Cerebral Palsy Diagnosis in Community Pediatrics

The Neuromotor Assessment for Cerebral Palsy Diagnosis: Physical Exam and the HINE

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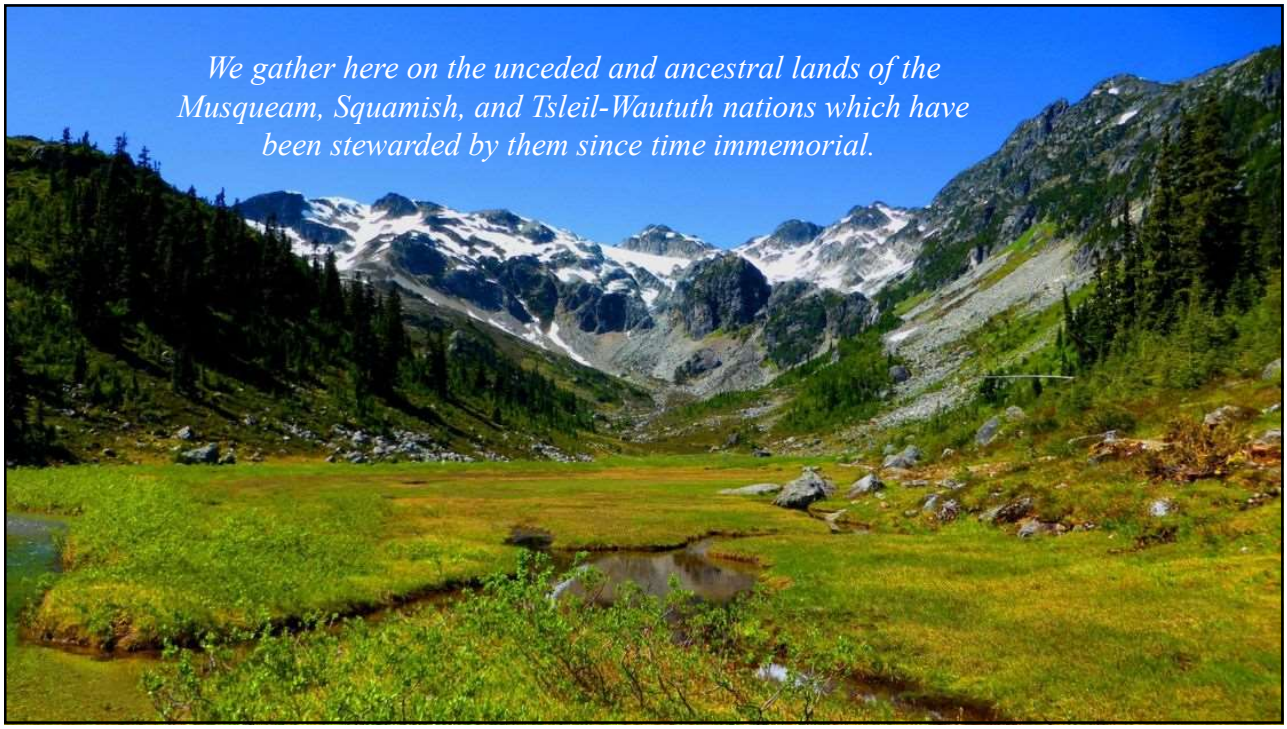

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Disclosure

No conflicts of interest or financial ties

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Learning Objectives

1. Describe the neurological exam and findings that support a diagnosis of cerebral palsy
2. Review the items on the HINE and their scoring
3. Explain how to interpret the HINE score

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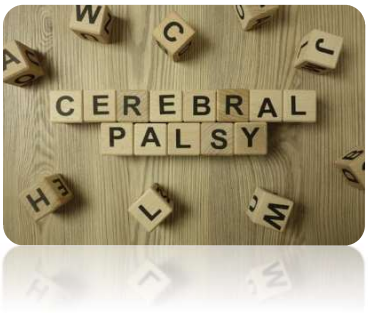
Cerebral Palsy – Definition



"Cerebral palsy is a group of permanent disorders of the development of movement and posture, causing activity limitation, that are attributed to non-progressive disturbances that occurred in the developing fetal or infant brain."

