

Early Signs of Impaired Motor Development in Infants and Toddlers

by Shani Norberg, M.D.

Identifying an infant or young child with abnormal motor development can be a difficult task. The clinical manifestations are broad, as are the possible etiologies. While some infants are easily identifiable as being at risk for developing cerebral palsy, others who are eventually diagnosed may have no obvious history of pre- or perinatal insult. In both cases, it may be months or even longer after birth before obvious manifestations of motor impairment begin to emerge.

Early intervention for a young child with cerebral palsy can and does make a difference in optimizing the health and quality of life of that child. The sooner a child receives needed services such as physical, occupational and speech and language therapy, the more beneficial to the child. Not only can early intervention potentially improve functional outcomes, but it may also improve the psychological and emotional well-being of both the child and family. With early intervention, families are more able to set realistic expectations and cope with the issues related to raising a child with special needs.

The primary care provider plays a vital role, therefore, not only by being aware of the risk factors for cerebral palsy, but also through vigilance for the manifestations of motor dysfunction in infants who present without obvious risk factors.

The risk factors

Cerebral palsy is a general term for nonprogressive motor impairment resulting from an injury to the developing central nervous system. It occurs at a rate of 1.2 to 2.5 per 1,000 live births.

Two categories of infants are easily identified as being at risk: preterm infants who have a low or very low birth weight, and full-term infants who are systemically and neurologically ill during the newborn period, as indicated in figure 1. Among preterm infants, the risk for developing cerebral palsy increases as the birth weight decreases. This group is disproportionately represented in the spastic diplegia cerebral palsy subtype due to subcortical periventricular white matter injury.

Spastic quadriplegia is most common among full-term infants who have neurologic dysfunction during the perinatal period. The typical injury is in the watershed regions of blood flow between the distributions of the anterior, middle and posterior cerebral arteries.

The third group of children who develop cerebral palsy are normal-birth-weight babies with no known history of pre- or perinatal brain injury. In fact, the majority of cases of cerebral palsy in normal weight infants occur in those who have Apgar scores of 7 to 10 at 1 minute post-delivery.

Figure 1

Risk Factors for Cerebral Palsy

- pre-maturity
- low birth weight
- twinning
- abnormal neurologic exam in the first hours/days of life
- low Apgar scores (<3 at 5 minutes)
- seizures within the first 48 hours of life
- evidence of maternal infection
- maternal thrombolytic disease
- placental insufficiency
- maternal toxin exposure
- Rh incompatibility/kernicterus (severe jaundice)
- traumatic labor and delivery
- birth asphyxia
- mechanical ventilation
- ECMO (extracorporeal membrane oxygenation)
- dysmorphism or organ anomalies

A careful history of the pregnancy, birth and perinatal period may help reveal risk factors. Their presence is not necessarily cause for alarm, especially if the child is doing well. However, the possibility remains that motor impairment may manifest at a later date. In those children who have no obvious risk factors, developmental screening and physical examination play an even more vital role in identifying motor abnormalities.

The motor exam

A standardized developmental screening tool, such as the Denver II, can be extremely helpful in detecting deviations from normal motor development. Any such deviation should prompt a detailed neurologic motor assessment, using the standard neurologic exam. The lack of objective, quantifiable methods for measuring strength, quality of movement and tone may make the motor exam a challenge, however, especially in an infant or toddler who has limited ability to cooperate.

In addition to a standard developmental assessment and neurologic exam, many clues to motor impairment can be detected by keen observation. For example, any asymmetry of movement may suggest a focal CNS lesion and is important to note. Other clues to impaired motor function include:

- development of a hand preference before 12 months of age – indicative of motor impairment in the opposite side (hand preference typically does not develop until about 2 years of age).
- asymmetry of thumb-nail width, limb size or muscle mass – suggests hemiatrophy of the limb with motor impairment
- persistent fisting of hands after 3 months of age – suggestive of hypertonia/ cortical spinal tract dysfunction
- presence of abnormal involuntary movements/limb posturing/ataxia – suggests injury to basal ganglia/ cerebellum
- marked hip abduction when lying supine – indicative of axial hypotonia

Hypotonia (low muscle tone) is evidenced by a drooping of the child's head, trunk and limbs when the child is held in horizontal suspension, and by the child's shoulders slipping through the examiner's hands in vertical suspension. If hypertonia is present, scissoring of the lower extremities in vertical suspension may be noted.

