Early recognition of infants at risk for development disability is important. The early identification of a developmental delay is a challenge to all physicians, however. It is difficult to differentiate between infants who are lagging behind in skill acquisition but will achieve the usual developmental milestones and infants who are truly deviating from the expected pattern. Identifying children in the first year of life provides the opportunity for early referral for interventional services and diagnosis. The physician can supply factual information and devise a realistic approach for the care of these conditions and then counsel parents regarding possible outcomes for their child. Children with chronic medical conditions and children growing up with precarious social and environmental circumstances are at risk for developmental delay. Early diagnosis of at-risk infants is possible once a thorough history is obtained, a complete physical examination is performed, and an assessment of the functional developmental level is secured.

Perinatal history

A thorough perinatal history offers vital information that, when analyzed, provides important clues to possible risk factors that may have a later impact on a child’s functioning. Not only should gestational age, birth weight, and Apgar scores be obtained but also pertinent pregnancy information should be reviewed. Most importantly, was there prenatal care before the birth of the child? Early support of a pregnancy leads to earlier maternal and fetal intervention and improved fetal outcome. By definition, a high-risk pregnancy places the mother or infant at higher risk for medical complications. Some maternal circumstances
have an impact on the medical and developmental functioning of the infant, including inadequate or excessive maternal weight gain, diabetes, lupus, seizure disorder, and other chronic diseases. Increasing maternal age has a direct correlation regarding the increased prevalence of chromosomal anomalies. Some of the entities that have a direct influence on infant outcome include placental insufficiency, infection, preterm birth, multiple gestation, fetal demise in a multiple pregnancy, illegal drug use, prescription medication use, and alcohol and tobacco use. Cocaine-exposed infants have been found to have significant cognitive deficits and a doubling of the rate of developmental delay during the first 2 years of life, although contradictory studies have suggested that there was no direct effect on cognitive outcome but indirect effects were mediated through the home environment [1–3].

Some factors affect delivery and have an impact on a neonate’s well-being. The length of labor—either prolonged or precipitous—is important to note. Friedman characterized normal labor by studying normal nulliparous and multiparous women during routine labor. From these studies he developed the concept of a dilation curve. Labor was divided into a latent phase, active phase, and second stage (Fig. 1) [4]. There are marked individual variations in the length of labor; however, the average length of the first stage of labor can range from 7 hours in a nulliparous woman to 4 hours in a parous woman. The second or active stage usually lasts from 50 minutes in a nulliparous woman to 20 minutes in a multiparous woman. A short or long second stage of labor can have an affect on fetal well-being. Cesarean section itself does not place a baby at high risk;
however, the reason for the cesarean section may. Were fetal heart rate problems, infection, or a failure to progress the reason for the surgical delivery? An operative delivery may lead to transient tachypnea of the newborn. This entity was first described in 1966 by Avery and was believed to be caused by the delayed absorption of fetal lung fluid [5]. Passage of heavy, thick meconium before or at the time of delivery may indicate fetal distress, and it places the infant at higher risk for the development of meconium aspiration syndrome. Meconium is found in 8% to 20% of deliveries and is usually light (meconium staining). Passage of meconium is a poor predictor of later neurologic problems. In the large National Perinatal Collaborative study, less than 0.5% of infants with a birth weight more than 2500 g and meconium staining had neurologic problems [6]. Fetal hypoxia, as measured directly by scalp pH or indirectly by fetal heart rate tracing, sets the stage for possible neonatal complications but is not a specific predictor of later problems.

**Neonatal considerations**

The Apgar score, devised by the anesthesiologist Dr. Virginia Apgar in 1952, was one of the first objective, clinical measures used to assess a newborn’s well-being. It consists of five observable measures: heart rate, respiratory effort, color, muscle tone, and response to noxious stimuli. The Apgar score was developed as a tool to assess the condition of an infant at birth. A low Apgar score is not synonymous with asphyxia. Asphyxia implies fetal hypercarbia and hypoxemia that can lead to metabolic acidosis. Medications, congenital anomalies, gestational age, and acute events all may have an impact on the Apgar score. The 1-minute Apgar score indicates if ongoing intervention is needed. A low Apgar score correlates poorly with later development of cerebral palsy. Nelson and Ellenberg found that 55% of children with cerebral palsy had Apgar scores of 7 to 10 at 1 minute, and 73% of children with cerebral palsy scored 7 to 10 at 5 minutes. Of the children who had Apgar scores of 0 to 3 at 10 minutes or later and survived, 80% were free of major handicap at early school age [7–10].