— Rosenbaum et al., 2007

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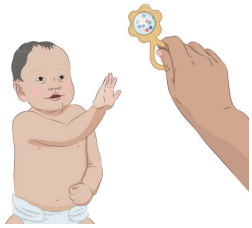
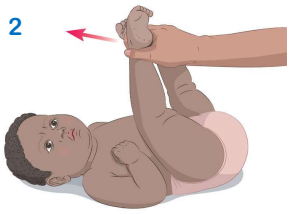
Red flags of CP in infants

1



Demonstrates a hand preference before 12m

2



Demonstrates stiffness or tightness in the legs

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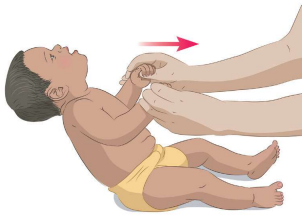

Demonstrates a persistent head lag beyond 4m of age

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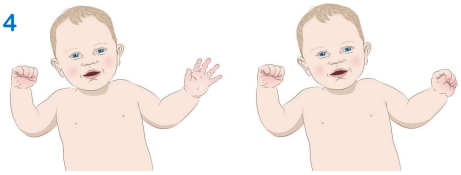

Keeps their hands fisted (closed/clenched) after the age of 4m

Recommendations from: BC Cerebral Palsy Advisory Committee 2017-2021 and The PROMPT Group 2019

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Red flags of CP in infants

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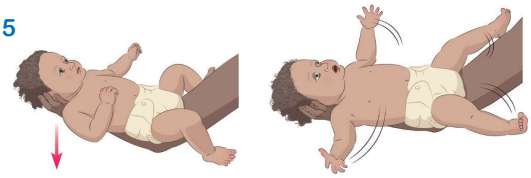

Demonstrates persistent primitive reflexes, including startle (Moro) reflex beyond 6mo of age, or "Fencer" (ATNR) beyond 4m of age

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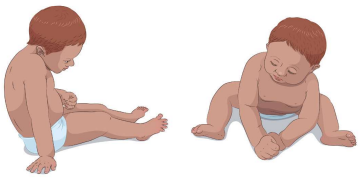

Not able to sit without support beyond 9m of age

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Demonstrates consistent asymmetry of posture and movement after the age of 4m

8

Demonstrates consistent toe-walking or asymmetric-walking beyond 12m of age

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Unable to walk by 18m of age

Recommendations from: BC Cerebral Palsy Advisory Committee 2017-2021 and The PROMPT Group 2019

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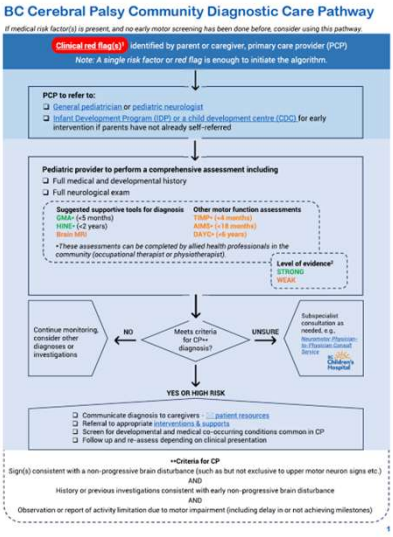
How is CP diagnosed?



BC Cerebral Palsy Community Diagnostic Care Pathway

If medical risk factor(s) is present, and no early motor screening has been done before, consider using this pathway.

Clinical red flag(s)* identified by parent or caregiver, primary care provider (PCP)

Note: A single risk factor or red flag is enough to initiate the algorithm.

PCP to refer to:
- General pediatrician or pediatric neurologist
- Infant Development Program (IDP) or a child development centre (CDC) for early intervention if parents have not already self-referred

Pediatric provider to perform a comprehensive assessment including
- Full medical and developmental history
- Full neurological exam

Suggested supportive tools for diagnosis: GMA+ (<5 months); HINE+ (<2 years); Brain MRI

Other motor function assessments: TIMP+ (<4 months); AIMS+ (<18 months); DAYC+ (<6 years)

+These assessments can be completed by allied health professionals in the community (occupational therapist or physiotherapist)

Level of evidence[2]: STRONG; WEAK

Meets criteria for CP** diagnosis?

NO → Continue monitoring, consider other diagnoses or investigations

UNSURE → Subspecialist consultation as needed, e.g. Neurometry (Physician-to-Physician Consult Service) BC Children's Hospital

YES OR HIGH RISK
- Communicate diagnosis to caregivers - patient resources
- Referral to appropriate interventions & supports
- Screen for developmental and medical co-occurring conditions common in CP
- Follow up and re-assess depending on clinical presentation

**Criteria for CP

Sign(s) consistent with a non-progressive brain disturbance (such as but not exclusive to upper motor neuron signs etc.)

