Third Course "Gait Analysis and Clinics: a focus to a clinical cases "

Trama Project

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Cerebral Palsy : Description of the pathology and Functional clinical scales

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Santiago

Definition:

- It is a syndrome, characterized by a motor disorder (movement, tone and posture), secondary to a brain injury, not progressive, which is produced in an immature brain, in the pre, peri or postnatal period until 3 to 5 years old.

Cerebral Palsy Definition

"However, the term not progressive, can contribute to a misunderstanding of the secondary musculo-skeletal pathology, which is not static, but definitely progressive.

- Boyd, Graham,1997

Epidemiology:

- From the decade of 70, is the most prevalent pathology , in the IRI Santiago.
  Today, it reaches 36.3% of the incomes dg (November 2007).

- Decade of '70:
  ↓ Better perinatal care and appearence of neonatal UCI.

  Decade of the´90s and beyond:
  ↑ Survival of children with very low birth-weight.

Incidence:

- <u>Prematurity and low bird weight:</u>

✍ Developed countries: incidence of 5 – 7% of newborn child.

✍ Developing countries: 10-19% of new borns.

✍ Chile, in 1989, 6,3%.

Damages originor causes are: asphyxia, intraventricular or subependimary haemorrhage.

Etiology:

- Risk factors are related to:

  Pre-natal period: HTA - Diabetes - Cholestasia intrahepatic - Erytroblastosis fetal - congenital infections (TORCHS) - genetic syndromes.

  Perinatal Period: Prematurity - placental complications - Presentations altered – Birth Cord Problems - Childbirth prolonged.

  Post-natal period: Injuries - Infections - AVE – toxic-metabolics affections or diseases.

  Remaining 20% are causes not specified.

Anatomopathology of cerebral damage: Preterm infants

-Intrinsic Vulnerability of the Preterm Brain child to an ischemic and haemorrhagic injury. This predisposes to:

1 – Primary Artery Ischemic Damage of the white matter: Leukomalacia Periventricular (LPV): Bilateral. Clinic: Spastic Diplegia.

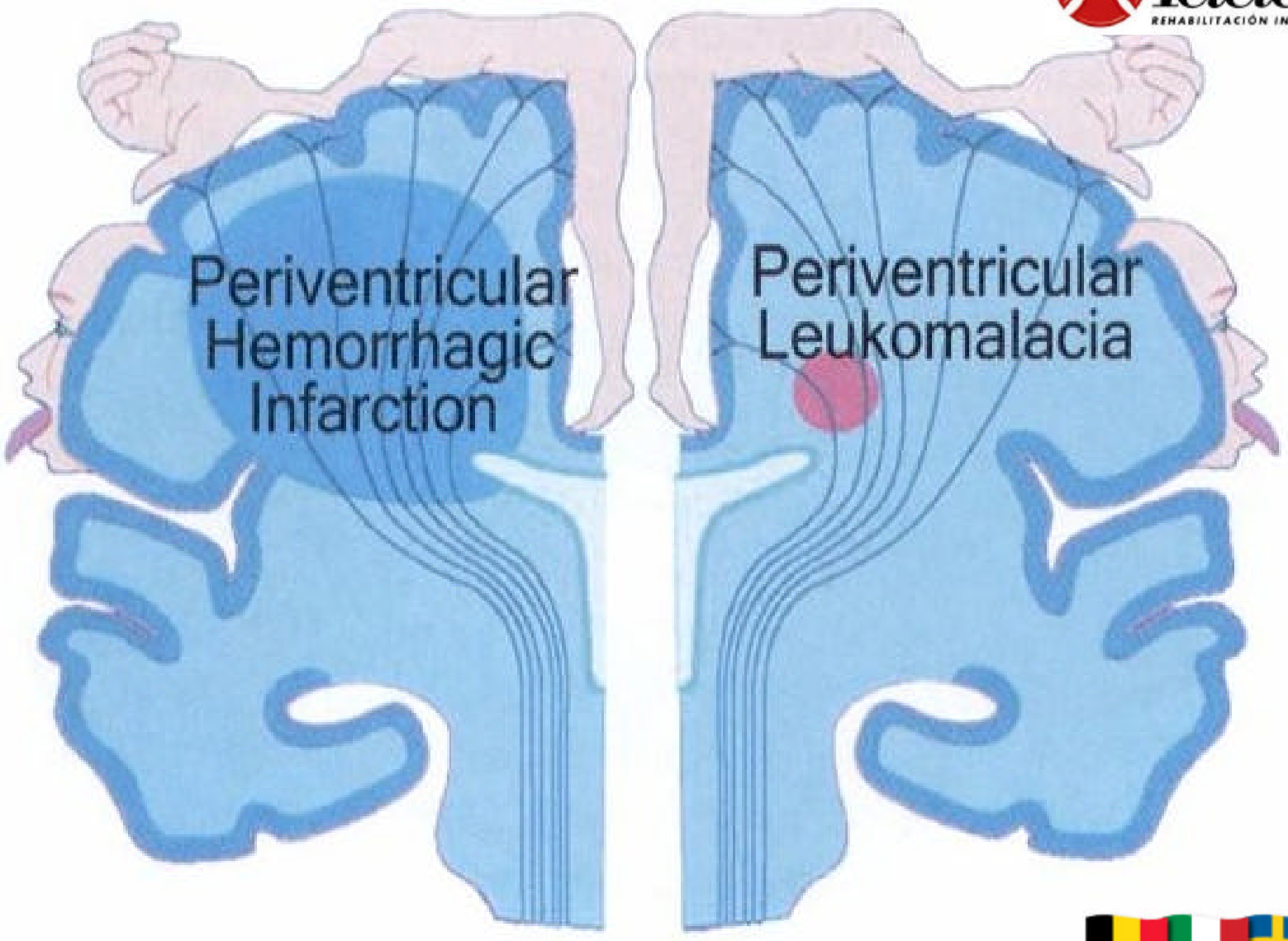
Anatomopatology of cerebral damage: Preterm child

2 - Parenchymal complications of Intraventricular Hemorrhage:

- Infarction (Heart attack) Hemorrhagic Periventricular (IHPV): Unilateral. Clinic: Hemiparesy spastic.

-Hidrocephalic Post-hemorrhagic (HPH): Bilateral. Clinic: Spastic Diplegia.

LPV + IHPV: Clinic: Triplegia.


Periventricular
Hemorrhagic
Infarction
Periventricular
Leukomalacia

Anatomopatholoy of cerebral damage:
Well born child

- Cerebrovascular lessions result from:
  Hipoxic-hypoperfusion insults to the entire brain.