It is important to assess accurately a newborn infant by determining its gestational age and recording the growth parameters. The newborn’s growth parameters reflect the in utero environment. Newborns are classified according to their birth weight as small for gestational age (less than the tenth percentile), average, or large for gestational age (more than the ninetieth percentile). The National Center for Health Statistics revised the individual growth charts in 2000. These charts incorporated newer data from five national health examination surveys. There are some minor differences in the percentile lines. Most of the differences are found in the charts for infants and there are differences at the outer percentiles (ie, smallest and largest children) [11].

Maternal diabetes and maternal obesity are well-known predisposing factors in the development of large-for-gestational-age infants. Other factors that are associated with macrosomic infants include (1) large size of parents, particularly
obesity in the mother, (2) multiparity, (3) maternal age, (4) prolonged gestation, (5) male fetus, (6) previous large infant, and (7) race and ethnicity [12–15].

The incidence of congenital anomalies and intellectual and developmental delay is statistically more common in preterm and term infants of high birth weight. Obstetric complications continue to occur in this population, including birth trauma, intrauterine growth restriction, and intrapartum asphyxia. The infant of a mother with diabetes displays its own set of medical complications, including neonatal respiratory distress, hypoglycemia, hypocalcemia, hyperviscosity (polycythemia) syndrome, cardiomyopathy, and congenital anomalies [16–19].

Small-for-gestational-age infants are at risk for increased adverse affects in the newborn period. These infants have a birth weight less than the tenth percentile, taking into consideration the population-specific birth weight and the gestational age. The proportionate reduction in head and body size has been termed symmetrical growth restriction. Asymmetrical growth restriction refers to the relative sparing of head size in proportion to the smaller body size. By definition, intrauterine growth-restricted infants have had a rate of fetal growth that was less than normal, which produces an infant who is small for gestational age. Problems in this group of infants include perinatal depression, hypothermia, hypoglycemia, polycythemia-hyperviscosity syndrome, and immune dysfunction. These children remain at risk for compromised health and development throughout their childhood. This is particularly evident as far as somatic growth is concerned. Catch-up growth is usually evident by 4 months of age if it is going to occur. From 4 months onward, the velocity of growth remains constant and these children remain small [20]. More troublesome are the long-term studies that suggest that these infants can demonstrate lower cognitive performance, suboptimal school achievement, and behavioral or mental health problems [21–23].

A spectrum of hypoxic-ischemic encephalopathy exists. It is usually classified as mild, moderate, or severe [24]. Infants who manifest mild degrees (ie, normal neurologic examination at the time of discharge) rarely exhibit neurodevelopmental sequelae. Infants with a more moderate degree of level of encephalopathy have a 20% to 40% chance of an abnormal outcome. One hundred percent of babies with severe encephalopathy demonstrate an abnormal outcome [25–29]. The criteria for hypoxic-ischemic encephalopathy are as follows: (1) an Apgar score of 0 to 3 for more than 5 minutes, (2) an umbilical artery metabolic acidosis or mixed respiratory-metabolic academia with pH less than 7, (3) newborn neurologic sequelae (eg, seizures, hypotonia, or coma), and (4) multiorgan system dysfunction.

The initial concerns surrounding premature birth relate to survival. Chances for survival increase from 22 through 33 weeks’ gestation. At each gestational age, a lower birth weight carries a higher risk of mortality [30]. Premature infants may experience a wide range of complications, including chronic lung disease, periventricular leukomalacia, sepsis, retinopathy of prematurity, intraventricular hemorrhage, necrotizing enterocolitis, hearing deficits, and birth defects [31]. These neonatal morbidities have an increasing adverse effect on neuro-
logic, developmental, neurosensory, and functional outcomes with decreasing birth weight.