Elicitation of deep tendon reflexes requires practice and patience. In the presence of hypotonia, decreased or absent reflexes suggest a peripheral nervous system disease. Evaluation for neuromuscular disorders is prudent in such cases. On the other hand, hyperreflexia in the presence of low or increased tone is indicative of CNS dysfunction. Other signs of upper motor neuron disease include ankle clonus (> 7-8 beats in infancy), a positive Babinski response (after 12 months

of age), the Hoffman reflex, and the crossed adductor reflex. The Hoffman reflex is elicited by flicking the terminal phalanx of the patient's middle finger downward, resulting in thumb flexion and adduction (in the absence of upper motor neuron dysfunction only 15 to 20 percent of people have thumb movement). The crossed adductor reflex can be noted during the elicitation of the patellar reflex and consists of contraction of the thigh adductors in the opposite leg. It is normal until about 8 months of age, then dissipates. The persistence or asymmetry of this reflex is abnormal.

Primitive reflexes

Assessment of the primitive and protective postural reflexes (Tables 1 and 2) is also a crucial part of the motor exam. Primitive reflexes normally develop in utero, while postural reflexes develop later in infancy. An asymmetry of response or abnormal persistence of primitive reflexes may be one of the earliest signs of abnormal motor development. Also, the failure of protective postural responses to develop in a timely manner is indicative of abnormal motor development.

Tables 1 and 2 (see insert) list the major primitive and postural reflexes, and their normal developmental courses. Marked deviations would warrant a referral for a thorough neurologic evaluation.

Neurologic evaluation – what to expect

One of the most important goals of a neurologic evaluation is for the examiner to distinguish whether the motor impairment represents a static condition (i.e. cerebral palsy) or a progressive process. As the developing CNS matures, changes in tone and the appearance of abnormal involuntary movements may seem to evolve over time. This may make a nonprogressive process difficult to distinguish from a slowly progressive neurologic disease. A pediatric neurologist must scrutinize for potentially serious and/or treatable neurologic disorders such as inborn errors of metabolism, neurodegenerative disease, neuromuscular disorders or spinal cord lesions.

A brain MRI is extremely helpful in the evaluation of a central motor impairment, especially when reviewed by a neuroradiologist with experience in the assessment of CNS development and the neurologic disorders of infancy and early childhood. The scan can be particularly useful for diagnosing neuronal migration disorders, structural abnormalities or evidence of previous infarction, hemorrhage, or infection. Further testing may be indicated depending on the suspected underlying condition.

A comprehensive team approach to treatment that draws on the expertise of a variety of pediatric specialists is to the child's greatest benefit. In addition to the child's primary care

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Author's Profile



Dr. Shani Norberg is Newest Member of Gillette's Neurology Team

Shani Norberg, M.D., joined the pediatric neurology staff at Gillette Children's in June, following the completion of an epilepsy fellowship with Minnesota Epilepsy Group in St. Paul. She graduated from the University of Minnesota Medical School, and continued there completing a dual track residency in pediatrics and neurology.

In addition to her specialization in epilepsy and seizure disorders, Dr. Norberg has a special interest in neurologic disorders of the newborn and young children. Her position at Gillette Children's will include an integral role in the newly developed Infant Toddler Program for young children with cerebral palsy and related disorders.

For more information about Gillette Children's Infant Toddler Program, please call (651) 290-8712. To reach Dr. Norberg directly, call (651) 229-3870.

provider and pediatric neurologist, this may include a developmental pediatrician, rehabilitation medicine specialist, orthopaedist, geneticist, gastroenterologist, ophthalmologist, neurosurgeon and/or craniofacial surgeon. The team of physicians can work in conjunction with rehabilitation therapists, a child psychologist, child family specialist, nutritionist, and other pediatric specialists to optimize the child's well-being and level of function.

The pediatric neurologist also plays a vital role in helping to direct families to community resources that help ensure appropriate intervention to enhance the child's development. In addition, the pediatric neurologist can provide counseling and education to the family regarding the potential etiologies, natural history and prognosis of neurologic disease.

To reach Dr. Norberg directly, please call, (651) 229-3870. For more information about Gillette Children's Infant Toddler Program, please call (651) 290-8712. For more information about early intervention services in your state, or to find an Interagency Early Intervention Committee serving your area call:

Minnesota Metro	(651) 215-8956
Statewide	(800) 728-5420
Iowa	(515) 281-7145
North Dakota	(701) 328-8936
South Dakota	(605) 773-4478
Wisconsin	(608) 266-7469

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Referral Information

Gillette Children's accepts referrals from physicians, community professionals and outside agencies. Contact the admitting manager at the number listed below. Physicians who are on staff may admit patients through our Admitting Department from 7 a.m. to 4:30 p.m. Physicians who are not on staff should contact the admitting manager.