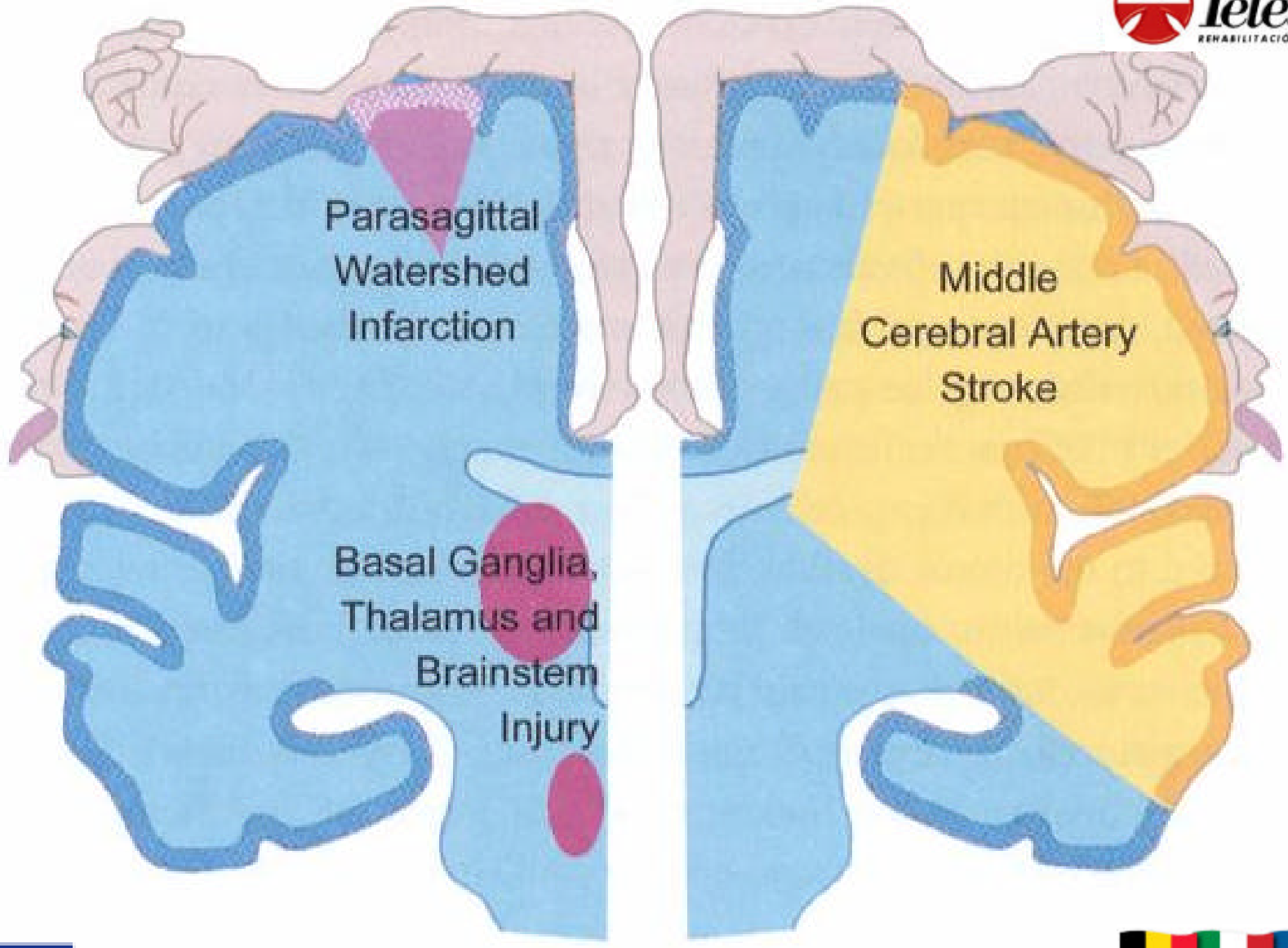
  - Focal infarct secondary to an embolic occlusion of a cerebral artery..

Anatomopatology of cerebral damage: well born child

- This creates or causes the folowing damages:
  Brain damage parasagittal. Clinic: Cuadriparesy.

  Damage from basal Ganglia. Clinic: extrapiramidal commitment + spastic .

  Damage Arterial-focal occlusive or stroke. Clinic: will depend on the territory injured.


Parasagittal
Watershed
Infarction
Middle
Cerebral Artery
Stroke
Basal Ganglia,
Thalamus and
Brainstem
Injury

Musculoeskeletic Progression in Cerebral Palsy

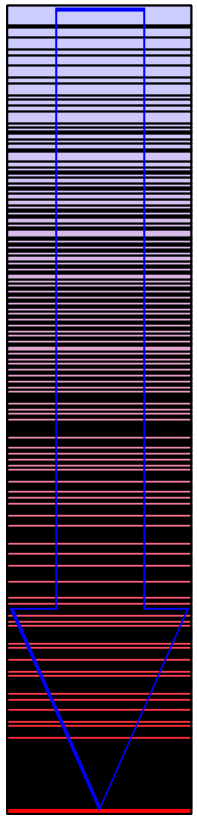
Static

SNC Injury

Progressive

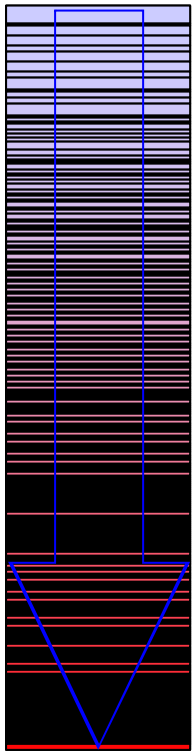
Deformity

muculoeskelatal



- **Upper motor neuron syndrome.**
- **Spasticity and weakness.**
- **Failure in the longitudinal bone growth.**
- **Muscle contracture.**
- **Bone Torsion.**
- **Articulate Instability.**
- **Dislocation of joints and degenerative changes.**

Progresion of gait commitment in Cerebral Palsy



Due to changes associated with age or with the clinic intervention, frecuently you can observe the following changes:

- The muscle commitment becomes increasingly proximal.
- The compensatory mechanisms are becoming less effective.
- In the long term, occur musculoskeletal pathologic changes.
- It happens a consequent increase of lordosis and hips hyperflexion.

Clinic

- Depends on anatomic commitment:

✍ **Spastic (70%)**: piramidal tract commitment.

✍ **Diskinetic or atetosic (5%):**choreoatetosis or distonia, commitment of extrapiramidal tract.

✍ **Ataxic (5%)**: cerebellum commitment.

✍ **Mixed (20%)**: commitment of more than one tract.