Vohr et al reported on the neurodevelopmental, neurosensory, and functional outcomes of 1151 extremely low birth weight (401–1000 g) survivors cared for in the 12 participating centers of the National Institute of Child Health and Human Development Neonatal Research Network. They identified medical, social, and environmental factors associated with these outcomes. Twenty-five percent of the 1480 surviving infants evaluated at 18 months of age had an abnormal neurologic examination, 37% had a Bayley II mental developmental index of less than 70, and 29% had a psychomotor developmental index of less than 70. They

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**Box 1. Risk category for developmental delay by medical diagnosis**

*High risk*

1. Birth weight less than 1250 g
2. 30 weeks’ gestation or less
3. Intraventricular hemorrhage/periventricular leukomalacia
4. Severe perinatal asphyxia
5. Severe neurologic problems
6. Bronchopulmonary dysplasia that requires home oxygen
7. Complex congenital/cyanotic heart disease
8. Abnormal neurologic examination at discharge
9. Significant feeding problems/requirement of gavage feeding
10. Intracranial pathology: congenital or acquired
11. Extracorporeal membrane oxygenation
12. Diaphragmatic hernia
13. Persistent pulmonary hypertension of the newborn/required inhaled nitric oxide/oscillatory ventilator
14. Significant circulatory failure
15. Congenital viral infection (HIV, TORCH)
16. Prolonged or persistent hypoglycemia
17. Multiple/major congenital anomalies and genetic disorders

*Moderate risk*

1. Birth weight between 1250 and 1500 g
2. Prolonged ventilation and high-frequency ventilation
3. Surgical: cloacal anomalies/gastroschisis/omphalocele
4. Tracheostomy
5. Metabolic disorders
found that neurologic, developmental, neurosensory, and functional morbidities increased with decreasing birth weight. The factors significantly associated with increased neurodevelopmental morbidity included chronic lung disease, grades 3 to 4 intraventricular hemorrhage and periventricular leukomalacia, steroids for chronic lung disease, necrotizing enterocolitis, and male gender. The factors significantly associated with decreased morbidity included increased birth weight, female gender, higher maternal education, and white race [32]. Compromised neurologic status affects cognitive function and later school performance. Emerging studies of this extremely low birth weight population reveal significantly poorer school performance, with particular difficulty in the area of mathematics. Even children without neurologic impairments have scores that are significantly lower on cognitive and achievement measures. Social and environmental factors, including maternal level of education, contribute to outcome (Box 1) [33–37].

**Developmental history**

A child’s development should follow a predictable pattern. Reviewing a child’s history of acquisition of developmental milestones offers a way to detect deviations from normal. A developmental history is usually organized by domains of development. Areas to be included are gross motor skills, fine motor skills, social interaction, language, and self-help. These domains are not mutually exclusive, and a child’s behaviors can be thought of as belonging to more than one domain. For example, a 9-month-old child requires social maturity, motor planning and performance, and symbolic language skills to “wave bye-bye.” Anticipatory guidance guidelines offer information on the timing and standard deviation for normal development. The “Bright Futures” publication identifies several desirable health, social, and developmental outcomes as a result of the implementation of the health supervision. By eliciting a developmental history at each visit, the pediatrician has an opportunity to create a supportive relationship with the parents and educate the family on normal development of their child.

**Social history**

The environment in which the family resides has an impact on the development of the child. Parental education, financial resources, marriage status/living arrangements, and family support structures all have an impact on the outcome of the family. Poverty is one of the primary predictors of poor health outcomes for children. The child-rearing practices of persons who live in poverty are more likely to lack some of the elements that are fundamental for optimal outcomes. Fundamental needs that may not be met include literacy, stimulation, parental time, books, appropriate educational toys, guidance, role models, and
high expectations [38–42]. Caldwell and Bradley developed a psychometrically valid inventory to describe the quality of the home environment: the HOME scale (Home Observation for Measurement of the Environment). This is a 45-item (infants and toddlers) or 55-item (preschool children) observational assessment [43].