AND

History or previous investigations consistent with early non-progressive brain disturbance

AND

Observation or report of activity limitation due to motor impairment (including delay in or not achieving milestones)

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Introducing a new care pathway to support clinical decision-making in diagnosis of CP

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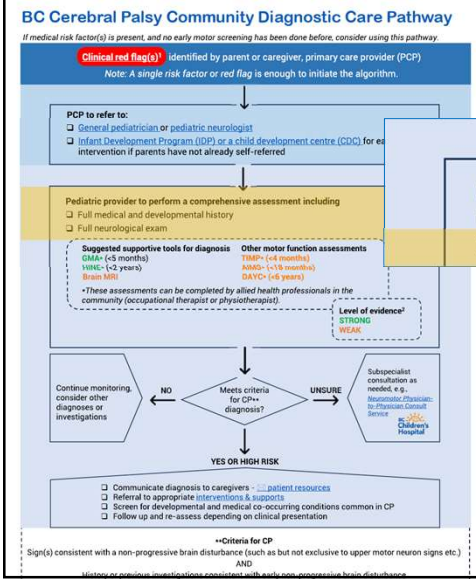
How is CP diagnosed?



Pediatric provider to perform a comprehensive assessment including

- ❑ Full medical and developmental history
- ❑ Full neurological exam

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How is CP diagnosed?

The general examination

- Weight, height, head circumference
- Dysmorphic features
- Nutritional status
- Skin

- Scoliosis
- Midline defects

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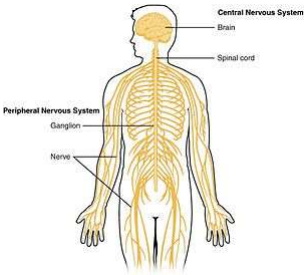
Neurological system

CNS vs PNS



CNS
- Brain
- Spinal cord

PNS/Lower motor unit
- Peripheral nerve (motor/sensory)
- Synapse/NMJ
- Muscle

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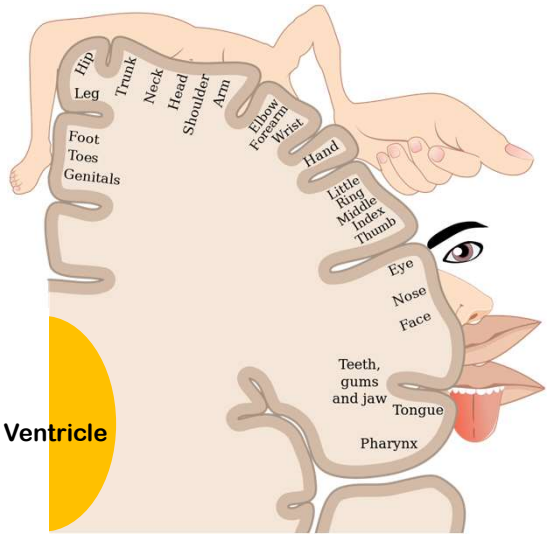
The motor homunculus



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The neurological exam

- Cranial nerves
- Eyes/vision- movements, fields, acuity
- Hearing
- Sensory

- Motor
- Cerebellum
- Gait and movement
- Primitive and Developmental reflexes

- General dev. assessment (signs for other disorders)

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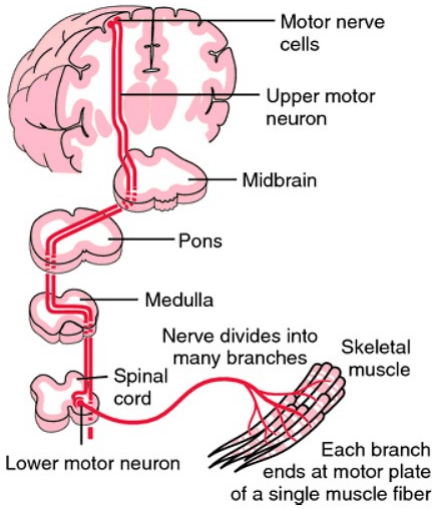
Motor pathway: UMN vs LMN



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Motor Exam

- Muscle bulk
- Tone:
  - Types of abnormal tone
    - spasticity, dystonia, rigidity, hypotonia
  - Slow and fast movement (spastic catch?)
  - Scales – Modified Ashworth Scale (MAS)
- Range of motion (ROM)
- Strength (Manual muscle testing 1-5)
- Deep Tendon Reflexes (DTRs), Clonus?