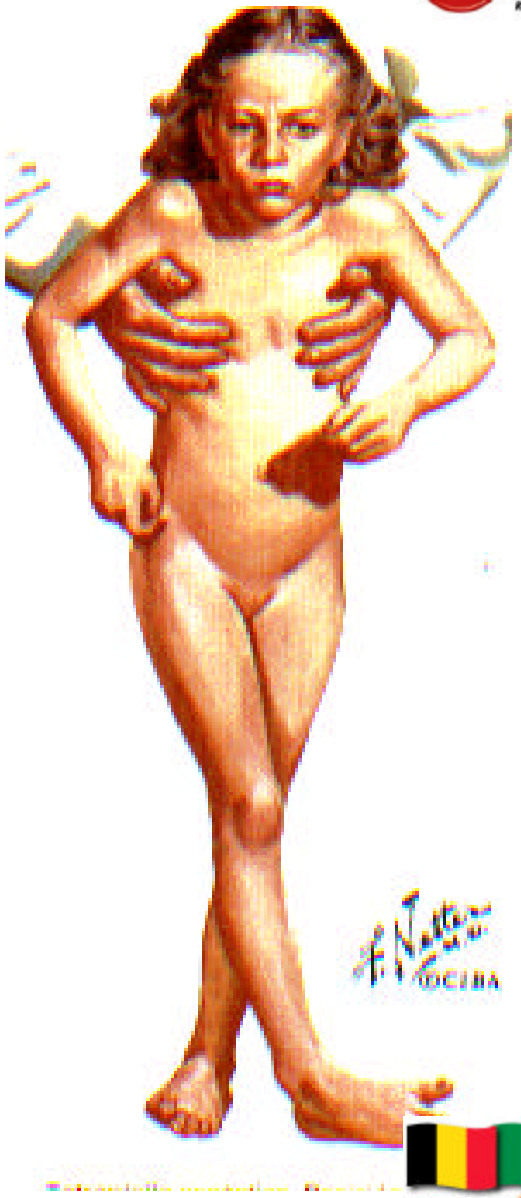
Topographic Classification:

- **Hemiplegia** (25%): hemybody commitment. (one half of the patient body)
- **Diplegia** (30%): commitment of four limbs, principally the lower ones.
- **Paraplegia**: impairment only at the lower limbs.
- **Tetraplegia** (15%) **or cuadriplegia**: impairment of the 4 limbs.
- **Triplegia**: injury of the two lower limbs and one upper limb.

Hemiplegia

Diplegia

Tetraplegia

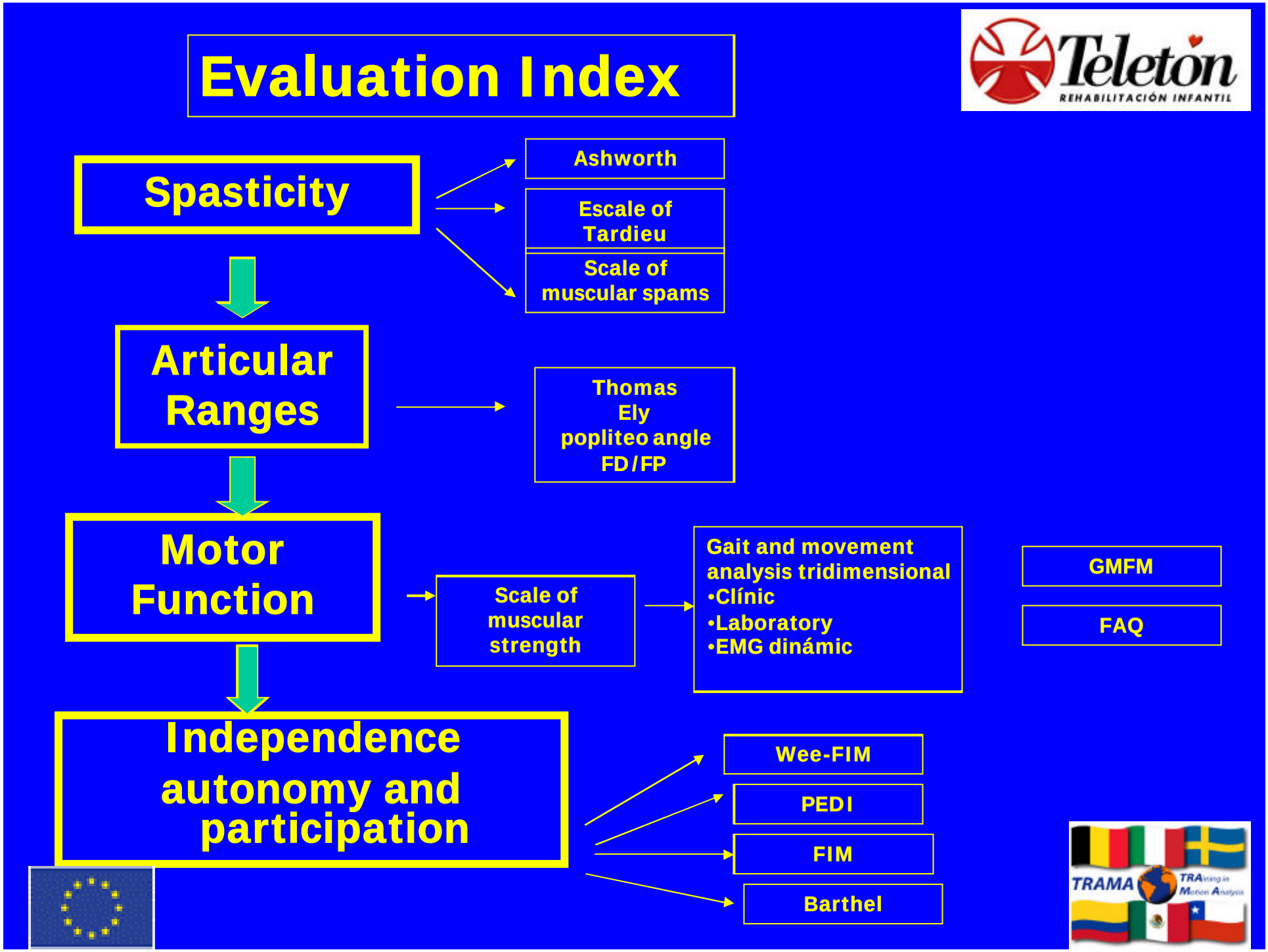


Dysquinesia

Ataxia

Clinic Evaluation Scales

Evaluation Index



Scales of General Functional Evaluation

Wee-Fim

(Wee - Functional Independence Measure):

- Measure of the children functional independence.
- System to measure the daily functional development, in patients with discapacity.
- Contains 18 elements related with selfcare, motion and cognition aspects.
- Applied to children and teenagers from 6 months to 21 years old, with development functional retards.