Family history

A concise, systematic approach to obtaining a complete family history can provide useful information. The history should encompass three generations: (1) patient and siblings, (2) parents and their siblings, and (3) grandparents and their siblings. The usual record consists of medical conditions. If there have been deaths of family members, the age at death and the cause of death should be noted. Specific questions should be asked regarding illnesses that have affected more than one family member, congenital anomalies, and genetic disorders within the nuclear and extended family unit. The interview also should focus on the educational achievement of the adults, school difficulties of family members, and speech, language, learning, and developmental problems.

Physical examination

When performing the physical examination [44], knowledge of normal anatomy and its variants helps the physician recognize significant findings. The basic techniques of physical examination should be used and fine tuned to recognize any subtle physical clues that might be overlooked. Fetal embryogenesis and development is a highly intricate process, with parallel and sequential growth taking place. Any alterations at a specific time may affect more than one organ system. A well-known example is the association of ear deformities and kidney anomalies. The ear and kidney have active growth at the same time, so intrauterine influences are reflected on both organs. Parents are highly sensitive observers of their children, and their concerns should be addressed openly.

Quiet observation of the child can lead to a wealth of information. Look for subtle differences between opposing sides of the body, face, or extremities. Unusual or abnormal postures and positioning can lead you to the site of pathology. Torticollis can be suspected by the abnormal tilt or rotation of a baby’s head at rest. Passive and active range of motion can confirm this diagnosis.

A complete head-to-toe examination is important to identify abnormalities that may have an impact on a child’s development. The examination may begin with accurate measurement of growth parameters. Weight, height, and head circumference should be documented routinely and plotted on standard growth forms. When a child is born prematurely, the adjusted age may be used for plotting these growth parameters. It is often practical to plot growth parameters at the chronologic age, however, with the understanding that these parameters are at a lower percentile than if the child were plotted at the adjusted age. To calculate
the adjusted age, the amount of prematurity is subtracted from the chronologic age. The adjusted age should be used when evaluating the developmental level of infants and young children.

During the course of the physical examination deviations should be noted. Identify, as clearly as possible, any abnormal features. It is often helpful to know if the baby resembles a family member. Skull shape can vary somewhat among racial groups, and small degrees of asymmetry can be seen in normal individuals. More marked asymmetry is often caused by intrauterine deformation or possibly craniosynostosis. The head circumference provides a rough estimate of brain size. Conditions such as microcephaly and macrocephaly may indicate an underlying brain anomaly.

Placement of a child’s ears is best judged in relation to other landmarks on the head and face. Low-set ears and posterior rotation of the ear are common abnormalities. The junction of the upper pinna to the scalp should be at the same level as the outer canthus of the eye. The upper limit of the pinna should be at the level of the eyebrow, whereas the lower level of the pinna should be at the level of the alae nasi. Preauricular pits or tags may occur in normal individuals, and variations in the form of a helix are also relatively common.

In general, the face is divided into thirds, with the distance between the inner canthi of both eyes comparable to the distance between the inner and outer canthi of each eye. The slant of the palpebral fissure varies, and there are ethnic variations of eye shape and lid placement. Clefts within the eyelid are considered abnormal. A white pupil or abnormal placement of the light reflex is always abnormal. Marked strabismus may be either divergent or convergent in one or both eyes. If there is a constant deviation after 5 months of age, it requires examination by a specialist. Pendular nystagmus is a sensorial deficit that always requires referral. Bilateral lid ptosis may indicate a neuromuscular abnormality.

In the center of the face are only two structures: the nose and philtrum. A change in length of one usually necessitates a compensatory change in the other. For example, a short nose often results in a long philtrum. The columella is the tissue that connects the nose tip to the face. This structure, along with the nose tip and alae nasi, provides an overall picture of the end of the nose. Nasal length and nasal width have considerable familial and ethnic variation, which makes it difficult to recognize abnormalities in this region.

