides some benefits; further research is needed to determine if these benefits are clinically worthwhile" (Corbetta D et al.).
- A personal history of pre-stroke disability strongly determines a worse result.
- Regarding the symptoms and clinical signs, a patient with stroke showing cognitive deterioration is associated with worse results after stroke. Global aphasia has the worst prognosis, whereas anomic, transcortical and conduction aphasia show the best improvements (Bowen A et al.).
- The symptoms and clinical signs include other potentially modifiable factors that can change the prognosis of the patient since they interfere with the rehabilitation process, that is, those factors associated with the conditions that usually appear after stroke: depression, malnutrition and dysphagia, incontinence and pressure ulcers (Quinn T et al.).
- One third of all stroke survivors develop post-stroke depression, which negatively affects participation in rehabilitation treatments, adherence to treatment and short-term recovery and increases the risk of death during the period after stroke (Hisham NF et al.).
- However, given the uncertainty associated with the estimation of an individualised prognosis for each patient, it will be necessary to monitor the patient by performing successive assessments of their progress in the rehabilitation process in order to modify the initial prognosis.

2.4. Comprehensive functional assessment in STROKE

The evaluation of the patient with stroke should be structured and methodical. It requires a team of specialists to achieve a multidisciplinary assessment of the motor, sensory and/or neuropsychological disabilities that may exist.

It is necessary to perform an individual assessment of the patient through a complete anamnesis, a basic general physical examination, a thorough neurological examination and the use of functional assessment scales, which allows us to quantify the disability and to propose an adequate treatment. To achieve these objectives, we use measurement instruments like scales and validated questionnaires, among others.

The scale used depends on the aspect to be assessed.

Neurological damage assessment

- In the acute phase, the National Institute of Health National Stroke Scale (NIHSS) is used for assessing neurological damage. This scale consists of 11 items that allow us to assess cortical functions, cranial nerves, motor function, sensitivity, coordination and language. It reliably quantifies stroke severity and classifies it into several groups: 0 points means no deficit; 1 minor; 2-5 mild; 6-15 moderate; 15-20 significant; > 20 severe deficit. It can be used to quantify variations, which are defined as an increase or decrease of 4 points with respect to the previous value. In addition, this scale correlates with the prognosis.

A score lower than 7 on the NIHSS scale is related to an excellent neurological recovery. The prognosis worsens as the points increase.

- To assess the level of consciousness, the Glasgow Coma Score is used.
- The Hunt and Hess scale is a system for classifying subarachnoid haemorrhage.
- The Canadian Neurological Scale is used as a tool to diagnose neurological deficit.
- Finally, the Orpington Prognostic Scale assesses the severity of stroke and determines the patient rehabilitation needs.

Basic activities of daily living (ADLs)

The basic ADLs are a basic factor. We need to know if the patient is functionally able to perform the most basic tasks described below.

- Functional independence measure (FIM). It assesses the functional independence in the basic ADLs, with excellent validity and reliability. Its maximum score is 126; a score lower than 40, or lower than 60 in people over 75 years, is considered an unfavourable prognostic factor of function.
- Barthel Index. It is the most widely used scale for the assessment of basic ADLs, it has excellent validity and reliability, but low sensitivity in patients with a good functional level. Its maximum score is 100, which would mean there is complete independence in the basic ADLs; a score equal to or greater than 85 means good autonomy, whereas an index lower than 20 indicates a very severe disability. Ten areas are analysed: feeding, bathing, grooming, dressing, bowel and bladder control, toilet use, chair/bed transfer, ambulation, going up and down stairs.
- The Modified Rankin Scale is another scale that globally assesses the level of physical disability after stroke.

Instrumental activities of daily living (IADLs)

Instrumental activities such as cooking, shopping, using public transport, etc. are more complex to perform. These activities allow the person to participate in the community and society.

- Frenchay Activities Index. This questionnaire assesses the instrumental activities of daily living.

Work and leisure

This section deals with two related but different types of activity: productive work and leisure activities. People with stroke may require specialised advice and support to resume these activities.

- Use a list of the job requirements.
- Perform the questionnaires for cognitive evaluation, general function and upper limb function to establish the global function, if necessary.
- Prepare an action plan for potential problems that may arise when performing work.

- Compare the requirements of the job with the capabilities of the person who has suffered the stroke and determine the gaps. It may be necessary to adapt the work environment, to use strategies to compensate the functional limitations in mobility and arm function, and to manage fatigue.