Measure of Children functional Independence (WeeFIM)

- **Self care**
  - A. Food
  - B. Selfclean
  - C. Bathroom
  - D. Upper dressing
  - E. Lower dressing
  - F. Water closet Use
- **Sphincter Control**
  - G. Managment of bladder
  - H. Management of intestine
- **Transferences**
  - I. Chair - Wheel chair
  - J. Water closet
  - K. Bathtub - shower
- **Locomotion**
  - L. Gait /Wheel chair/ crawl
  - M. Stairs
- **Comunication**
  - N. Understanding
  - O. Expresion
- **Social knowledge**
  - P. Social Interaction
  - Q. Problems -Solving
  - R. Memory

The Independence of each article qualified from 1 to 7

Msall ME. Et al. Clin Pediatr. 1994

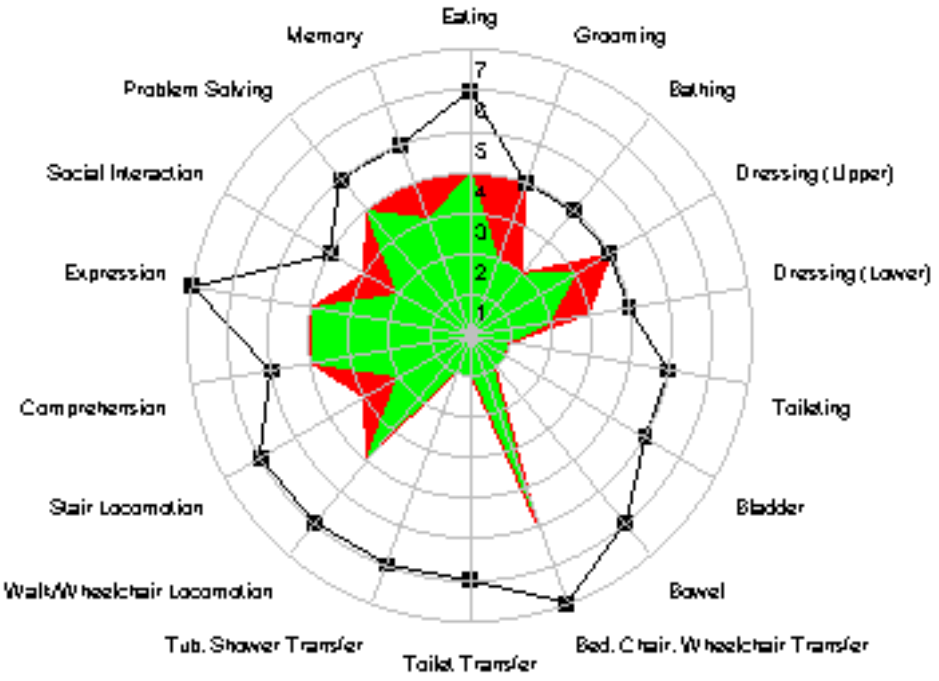
Measure of functional independence for Wee-FIM children, and for FIM adults

Selfcare

Transfer

Cognition

Total points: 18 to 126



Measure the functional development of patient and the assistance require.
Permits the evaluation to a groupal level and institutional.
Following and prediction.

GMFM: ¿What GMFM means? (Gross Motor Function Measure)?

- Clinic measure to evaluate the changes at the gross motor function of children with Cerebral Palsy.

- Measure relevant aspects regarding clinical point of view and which present a high potential change.

- 2 versions: GMFM-88 and GMFM-66.

- Observation and standarized.

- Do not require to compare with patterns of healthy children.

Evaluation of Gross Motor Function (GMFM)

Gross Motor Habilities based on a development goals

A. Lying, rolling

B. Seated

C. Crawling, kneeling

D. Standing

E. Walking, running, jumping

Puntaje	
No start	0
Complete <10% de la tarea	1
Complete the work 10%-100%	2
Complete the work	3