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Muscle strength

Grade	Description
0/5	No muscle movement
1/5	Muscle movement without joint motion
2/5	Movement with gravity eliminated
3/5	Movement against gravity but not against resistance
4/5	Movement against gravity and light resistance
5/5	Normal strength

Le Blond *et al.*[7]

Reflex Grading Scale	
Grade	Description
0	*Absent*
1+ or +	*Hypoactive*
2+ or ++	*"Normal"*
3+ or +++	*Hyperactive without clonus*
4+ or ++++	*Hyperactive with clonus*

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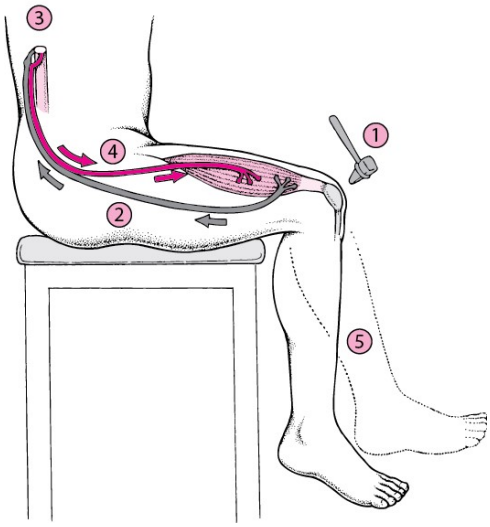
The reflex arc- UMN sign



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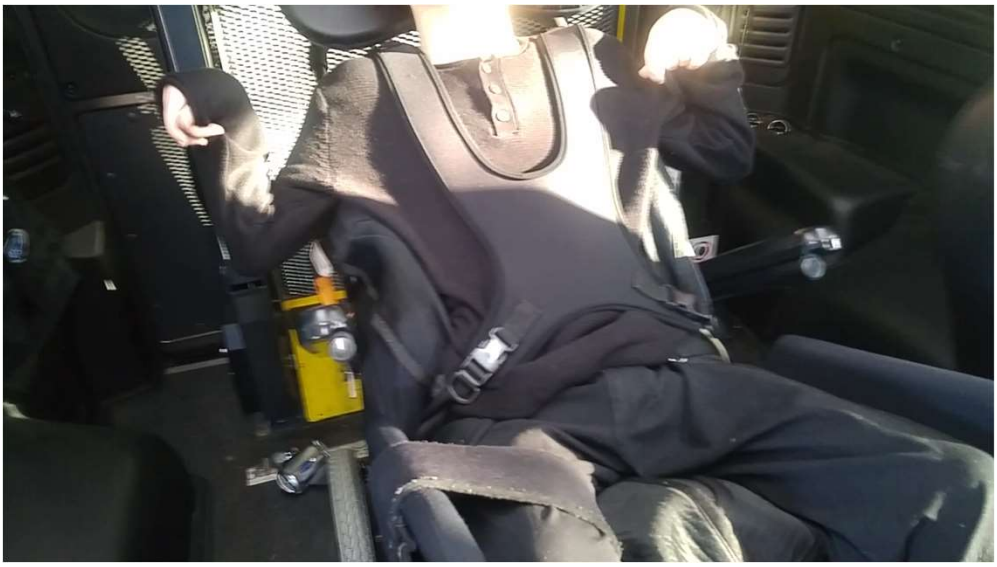
Spastic catch



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Modified Ashworth Scale (MAS)

Table 2: The Modified Ashworth Scale (Bohannon and Smith, 1987)

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the ROM when the affected part(s) is moved in flexion or in extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the reminder (less than half) of the ROM
2	More marked increase in muscle tone throughout most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement is difficult
4	Affected part(s) rigid in flexion or extension

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UMN vs LMN

	LMN	UMN
Muscle Tone	↓	↑
DTR	↓	↑
Muscle Strength	↓	↓
Muscle Mass	↓	Normal ↑↓
Fasciculation	Yes/No	No
Cognitive fx.	Normal	?