The perioral region is evaluated by inspection. The size, symmetry, and shape of the mouth, lips, and nasal labial folds should be reviewed along with the contour of the chin and cheeks. Often abnormalities of nervous innervation to the lower face may be demonstrated when the child cries or laughs. The intraoral cavity should be examined for patency of palate and its configuration. A cleft palate is the most common major mouth malformation. There are two classes of palatal clefts: those that occur in isolation and those that occur in association with a cleft lip.

When examining the neck it is important to demonstrate head position at rest. Abnormal hypertonia of neck extensors is demonstrated by an exaggeration of the space between the posterior neck and table surface when the infant is supine.
The relative width and length should be assessed. Neck mobility, including extension, flexion, and rotation, is evaluated by passive and active range of motion. A short neck usually is the result of an absence or malformation of one or more cervical vertebrae, and neck mobility is then limited, particularly during flexion. Rotational activity is more often limited with torticollis.

The shoulders superiorly and lower rib inferiorly delineate the chest. General shape of the thorax and nipple placement and symmetry should be noted. One of the minor variants that is often seen is pectus excavatum (funnel chest). This condition may be of cosmetic concern but usually causes no physiologic problems. Shield chest is an unusually broad and often short upper thorax and is frequently associated with wide-spaced nipples.

The back is first inspected for general configuration and symmetry. Special attention should be paid to the lower back, where sacral dimples or other midline abnormalities may be found. If an abnormality is found, it must be differentiated from a minor or major degree of spinal dysraphism. The chance of an underlying defect increases if found above the natal cleft. It may be necessary to separate the buttocks to view the entire spine.

Examination of the heart is accomplished through inspection, palpation, and auscultation. Congenital heart defects can occur in isolation or in association with other anomalies. Children with these defects may experience inadequate weight gain secondary to poor caloric intake and an increase in metabolic rate. The child can experience a concurrent decrease in strength and stamina, with a delay in the acquisition of motor milestones. Early intervention encourages normal developmental patterns until the heart defect can be corrected.

The abdominal examination begins with a brief inspection, and one should pay close attention to symmetry, muscle tone, and the presence of major or minor defects in the abdominal wall. Children who have had surgical procedures that required an abdominal approach experience disruption of their abdominal musculature and may display a decrease in abdominal flexor muscle strength. Special attention should be paid to the umbilicus. Umbilical hernias can range widely in size, and often the abdominal wall defect is considerably smaller than the hernial sac. A palpable defect smaller than 1 cm in diameter could be considered a normal variant and should close spontaneously within 2 to 3 years.

The genitourinary system is a complex system. The complexity is second only to that of the face and brain. Disruption in this area can be accompanied by changes within the pelvis. Bladder extrophy is one such condition in which the hips are often widely abducted with the pelvis tilted. Sitting skills may be delayed. It is important to partner with a surgeon to optimize motor skills without compromising surgical correction. Inspection of the female external genitalia is usually the only examination that is required. Internal inspection should be reserved for patients with a strong suspicion of anomalies. Examination of male genitalia involves inspection and palpation. Location of both testes should be documented. When either the testis or penis seems unusually small or large, referral to a pediatric urologist is warranted for further evaluation. When ambiguous genitalia are discovered, it is important to note the size and textures.
of the various structures. The location of the urethral opening also should be documented. Investigation should be undertaken to determine the presence or absence of the vaginal introitus. The possible labia majora should be palpated for masses that may represent a testis or ova testis.

The skin is the largest organ in the body; many cutaneous abnormalities have been described [48]. Many of these skin anomalies are localized and benign, whereas others may provide valuable clues to underlying medical or neurologic conditions. Areas of hyper- or hypopigmentation, changes in elasticity, and discrete lesions may lead to a significant medical diagnosis. The texture of the hair, placement of the hairline, presence of hair in the pubic or axillary area, and unusual patches of hair elsewhere on the body should be documented. Fine hair covering the body—lanugo—is often found in many infants. Nail color, size, shape, and thickness should be elucidated by physical inspection. Fingernails should be inspected from the dorsal surface and end-on.