Russell DJ, et al Dev Med Child Neurol. 1999

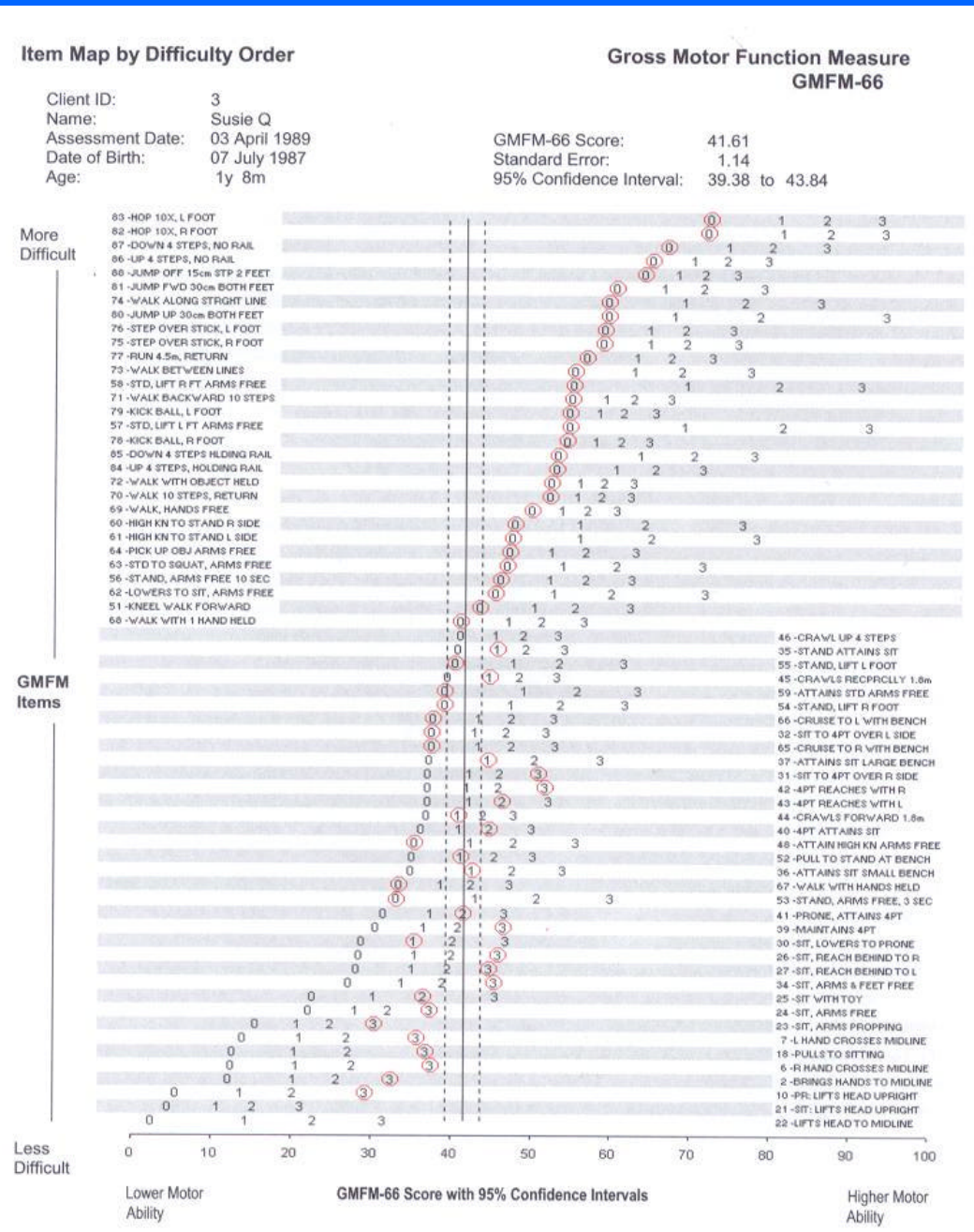
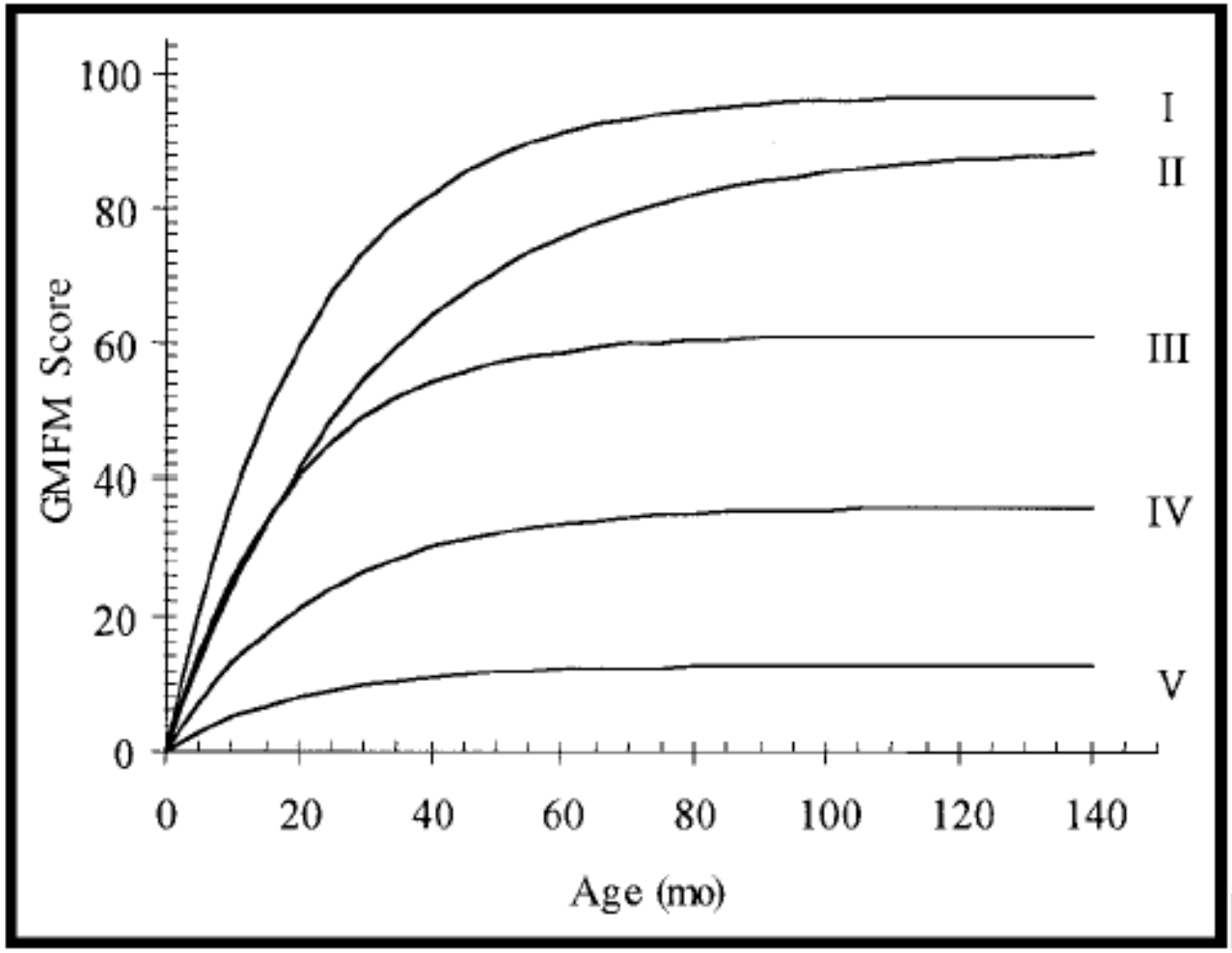


Fig. A3.3. Item map by difficulty order: initial assessment.

New system of Palsy Cerebral Classification (GMFCS)

- Create a data base and a registry, which allow us to compare the results, a treatment program and a clinic investigation.
- Classifies the gross motor function of Cerebral Palsy children in 5 levels.
- Validated for children for older than 2 years old.
- After this age, children are kept in the same track, which allows to predict motor function over time.
- There are 5 curves of motor growing .

Curves of motor growing



Before 2 years old

Habilities		Nivel I	Nivel II	Nivel III	Nivel IV	Nivel V
Head Control		XX	XX	XX	XX	
Sit						
	with support			XX	XX	
	Require EESS		XX			
	Good Balance	XX				
	go in - go out	XX				
Displacement						
	turn	XX		XX	XX	
	drag		XX	XX		
	crawl	XX	XX			
incorporation to biped						
	with assistance	XX	XX			
	independent					
Gait						
	lateral	XX	XX			
	Independent Assisted					
	Independent	< 2 years				

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Between 2 and 4 years old

Habilities		Nivel I	Nivel II	Nivel III	Nivel IV	Nivel V
Head Control		XX	XX	XX	XX	
Sit						
	with support					
	Require EESS		XX	en w	XX	
	Good Balance	XX				
	go in and out	XX				
Displacement						
	turns			XX	X	
	Drag		XX	XX	X , intradom.	
	Crawl	XX	XX	XX	X	
Incorporate to bidep						
	with assistance	XX	XX	XX		
	Independent					
Gait						
	lateral	XX		X		
	Independent Assistance		XX	X intradom.*		
	Independent	XX				

Between 4 and 6 years.

Ability		Nivel I	Nivel II	Nivel III	Nivel IV	Nivel V
sit on chair						
	Require support			XX	XX	
	Good balance	XX	XX			
	Go in and out	XX (chair)	X &	X &	X adult y &	
Marcha						
	lateral					
	independent assisted			X intra. c/ carr	X supervisin #	
	independent	XX	X intradom			
Use of wheel chair				XX extradom	XX	
run and jum		XX				
go up stairs						
	Independent	XX				
	holded		XX	X adult		

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& go in and out of a chair holded to a stable base.

Have difficulty in driving a cart and balance reactions in biped.

Between 6 and 12 years old.

Habilities		Nivel I	Nivel II	Nivel III	Nivel IV	Nivel V
gait						
	lateral					
	independent assisted			Plain Surface	X supervisión #	
	independent	XX	XX			
wheel chair use				Irregular surfac	XX	
run and jump		XX	difficulty			
to go up stairs						
	independent	XX				
	hold		XX	XX		

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Nivel I: They have trouble regarding speed regulation, balance and movement coordination.