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Motor Exam

Different positions:

- Supine
- Pull to sit
- Sitting
- Standing/Vertical suspension
- Horizontal suspension
- Prone

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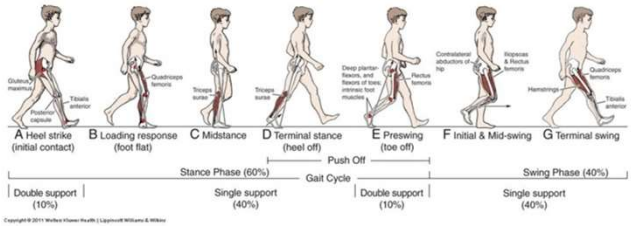
Phases of the gait cycle

Gait and movement:

- Walking and Running
- Stairs
- Tandem
- Gower's



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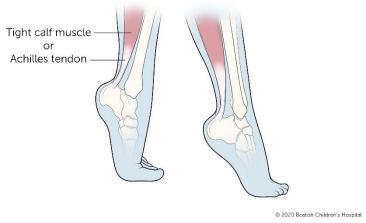
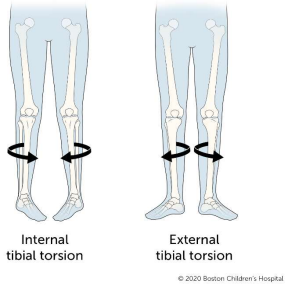
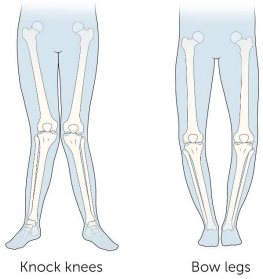
Gait (common pediatric deviations)







Toe walking
Common in young children who are just starting to walk.
Concerning if persists when walking is main way of mobility.

Intoeing or outtoeing
Usually related to excessive tibial or femoral torsion .
Common in early childhood.

Bowlegs and knock knees
Common stages of development and usually self-correct as a child grows.
Concerning if persist in pre-adolescence

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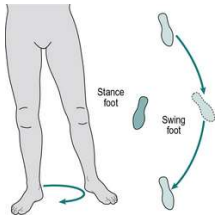
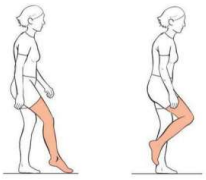
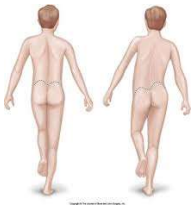
Gait (abnormal)



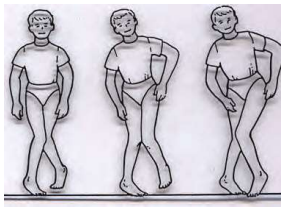
Circumduction gait
Excessive hip abduction as the leg swings forward.



Stepping gait
The entire leg is lifted at the hip to assist with ground clearance. Often accompanied by foot drop.



Trendelenburg gait
Hip abductor muscle weakness. While weight-bearing on the ipsilateral side, the pelvis drops on the contralateral side.



Scissoring gait
Stiff hip adduction. Associated with lower extremity spasticity

Ataxic gait
Instability with an alternating narrow to wide base of gait.

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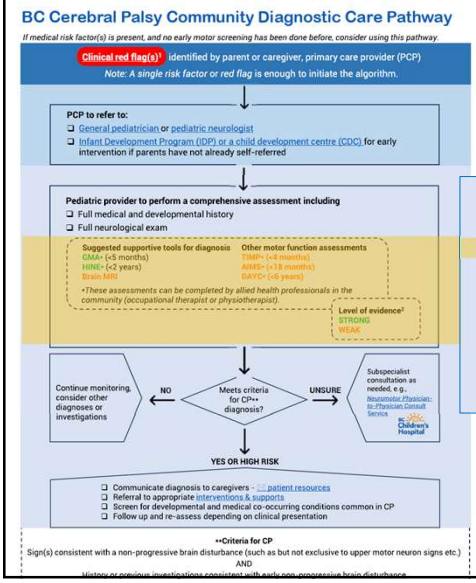
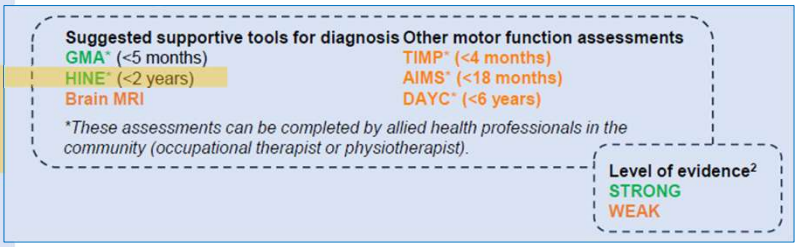
The Hammersmith Infant Neurological Examination (HINE)