Function of the upper extremity

When assessing the function of the upper limb, it is important to consider a basic examination of joint mobility, analytical strength, coordination and manual ability. Additionally, some scales can be used:

- Motricity Index. It is a useful scale to assess voluntary motor activity in three basic movements of the upper limb (shoulder abduction, elbow flexion and hand grip) as well as in three movements in the lower limb (hip flexion, knee extension and foot dorsiflexion). It is a valid and reliable scale where 0 represents a total paralysis and 100 means normality. An upper limb motor index above 18 four weeks after stroke indicates a good functional prognosis. A lower limb motor index of 38 three weeks after stroke indicates a good chance of independent gait.
- Fugl-Meyer Scale. It has good validity and reliability to assess the motor function and the sensitivity of the limbs involved as well as balance. It is applied clinically and in research to determine disease severity, describe motor recovery, and to plan and assess treatment.
- Action Research Arm Test. It is a tool to assess the function and dexterity of the upper limb.
- Box and Blocks test. It is a tool used to measure unilateral gross manual dexterity.
- Chedoke Arm and Hand Activity Inventory. It is an assessment questionnaire for the arm and the hand function.
- Nine Hole Peg Test. It assesses fine manual dexterity.
- Wolf Motor Function Test. It evaluates the motor ability of the upper limbs.
- Manual dynamometry. It allows us to know the maximum grip strength of both hands.

Cognitive

General aspects

The evaluation of the intellectual functions or cognitive evaluation is a very important part in the assessment of a patient with stroke. The evaluation begins the moment we greet the patient and start talking. The following questionnaires are available to complete and standardise the functional examination.

- The most widely used scale for cognitive assessment is the Mini Mental State Examination, a brief screening test to detect cognitive impairment. It has a maximum score of 30 with the threshold value for cognitive impairment being 23. It cannot be used in patients with aphasia.
- The Montreal Cognitive Assessment test can be used to detect mild cognitive impairment.
- Other tests include the Oxford Cognitive Screen and the Clock Drawing Test.

Cognitive and behavioural disorders are a major cause of disability after stroke. They can negatively interfere with the patient participation in rehabilitation, the performance of daily living activities, and participation in society, which worsens the functional prognosis. The neuropsychological assessment and the rehabilitation should focus on the following cognitive areas.

Apraxia

Apraxia is a disorder in which patients cannot perform purposeful movements, they have a good understanding of language and no primary motor deficit that prevents them from performing the movement. It is associated with lesions in the left hemisphere of the brain.

- Test for the upper limb Apraxia (TULIA): questionnaire to study it.

Attention and concentration

"Attention is an essential requirement to perform many cognitive and motor tasks. Patients with attention disorders must receive treatment focused on improving the level of alertness and the ability to maintain attention".

Executive functions

Executive functions organise, plan, initiate or inhibit behaviour, solve problems, enable self-regulation and are consequently linked to social behaviour. They may be altered when the frontal lobes are affected.

- They can be detected using the Behavioural Assessment of the Dysexecutive Syndrome questionnaire.

Memory

If memory is affected, patients may have difficulty learning new information or skills, remembering and retrieving information or remembering what they have to do in the future.

- The Rivermead Behavioural Memory Test is used to study memory.

Perception

Perception involves processing and interpreting incoming sensations, which is essential for everyday activities. Perceptual functions include alertness, recognition, discrimination and orientation.

- The Visual Object and Space Perception battery studies spatial perception.
- The Motor-free Visual Perception Test assesses visual perception.

Spatial attention

Neglect or spatial inattention is a disorder that affects the patients' capacity to direct their attention to the space around and to their own body, which limits their ability to respond and to orient themselves towards the stimuli that come from the space contralateral to the injury. It can occur in right hemisphere strokes and must be considered in relation to the ability to drive vehicles.

- Both the Behavioural Inattention Test and the Line Bisection Test detect spatial inattention.

Communication

Aphasia

Aphasia or dysphasia is an acquired disorder that can affect spoken language (comprehension and/or expression), or written language (reading and/or writing). Some cognitive functions stay relatively intact as a consequence of a focal brain injury.

From the moment we meet the patient, it is necessary to pay attention to the basic features of language: comprehension, spontaneous language, ability to find words, naming, repetition, reading and writing. Aphasia can be classified as global (the individual does not speak or understand), Wernicke's (the individual does not understand), Broca's (the individual does not speak fluently), transcortical sensory (the individual does not understand, but is able to repeat), transcortical motor (the individual does not speak fluently, but can repeat), conduction (the individual is not able to repeat), anomic (not able to name objects).

- The Boston Diagnostic Aphasia Examination is used to study aphasia. It differentiates the various types of aphasia and quantifies the degree of impairment in each language area.
- The Frenchay Aphasia Screening Test can also detect aphasia.

Dysarthria

Dysarthria is a motor speech disorder that affects clarity of speech, the quality and volume of the voice and, most of all, intelligibility (Déniz Cáceres A et al.). It can be detected by listening to the patient.

Apraxia of speech

Apraxia of speech is a speech disorder that impairs the ability to plan and perform the motor actions involved in speaking.