Nivel II: Walking with difficulty on irregular surface, slope and agglomerations.

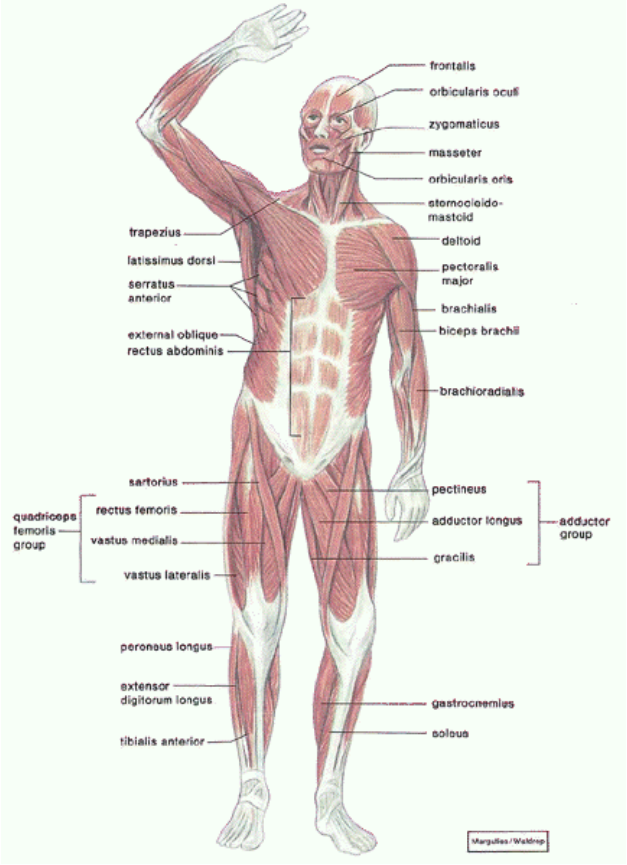
Nivel III: They can walk with a movility device, outdoor on flat surfaces, and they use a wheel chair on an irregular surfaces or in long distances.

Nivel IV: They maintain skills reached before 6 years, preferably using a wheel chair.

Specific Evaluation Scales

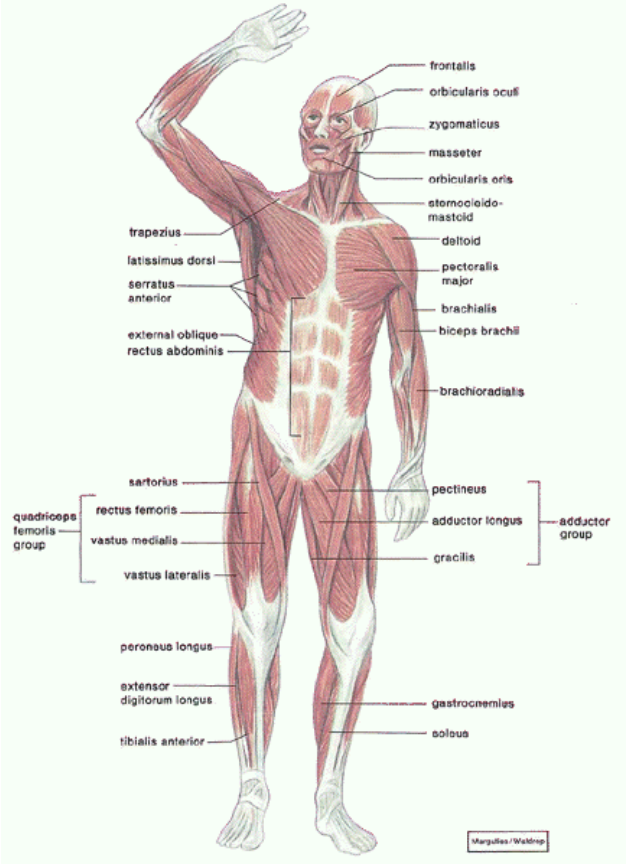
Measurement of muscle strength

- Difficult to evaluate.
- We have to estimate the degree of strength or weakness , which is hiden by spasticity.
- Measurement interfered by the antagonists co – contraction.
- Evaluation in different possitions, functional activities and facilitated.



Measurement of muscular strength

- It was done through the Medical Research Council Scale.
- Instrument most widely used to assess muscle strength.
- Ordinal scale based on manual muscle testing.
- Developed in the UK over 30 years ago.



Medical Research Council

- **0**: no visible or palpable contraction.
- **1**: contraction observed by a palpation or we can observe a minimum and brief degree of contraction.
- **2**: The patient is capable of moving the joint through the full arc if it eliminates gravity.
- **3**: The patient is capable to move the joint through the full arc, against the gravity, but the patient is unable to do it , if he pursues a minimal resistance.
- **4**: The patient overcome the gravity against a moderated resistance along the articular arc.
- **5**: Normal Strength.

Ashworth Scale modified

- There is a correlation between the graduation of this scale and the role or need of treatment.
- It's simple, low cost, validated and is widespread throughout the world.
- It is used to determine criteria for severity, treatment and results evaluation.

Ashworth Scale modified

- **1**: Slight increase of muscular tone (MT), slight hitching and liberation (release) with minimal resistance to the end.
- **1+:** Slight increase of MT, slight hitching followed by a minimal resistance throughout the movement.
- **2:** Increasement of MT, but the segment moves easily.
- **3:** substantial increase of MT, the passive movilization is difficult.
- **4:** Stiffness in flexion or extension.

Tardieu

- The difference between V1 and V3 allows us to stablish the degree of dynamic shortening versus the structured retraction.

- Therefore, it may be a forecast index to estimate the ROM gain or profit to treat spasticity.

Special Analysis and ROM

- They allow a “functional projection” and a clear therapeutic guidance.
- Examples:

Thomas


Ely


Silfverskjold

RE/RI cadera


Gait Analysis Laboratory tridimensional computarized

- Objective and integral Gait Analysis.
  - Measurement of time parameter and distance.
  - Record kinematic.
  - Reactions of force and kinetic.
  - EMG dinamic.
  - Visual register with video on two planes.

- Lets understand the interactions beteween trunk, hip, knee and ankle.
- Lets talk an universal language.
- Planning treatments.
- Monitoring Results.
- Validation of therapeutic interventions.

Gait Patterns in :

- DIPLEGIA
- HEMIPLEGIA

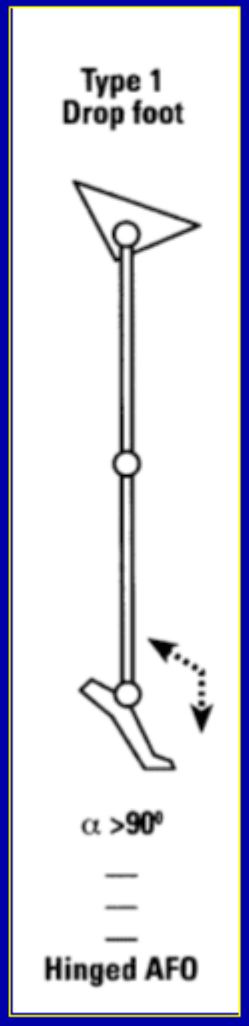
HEMIPLEGIA
Gait Patterns (Gage)

Type 1:
Drop foot

- The drop foot is more evident at the swing phase.
- La dorsiflexion of ankle is normal during the stance phase.