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The Hammersmith Infant Neurological Examination (HINE)

5 sections
26 scored items

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The Hammersmith Infant Neurological Examination (HINE)

- Low to no cost
- Quick & easy to administer and score
- Good inter-rater reliability
- For 2 to 24 Months
- Cut-off scores for prediction of CP
- Sensitivity and specificity is high (>90%)
- Provides prognostic information for ambulation
- Asymmetry score is sensitive for unilateral CP

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The Hammersmith Infant Neurological Examination (HINE)

HAMMERSMITH INFANT NEUROLOGICAL EXAMINATION (v 07.07.17)

Name | Date of birth

Gestational age | Date of examination

Chronological age / Corrected age | Head circumference

SUMMARY OF EXAMINATION
Global score (max 78)
Number of asymmetries
Behavioural score (not part of the optimality score)

Cranial nerve function	score	(max 15)
Posture	score	(max 18)
Movements	score	(max 6)
Tone	score	(max 24)
Reflexes and reactions	score	(max 15)

COMMENTS

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The Hammersmith Infant Neurological Examination (HINE)

ASSESSMENT OF CRANIAL NERVE FUNCTION

	score 3	2	score 1	score 0	score	Asymmetry / Comments
Facial appearance (at rest and when crying or stimulated)	Smiles or reacts to stimuli by closing eyes and grimacing		Closes eyes but not tightly, poor facial expression	Expressionless, does not react to stimuli		
Eye movements	Normal conjugate eye movements		**Intermittent** Deviation of eyes or abnormal movements	**Continuous** Deviation of eyes or abnormal movements		
Visual response Test ability to follow a black/white target	Follows the target in a complete arc		Follows target in an incomplete or asymmetrical arc	Does not follow the target		
Auditory response Test the response to a rattle	Reacts to stimuli from both sides		Doubtful reaction to stimuli or asymmetry of response	No response		
Sucking/swallowing Watch infant suck on breast or bottle. If older, ask about feeding, assoc. cough, excessive dribbling	Good suck and swallowing		Poor suck and/or swallow	No sucking reflex, no swallowing		

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The Hammersmith Infant Neurological Examination (HINE)

ASSESSMENT OF POSTURE (note any asymmetries)

	score 3	score 2	score 1	score 0	sc	Asymmetry / comments
Head in sitting	Straight; in midline		Slightly to side *or* backward *or* forward	Markedly to side *or* backward *or* forward		
Trunk in sitting	Straight		Slightly curved or bent to side	Very rounded / rocketing back / bent sideway		
Arms at rest	In a neutral position, central straight or slightly bent		**Slight** internal rotation *or* external rotation **Intermittent** dystonic posture	**Marked** internal rotation *or* external rotation or dystonic posture hemiplegic posture		
Hands	Hands open		**Intermittent** adducted thumb *or* fisting	**Persistent** adducted thumb *or* fisting		
Legs in sitting	Able to sit with a straight back and legs straight or slightly bent (long sitting)		Sit with straight back but knees bent at 15-20 °	Unable to sit straight unless knees markedly bent (no long sitting)		
in supine and in standing	Legs in neutral position straight *or* slightly bent	**Slight** internal rotation *or* external rotation	Internal rotation *or* external rotation at the hips	**Marked** internal rotation *or* external rotation *or* fixed extension or flexion or contractures at hips and knees		
Feet in supine and in standing	Central in neutral position Toes straight midway between flexion and extension		**Slight** internal rotation *or* external rotation **Intermittent** Tendency to stand on tiptoes or toes up or curling under	**Marked** internal rotation *or* external rotation at the ankle **Persistent** Tendency to stand on tiptoes *or* toes up or curling under		

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The Hammersmith Infant Neurological Examination (HINE)

ASSESSMENT OF MOVEMENTS

	Score 3	Score 2	Score 1	Score 0	score	Asymmetry / comments
Quantity Watch infant lying in supine	Normal		Excessive or sluggish	Minimal or none		
Quality Observe infant's spontaneous voluntary motor activity during the course of the assessment	Free, alternating, and smooth		Jerky Slight tremor	• Cramped & synchronous • Extensor spasms • Athetoid • Ataxic • Very tremulous • Myoclonic spasm • Dystonic movement		