Continence

It is advisable to examine bladder and bowel continence by:

- Ruling out urinary retention and dysuria.
- Measuring the frequency of urination and stools, volume and control of urination and bowel movements.
- Rectal examination to evaluate sphincter activity and reflexes.

Fatigue

Patients who have suffered a stroke have less endurance and fatigue occurs earlier. The following scales can be used to study fatigue:

- The Fatigue Severity Scale and the Modified Fatigue Impact Scale. Both are mainly used in multiple sclerosis.

Hydration and nutrition

The level of hydration and nutrition are important factors to consider.

- The Malnutrition Universal Screening Tool is validated for stroke.

Mobility

First, the active joint balance will be examined and, if limited, then the passive one will be also examined in functional tasks such as sitting, transfers, trunk control, standing and gait according to the degree of impairment of the patient. The following functional scales can be used:

- Fugl-Meyer Assessment of Motor Recovery after Stroke. It assesses the motor function after stroke: upper and lower limbs, balance, sensitivity, range of movement and pain.
- Rivermead Motor Assessment and Stroke Rehabilitation Assessment of Movement, which also evaluate the motor function.
- Chedoke-McMaster Stroke Assessment Scale. It is a screening scale which assesses physical disability and impairment.

Weakness and ataxia

As a consequence of the motor involvement of a hemi-body secondary to stroke, the muscle balance of the lower limb is altered, which causes weakness and affects standing and gait, skills that are necessary for independence in daily living activities. Weakness on one side of the body (hemiparesis or hemiplegia, depending on the severity) is a hallmark of stroke, occurring in 80% of people with this condition.

Ataxia is the loss of motor control and coordination and, therefore, of the ability to perform a specific movement. Ataxia occurs in about 3% of ischaemic strokes, mainly in those cases involving the cerebellum, but also as a result of a severe sensory dysfunction (known as sensory ataxia).

- Both the Motor Index and the Scale for the Assessment and Rating of Ataxia assess these two items.

Balance

Balance disorders in stroke patients are caused by the malfunctioning of several systems. There is a reduction in the motor control of the trunk and the lower limb affected by the stroke, an alteration in the sensitivity of the hemi-body damaged, and a perception disorder, which makes it difficult to maintain posture.

- The Berg Balance Scale is the most widely used scale to assess balance in adults.

Falls and fear of falling

Stroke typically affects the initial propulsion of gait, hip and knee flexion during the swing phase, and stability during the stance phase. This increases the risk of falls, which weakens the patients´ self-confidence, decreases their physical and social activity, and ultimately affects their functional independence.

Other factors that increase the risk of falling include muscle weakness, balance disorders, visual impairments, sensory deficits, cognitive damage and aging.

- The Timed "Up and Go" Test assesses basic mobility and balance.

Gait

It is essential to perform a gait assessment that objectifies the disorders caused by stroke.

- To carry out this assessment, the Functional Gait Categories of Sagunto Hospital can be used, which provide a quick, valid, sensitive and reliable assessment of gait.
- The 6-minute gait test assesses gait capacity and endurance.
- The 10-metre test evaluates the speed that the individual can reach.
- The Functional Ambulation Categories classify the type of gait that the patient can perform.
- The Rivermead Mobility Index test assesses functional mobility.

State of mind

Anxiety and depression

Up to one third of the patients with stroke have anxiety, which can be caused by the uncertainty about their recovery, current events, family and fear of having another stroke. Depression is common after a stroke, consequently, early detection and treatment are essential.

- The Stroke Aphasic Depression Questionnaire, the Depression Intensity Scale Circles or the Behavioural Outcomes of Anxiety can be used in patients with aphasia to assess their state of mind.
- The Beck Depression Inventory is a screening questionnaire that determines the levels of depression.
- The Hospital Anxiety and Depression Scale is another screening questionnaire that determines the levels of anxiety and depression.
- The General Health Questionnaire is a general questionnaire to screen psychiatric disorders.

Pain

Pain is a very common symptom that is quantified using the Visual Analogue Scale (VAS) from 0 to 10, depending on the pain intensity.

Neuropathic pain (central post-stroke pain)

It is a constant or intermittent neuropathic pain arising from the central nervous system which occurs after an ischaemic or haemorrhagic stroke. It affects a small percentage (2-5%) of patients.

- The self-administered Leeds Assessment of Neuropathic Symptoms and Signs scale can be used, which assesses chronic neuropathic pain.

Omalgia and subluxation

Pain in the shoulder of the plegic/paretic upper limb is a frequent condition. In early phases, it is associated with glenohumeral joint subluxation, whereas in late phases it is related to spasticity. It can be assessed by performing a physical examination of the shoulder that includes mobility, rotator cuff strength, symptoms of subacromial compression, and instability.