Examination of the extremities is best performed with the child in a recumbent or sitting position. Limb length and bulk are judged. A difference of more than 1 cm in leg length eventually produces a pelvic tilt [49]. Palpation of the limbs determines size and consistency of the muscles. When any asymmetry is suspected, referral for accurate measurement and evaluation is warranted. Examination of the large joints of the body should accompany the limb examination and should include rotation, flexion, extension, and active range of motion. During inspection of the hands and feet, syndactyly, joint laxity, and presence or absence of a plantar arch should be looked for. Increased flexibility across various joints is often seen in various ethnic groups and on a familial basis. Excessive hyperextensibility, particularly of small joints, along with creased elasticity of the skin is seen in Ehlers-Danlos syndrome.

The Ortolani maneuver should be performed at routine intervals during an infant’s life. A marked asymmetry of hip abduction warrants referral for further evaluation. Ultrasonic evaluation is best performed between 2 and 6 weeks of age but can be used up to 4 months of age. Once an infant is 4 months of age, the plain radiograph becomes the imaging modality of choice because the femoral head is ossified [50].

Subtle changes in a neurologic examination may have enormous significance in eventual development of that child. A complete neurologic examination should be performed at regular intervals. Evaluation of the nervous system provides information regarding motor function and sensory integrity. Neurologic findings can vary depending on the patient’s state of alertness and desire to interact with the environment. For example, immediately after a feeding, the neonatal reflexes tend to be less distinct and muscle tone may seem diminished compared with findings just before a feeding.

The cranial nerves are used to elicit some basic primitive responses. Evaluation should include the ability for the child to fix and follow and the ability to suck, swallow, and hear. Some of the primitive reflexes that should dissipate over the first 8 months of life include the palmar grasp, rooting/sucking, moro, and atonic neck reflex. Hands may remain closed until 2 months of age, and thumb
adduction should be checked for. The atonic neck reflex can be present until 3 months of age and should dissipate between 3 and 6 months of age. With the resolution of primitive reflexes, various postural reflexes are then elucidated. These reflexes include neck righting, parachute, and the Landau maneuver.

The peripheral deep tendon reflexes are synonymous with the stretch reflex. They describe a neuronal arc that consists of a muscle contraction with the impulse traveling to the dorsal route ganglia. The efferent side consists of the motor neuron along with its terminal structures that innervate the muscle. Central influences can modify the response of the motor neuron. The elicitation of a motor response means that the arc is intact and conducting impulses. The absence of response does not necessarily indicate an abnormal state because neural influences may suppress the reflex. Reflexes that should be checked include the biceps, triceps, patellar, and quadriceps reflexes, which are graded by the degree of response elicited. When no response is forthcoming, the grade is zero. If a reflex response is elicited by reinforcement, then the arc is intact, although possibly inhibited. A 1+ response is in the low normal range; 2+ is considered a normal or average response; 3+ is a brisk response and may indicate disease; a 4+ response is very brisk and is associated with clonus and shows evidence of disease.

The Babinski sign is considered by some researchers to be the most important sign in neurology. When present after the age of 12 to 16 months, it indicates dysfunction of the corticospinal motor system. The Babinski sign is referred to as being present or absent, not positive or negative. An absent Babinski reveals intact neurologic function and consists of flexion of the forefoot with adduction of the toes. The presence of a Babinski sign is an abnormal response and is seen with dorsiflexion of the great toe and fanning of the others. This is often accompanied by withdrawal at the knee and hip.

It is crucial to have a solid understanding of normal developmental landmarks to assess the state of nervous system function at the various ages in infancy. Motor skills are generally acquired in relatively constant sequence during the first 2 years of life. This sequential attainment of milestones cements the evidence of nervous system integrity. Factors unrelated to brain disease may hinder the orderly appearance of developmental milestones. Maternal or sensory deprivation may result in deficits in the motor and speech realms. Prematurity, serious generalized disease, and recurrent infections can have an impact and retard development during the first year of life. This may occur with an intact nervous system. As with all of pediatrics, the neurologic examination in an infant must be performed in a less systemized fashion than that of an adult. Quiet observation can yield a wealth of information, such as information in the areas of symmetry of limb movement, organization of ocular movements, and degree of interest in and an awareness of the baby’s surroundings. The ability to suck, cry appropriately, and move passively can be obtained [51].