Pathology

-Weakness of the anterior tibial, without contracture or calf spasticity.

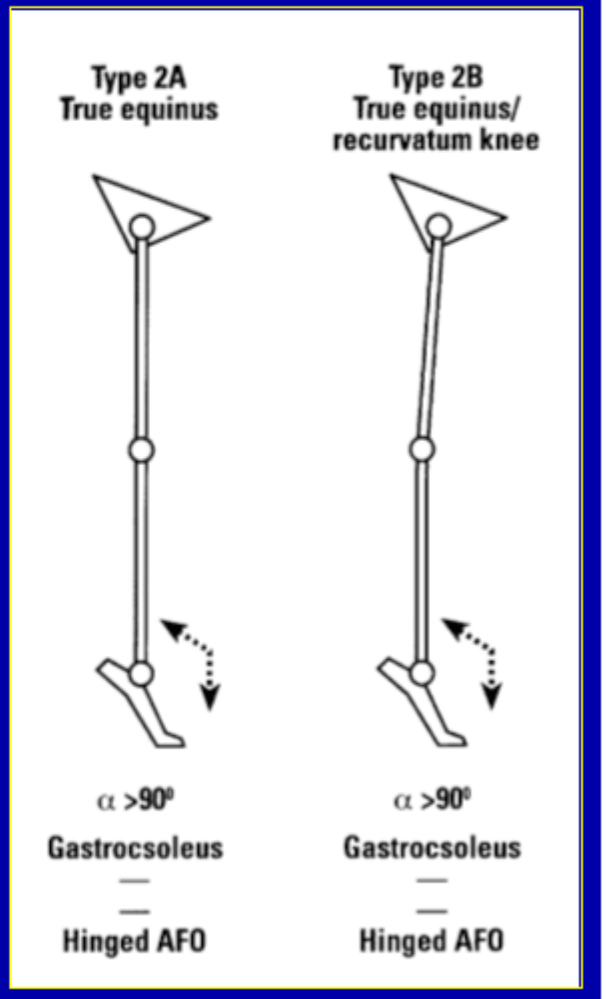


Type 2:
True Equinus

- Ankle in plantar flexion (true equinus) through most of its stance phase.
- Variable degree of drop foot at swing.

Pathology

-Contracture or spasticity gastrosoleus muscle.



HEMIPLEGIA
Gait Patterns (Gage)

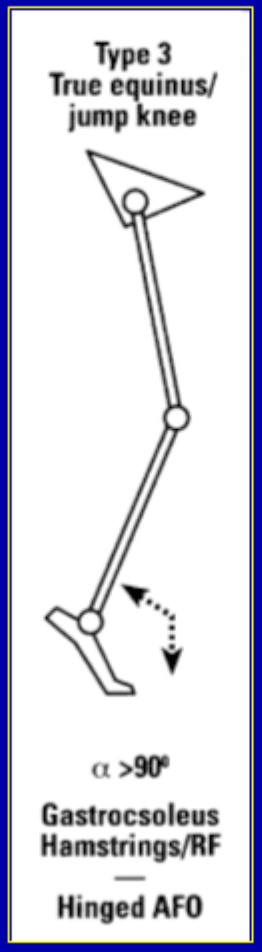
Type 3:

Jump Knee

- The ankle dorsiflexion prevented during stance phase.
-The knee is flectioned and rigid.

Pathology

- Contracture and/or spasticity gastrosoleus.
-Contracture and /or spasticity isquiotibialis and anterior rectus.



Type 4 :

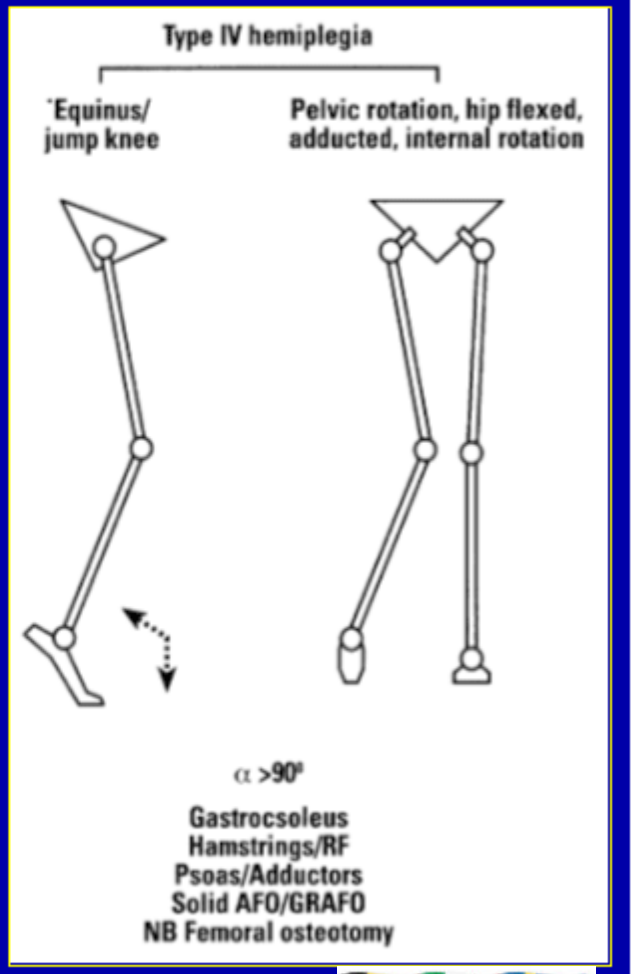
Equinus / jump knee /

Hip flexed adducted

- Equinus.
- Knee rigid and flexed.
- Hip flexed.
- Anterior inclined pelvic with
- Adduction of hip and internal
- rotation.

Pathology

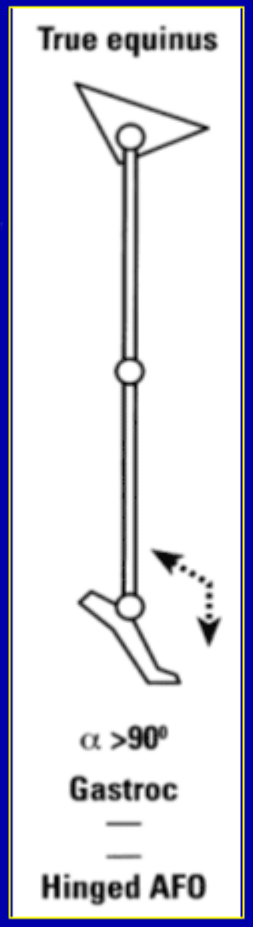
-Retraction and/or spastiticy of
-triceps sural, isquiotibials, adductors and hip flexors.