Sensitivity

Stroke may result in a loss of sensitivity, which affects the perception of touch, joint position sense, temperature and pain. The severity of the sensory loss is related to the severity of the motor loss.

- The Nottingham Sensory Assessment evaluates sensory impairment in stroke patients.

Spasticity and contractures

Spasticity is a motor disorder that increases muscle tone depending on the speed of the joint movement. The presence of muscle spasms should be ruled out. It requires treatment to avoid the occurrence of contractures that limit joint balance in the affected limbs.

- The Modified Ashworth Scale assesses the degree of spasticity.
- The Penn Scale evaluates muscle spasms.

Deglutition

Stroke may affect swallowing and, therefore, dysphagia must be ruled out to avoid respiratory infections. A 50 ml water swallowing test and a tongue mobility test are used. In this way, we reduce the main cause of mortality in patients with stroke in the acute phase. We also avoid the malnutrition that affects 30% of the patients, which is a predictor of poor functional outcomes and of an increase in mortality.

Vision

“People with stroke often experience visual problems that include altered visual acuity, loss of visual field (like hemianopsia) and disrupted eye movements, which causes diplopia, nystagmus, blurred vision, and loss of depth perception” (Bowen A et al.).

- The tests included in the perception section can be used. In addition, the patient can perform a visual acuity test and be referred to an ophthalmologist for a complete examination, if necessary.

3. KEY IDEAS

- Stroke occurs as a result of a decrease in the cerebral blood flow, either local or global, of ischaemic or haemorrhagic cause, that can last less than 24 hours (TIA) or longer than 24 hours, in which case a stroke is diagnosed.
- According to their pathophysiology, ischaemic strokes can be classified as atheromatous, cardioembolic and lacunar. Furthermore, haemorrhagic strokes can be classified into intraparenchymal, intraventricular and subarachnoid.
- The consequences of stroke include physical limitations due to motor deficits, language and swallowing disorders, psychic disorders, cognitive deterioration and secondary epileptic seizures.
- These consequences and their severity depend on the ischaemia duration and the anatomic location of the stroke. Around 50% of the survivors have some degree of disability. Stroke is estimated to be the most important cause of long-term disability or incapacity in adults.
- The incidence of stroke is estimated at around 200 new cases per 100,000 residents each year, with a prevalence estimated at around 6%, although there are variations.
- Strokes can also be classified from an anatomical point of view, based on the affected vessel as described by the Oxfordshire Community Stroke Project, which only uses clinical criteria: TACI, PACI, LACI and POCI.
- The clinical presentation of stroke is acute and will depend on the etiology, the topography and the extent of the injury (the ischaemia duration or the blood volume determine the severity of the injury), as well as the compensation ability of the collateral circulation.
- The symptoms of stroke vary depending on the affected artery territory. There are several neurovascular syndromes because different arteries can be involved: the internal carotid, anterior cerebral, middle cerebral, vertebrobasilar system and boundary syndromes.
- The main predictors of the functional results include the initial degree of severity of the stroke, topography and etiology of the lesion, patient's age, degree of neurological recovery during the first month, cognitive impairment, complications such as respiratory infection, malnutrition, eschars and depression.
- It is advisable to perform an individual assessment of the patient through a complete anamnesis, a general basic physical examination, a good neurological examination and to use functional assessment scales that allow us to quantify disability.
- The most widely used scales include the National Institute of Health National Stroke Scale, Glasgow Coma Score, Barthel's Index, Functional Independence Measure, modified Rankin Scale, Motricity Index, Fugl-Meyer scale, Mini-Mental State Examination, Montreal Cognitive Assessment, Rivermead Behavioural Memory Test,

Visual Object and Space Perception battery, Behavioural Inattention Test, Boston Diagnostic Aphasia Examination, Berg Balance Scale, Timed “Up and Go” test, the 6-minute gait test, the 10-metre gait test, Beck Depression Inventory, Visual Analogue Scale for pain, Nottingham Sensory Assessment, modified Ashworth Scale, Penn Scale, the 50 ml water swallowing test and tongue mobility test, and the visual acuity test.

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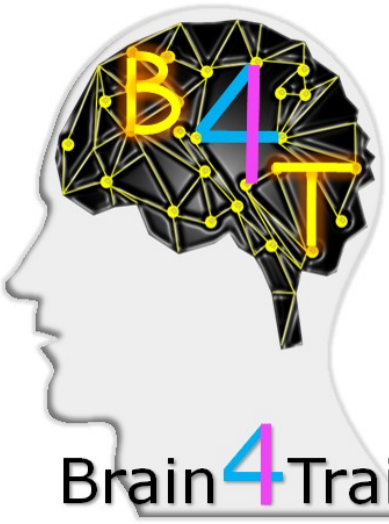

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