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The Hammersmith Infant Neurological Examination (HINE)

ASSESSMENT OF TONE

	Score 3	Score 2	Score 1	Score 0	sc	Asym/Co
Scarf sign Take the infant's hand and pull the arm across the chest until there is resistance. Note the position of the elbow in relation to the midline.	**Range:** R L R L		R L	R L or R L		
Passive shoulder elevation Lift arm up alongside infant's head. Note resistance at shoulder and elbow.	Resistance overcomeable R L	Resistance difficult to overcome R L	No resistance R L	Resistance, not overcomeable R L		
Pronation/supination Steady the upper arm while pronating and supinating forearm, note resistance	Full pronation and supination, no resistance		Resistance to full pronation / supination overcomeable	Full pronation and supination not possible, marked resistance		
Hip adductors With both the infant's legs extended, abduct them as far as possible. The angle formed by the legs is noted.	**Range: 150-80°** R L R L	**150-160°** R L	**>170°** R L	**<80°** R L		
Popliteal angle Keeping the infant's bottom on the bed, flex both hips onto the abdomen, then extend the knees until there is resistance. Note the angle between upper and lower leg.	**Range: 150°-100°** R L R L	**150-160°** R L	**~90° or > 170°** R L R L	**<80°** R L		
Ankle dorsiflexion With knee extended, dorsiflex the ankle. Note the angle between foot and leg.	**Range: 30°-85°** R L R L	**20-30°** R L	**<20°or 90°** R L R L	**> 90°** R L		
Pull to sit Pull infant to sit by the wrists. (support head if necessary)						
Ventral suspension Hold infant horizontally around trunk in ventral suspension; note position of back, limbs and head.						

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The Hammersmith Infant Neurological Examination (HINE)

REFLEXES AND REACTIONS

	Score 3	Score 2	Score 1	Score 0	sc	Asym / Co
Arm protection Pull the infant by one arm from the supine position (steady the contralateral hip) and note the reaction of arm on opposite side.	Arm & hand extend R L		Arm semi-flexed R L	Arm fully flexed R L		
Vertical suspension hold infant under axilla making sure legs do not touch any surface – you may "tickle" feet to stimulate kicking.	Kicks symmetrically		Kicks one leg more or poor kicking	No kicking even if stimulated or scissoring		
Lateral tilting (describe side up). Hold infant up vertically near to hips and tilt sideways towards the horizontal. Note response of trunk, spine, limbs and head.	R L	L R	R L	R L		
Forward parachute Hold infant up vertically and quickly tilt forwards. Note reaction /symmetry of arm responses,	(after 6 months)		(after 6 months)			
Tendon Reflexes Have child relaxed, sitting or lying – use small hammer	Easily elicitable biceps knee ankle	Mildly brisk bicep knee ankle	Brisk biceps knee ankle	Clonus or absent biceps knee ankle		

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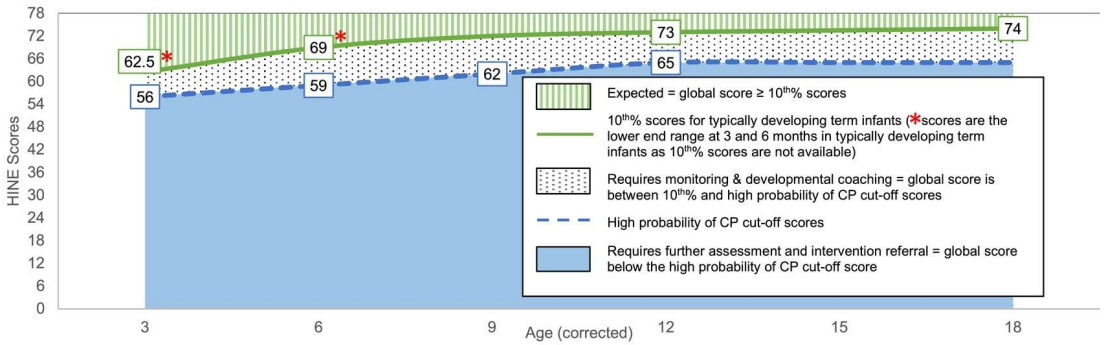
Interpreting the HINE score