DIPLEGIA
Gait Patterns (Sutherland)

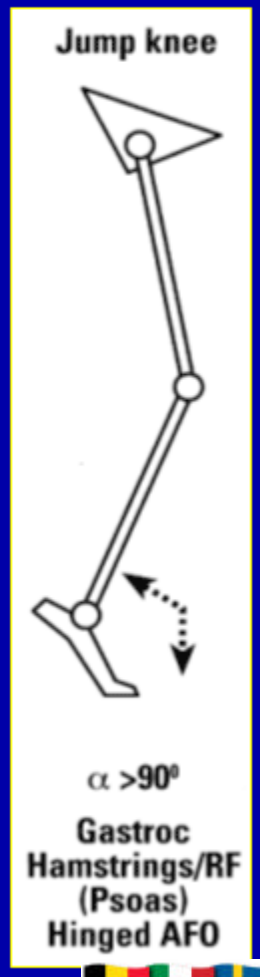
Type I:
Real equinus
-Plantar flexion ankle during stance phase.
- Extenxion of knee and hip.

Pathology
- Contracture and/or spasticity Gastrocnemio.



Type II:
Jump knee
- Equinus ankle.
- Knee and hip flectioned.
- Anterior pelvic inclined.
- Increased lumbar Lordosis.

Pathology
- Contracture and/or spasticity of Gastrocnemio.
- Contracture and /or spasticity of knee and hip flexors.
- + / - anterior rectus activity.



EJN, 2001

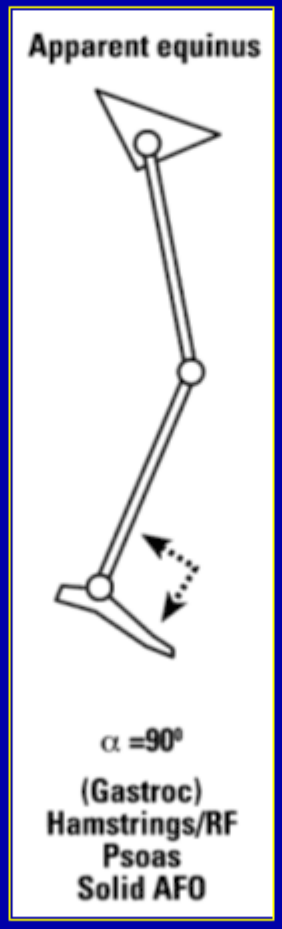
DIPLEGIA
Gait Patterns (Sutherland)

Type III:
Equinus apparent
(with or without stiff knee)

- Equinus decreasing (The ankle have a normal angle of dorsiflexion).
- Increasing of knee and hip flexion.

Pathology

- Muscles of calf become weak.
- Coupling incompetent of PF-KE.
- excessive flexion of knee and hip in the stance phase.

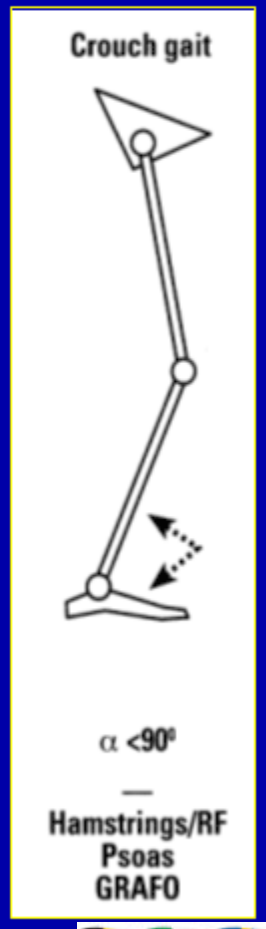


Type IV:
Crouch gait:

- Excessive Dorsiflexion of ankle.
- Excessive flexion of knee and hip.

Pathology

-Exaggerated tibial move forward.
-The mechanism declined PF-KE.



Normalcy Index (NI)

The objective of the NI is to find a single numeric value that reflects the extent to which the gait of the patient , with Cerebral Palsy, deviates from a normal average. More higher value, better functional commitment.

It consists of 16 parameters: temporo-spatial and kinematics, selected by clinical factors and convenience (Normal Value: 16-32).

Useful for evaluating results of therapeutic actions (medical or surgical) and compared with normal parameters, but is NOT a diagnostic index, its value NOT identifies the origin of the disturbance, OR NOT aimed at the therapeutic choice.

Normalcy Index

Considered parameters:

- Toe – off time.
- Gait speed.
- Cadence.
- Pelvic tilt average.
- Pelvic tilt range.
- pelvic rotation average.
- Minimun hip flexion.
- Hip flexion range.
- Hip peak abduction, in swing phase.
- Average of the hip rotation, in stance phase.
- Knee flexion, at the initial contact.
- Moment of peak of knee flexion.
- Knee flexion range.
- Peak Dorsiflexion, in stance phase.
- Peak dorsiflexion, in swing phase.
- Angle average of the foot progression.

Severity of commitment:

- **Mild** (30%): walk alone, independent in AVD, normal language, normal or limit intelectual coefficient. Integrates a normal life without further treatments.

  IRI: 28%.

- **Moderated** (30-50%): requires technical assistance to achieve gait and AVD independence. There are some comunication problems, IC normal or mild RM. Requires aid to integrate normal life.

  IRI: 30%.

Commitment Severity

- **Severe** (50-70%): the motor impediments, mental and/or sensory prevent the child achieving full independence in self care. Even with different and continued treatments, their integration is partial.

  IRI: 25%

- **Grave** (70-100%): maximum commitment in all areas of development, little environmental nexus. Without opportunities of social integration.

  IRI: 12%.

Pathologies or Associated Deficiencies:

- Mental Retard.
- Sensorial changes (visuals or auditives).
- Language changes.
- Convulsive Syndrome.
- Learning problems.
- Emotional problems.
- Nutrition changes.
- Dental changes.
- Frequent breathing diseases.

Diagnosis

- Ideally the diagnosis should be as early as possible, usually, the Cerebral Palsy diagnosis, is established within two years old. The diagnosis of clinical commitment after 4 years old.

- High index of suspicion, as opposed to risk factors (prenatal, natal and postnatal).

- Firsts manifestations:

  RDSM, during period of nursing.

  Hypotonic Syndrome.

Evolution

- Although it is not an evolutionary pathology in the brain anatomical injury, is a dinamic chart, as their manifestations change with growth, producing:
- Tone changes.
- Muscular retractions.
- Bone deformities (limbs and spine).
- Functional changes.

THANK YOU