Admitting Manager (651) 229-3845	Craniofacial Program (651) 229-3905
Admitting Department (651) 229-3848	Infant Toddler Program (651) 290-8712
Arthritis Program (651) 229-3903	Neuromuscular Program (651) 229-1716
Brain Injury/ Rehabilitation Program (651) 229-3877	Orthopaedic Program (651) 229-1758
Cerebral Palsy Program (651) 290-8712	Spina Bifida Program (651) 602-6889
	Spine Orthopaedics/ Upper Extremities Program (651) 229-3929

Pediatric Orthopaedic Update for Primary Care Physicians, Nurse Practitioners and Physician Assistants

Friday, December 7, 2001

Location: Gillette Children's Specialty Healthcare, St. Paul, Minn.

This continuing medical education course will examine a variety of musculoskeletal conditions that may be first evaluated in the primary care setting. Participants will rotate through eight small-group sessions. Topics include: Fracture Care and Casting, Developmental Dysplasia of the Hip, Toe Walking, The Limping Child, Juvenile Rheumatoid Arthritis, Sports Medicine Assessments, and Back Pain and Scoliosis. These sessions will focus on the physical examination, diagnostic work-up and treatment plans. For additional information, or registration materials, contact Patrick Cavanaugh at (651) 229-1758.

Children with Special Needs – A Focus on: Seizures, Cerebral Palsy, Fetal Alcohol Syndrome, Congenital Facial Deformities, Self-esteem in Children, and Psychological Testing and the IEP

Thursday, November 1, 2001 Location: Holiday Inn and Suites, Duluth, Minn.

This course has been designed to provide participants with an educational experience covering a broad range of topics impacting the education, development and health of children with special needs.

This workshop has been designed for nurse practitioners, nurses, physical therapists, occupational therapists, physical therapy assistants, certified occupational therapy assistants, psychologists, social workers, educators and family members. For more information, or registration materials, contact Cynthia Smith at (320) 848-2509.

Table 1: Primitive Reflexes

REFLEX	ONSET	ELICITATION	EXPECTED SUPPRESSION OR INHIBITION
Moro reflex	Birth	Elicited spontaneously by a sudden movement, loud noise, or change of light. Elicited during exam by lifting infant's head 30-45° in relation to the trunk, followed by extension of the neck by letting the head drop slightly into examiner's hand or onto the exam table. Consists of symmetric abduction and flexion of the arms, followed by symmetric adduction and flexion of the extremities. Often accompanied by crying.	Typically by 6 months of age. Abnormal if absent or asymmetric.
Asymmetric tonic neck reflex (fencing reflex)	Birth	Examiner turns infant's head to one side when infant is in supine position. The arm and leg on the side to which the head is turned extend outward, with flexion of limbs on the opposite side, in a fencing-like position.	Suppressed while awake at about 6 months of age. Abnormal if infant remains in this posture beyond several seconds, or if the reflex persists beyond 6 months of age. Indicative of a lesion in the hemisphere opposite the direction to which the face is turned.
Palmer grasp reflex (grasp response)	Birth	A finger or small object placed in the infant's palm elicits an involuntary flexion or grasp. Attempts to remove the object produce an even tighter grasp.	Suppressed by about 2 to 4 months of age. Should disappear by about 6 months of age. Abnormal if asymmetric or persistent. Often seen in hemiplegia.
Placing reflex	Birth	The infant is held upright, and the dorsal aspect of the foot is allowed to touch the surface of the tabletop. Infant's hip and knee will flex as the infant withdraws the foot.	Disappears by 5 months of age. Abnormal if asymmetric or persistent.

Table 2: Maturation/Postural Responses

RESPONSE	ONSET	ELICITATION	EXPECTED DISAPPEARANCE OR INHIBITION
Traction	By 5 months of age	Infant is pulled to sitting from the supine position by the hands. The infant anticipates the movement, resists by pulling against the examiner's pull, and raises head. Abnormal if head lag persists.	Persists
Landau reflex	By 10 months of age	The infant is held in prone horizontal suspension. The examiner flexes the infant's head, eliciting flexion of the infant's legs and trunk.	By 2 years of age*
Parachute response	By 10 months of age	The infant is held in prone position. The body is moved abruptly headfirst in a downward direction. The infant outstretches both arms and legs symmetrically.	Persists*
Head righting	By 4 months of age	Infant is gently swayed from side to side while in vertical suspension. Infant can keep the head vertical despite the body tilting.	Persists*
Trunk righting	By 8 months of age	Sitting infant is gently but abruptly pushed to one side past midline in the horizontal plane. Infant flexes trunk toward the force and outstretches hand and arm away from the force.	Persists*

*Abnormal if fails to develop or if asymmetric