Column 1	Column 2 Global scores for typically developing term born infants[1,2]	Column 3 Global scores for low-risk LPT and VPT infants[3]	Column 4 Global scores for low-risk EPT infants[4]	Column 5 Cut-off scores for high probability of CP[5]
Child´s Age (corrected)	**37-42 weeks GA** Median (range)	**mean GA 32 weeks (range 27-36)** Median (range)	**mean GA 27 weeks (range 23-31)** Median (range)	**All birth gestational ages but definitive data not available for EPT infants**
3 months	**67** (62.5*-69)[2]	**62** (51-69)[3]	**58** (47-69) (10th% 53)[4]	**≤56** (sen 96% sp 85%)[5]
6 months	**73** (69*-76.5)[2]	**66** (52-72)[3]	**67** (54-76) (10th% 62)[4]	**≤59** (sen 90% sp 89%)[5]
9 months	*N/A*	**70.5** (57-76)[3]	**71.5** (62-78) (10th% 67)[4]	**≤62** (sen 90% sp 91%)[5]
12 months	**76** (63-78) (10th% ≥73)[1]	**72.5** (60-77)[3]	**73.5** (67-78) (10th% 70)[4]	**≤65** (sen 91% sp 90%)[5]
18 months	**78** (71-78) (10th% ≥74)[1]	*N/A*	*N/A*	*N/A*
	10th percentile scores (10th%): 90% of infants score at or above this level. * See legend in graph below.	Data for LPT and VPT infants are combined – medians are similar, but the range span is narrower for LPT than VPT	Note median scores are considerably lower for EPT infants than FT, LPT and VPT infants at 3 months.	A global score <40 at any age is highly predictive of CP GMFCS III-V at 2 years of age[7].

N/A not available, Low-risk - no additional CP etiologic risk aside from being preterm[3,4],LPT Late preterm 33-36 weeks gestational age (GA), VPT very preterm 27-32 weeks GA, EPT extremely preterm (23 -31 weeks GA) as defined in this study[4], sen (sensitivity), sp (specificity)

Fehlings, D., Makino, A., Church, P., Banihani, R., Thomas, K., Luther, M., Lam-Damji, S., Vollmer, B., Haataja, L., Cowan, F., Romeo, D., George, J. and Kumar, S. (2024), The Hammersmith Infant Neurological Exam Scoring Aid supports early detection for infants with high probability of cerebral palsy. Dev Med Child Neurol. https://doi.org/10.1111/dmcn.15977

Interpreting the HINE score



Fehlings, D., Makino, A., Church, P., Banihani, R., Thomas, K., Luther, M., Lam-Damji, S., Vollmer, B., Haataja, L., Cowan, F., Romeo, D., George, J. and Kumar, S. (2024), The Hammersmith Infant Neurological Exam Scoring Aid supports early detection for infants with high probability of cerebral palsy. Dev Med Child Neurol. https://doi.org/10.1111/dmcn.15977

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Reviewing the criteria and definition of CP

Do findings meet criteria for diagnosis?

- ✓ A group of permanent disorders of the development of movement and posture
- ✓ attributed to non-progressive disturbances that occurred in the developing fetal or infant brain
- ✓ causes activity limitation

Sign(s) consistent with a non-progressive brain disturbance (such as but not exclusive to upper motor neuron signs etc.)

AND

History or investigations consistent with early non-progressive brain disturbance

AND

Observation or report of activity limitation due to motor impairment (including delay in or not achieving milestones)

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Further Learning and Resources

Sunny Hill Neuromotor Physician to Physician consult

- Virtual consults available with developmental pediatricians
- 15-20 min appointments available
- Download booking form online – Sunny Hill Website

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Further Learning and Resources

Hammersmith Infant Neurological Exam

https://hollandbloorview.ca/our-services/programs-services/neuromotor-services/hammersmith-infant-neurological-examination-hine

https://www.mackeith.co.uk/hammersmith-neurological-examinations

Pathways™

Request an account and find all the resources mentioned in one hub
https://pathwaysbc.ca/login

UBC CPD
https://ubccpd.ca/cp-resources

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Nandy Fajardo, Physiotherapist, Sunny Hill Health Centre

Cynthia Vallance, Patient and Family Engagement Advisor

Carol Lai, Project Manager, Sunny Hill Health Centre

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Thank you for attending

Please make sure to complete our evaluation survey!

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