The Moro reflex should be a part of the examination of any infant. It is normally present from birth until 3 to 4 months of age. During this 4-month period, the intensity of the response should diminish. If the Moro reflex persists
in a full-term infant past 4 months of age, neurologic disease should be suspected. If it is present at 6 months of age, it almost always indicates a significant disorder. Absence of the response in a neonate does not necessarily indicate brain disease and is often difficult to elicit in premature infants. An asymmetric response may suggest hemiparesis, injury to the brachial plexus, or a fracture of the clavicle or humerus.

Rooting and sucking reflexes are more active if the child has not been recently fed. Persistence of these reflexes beyond 4 months of age suggests bilateral brain dysfunction. Chewing or mouthing movements may indicate an underlying neurologic disorder.

The infant should blink in response to a bright light, and the pupils should constrict simultaneously. Conjugate movements develop rapidly after birth; however, infants are often unable to follow objects during the first few weeks of life. By 3 months of age an infant should be able to fix and follow a red ring.

The newborn infant’s hands are held in a fisted position during much of the awake period. The hands tend to open and become more relaxed after 4 weeks of age. Persistence of a specific posture in one hand after 2 months of age may indicate an emerging spastic hemiparesis. The grasp reflex is symmetrical and present at birth and should persist for 2 to 3 months.

The asymmetric tonic neck reflex, or fencing pose, is a normal response between 1 and 5 months of age. The infant should be able to overcome this response (nonobligate). Persistence of this reflex or response that persists beyond 6 months of age or is an obligate response is considered abnormal.

Stepping movements are obtained by supporting a child in an upright position with the bottom of his or her feet in firm contact with a table. This response lasts for 3 to 4 weeks and provides evidence of neurologic integrity. While holding the child in this position, an assessment of muscle tone also can be made. Scissoring of the legs is always considered abnormal.

By 6 months of age, a normal infant no longer should show evidence of these primitive reflexes. Persistence of these reflexes without a good explanation requires further investigation.

Performing the Amiel-Tison angles completes neurologic examination [52]. These measurements of passive tone are similar to what is obtained in the newborn examination. The angles that are tested include the scarf sign, popliteal angle, adductor angle, heel-to-ear maneuver, and foot dorsiflexion. There are age-appropriate standards for measuring the various angles. As a child grows from infancy to young childhood, he or she becomes more flexible with an increase in measured angles. Asymmetry between the two sides can be elicited. An assessment of muscle tone can be obtained while performing these maneuvers (Fig. 1).

The scarf sign is performed with the child in the supine position. In a quiet alert state, with the child’s back flat against a hard surface, the wrist is grasped and swept across the chest until resistance is felt. Three possible positions are obtained: (1) the elbow does not reach the midline, (2) the elbow passes the midline, (3) the arm encircles the neck.
The popliteal angle is obtained with the child in the supine position with the buttocks on the table surface. With the hands placed over the child’s knees, the thighs are flexed laterally and then the lower leg is extended. The angle is measured based on the measurement between the thigh and calf. Both legs are measured simultaneously. A difference between the two sides of 10° to 20° indicates significant asymmetry.

The adductor angle is obtained with the infant in the supine position, legs extended and gently abducting the lower extremities. The angle is measured by drawing an imaginary line along both inner thighs with the vertex at the symphysis pubis. If this angle is bisected, the two angles should be relatively equal.

The heel-to-ear maneuver requires a measurement with both legs extended and then moved toward the head. The angle is measured from the flat surface along the back of the leg to the infant’s heel. The pelvis should not lift off the table. If it is not possible to extend the lower limbs because the hips are in a fixed hyperflexed posture, then this is considered an abnormal sign.

Foot dorsiflexion is measured with the leg extended and the foot flexed onto the shin. Pressure should be applied to the sole of the foot. The dorsum of the foot and the anterior aspect of the leg form the angle. The usual range of 60° to 70° persists throughout infancy. A slow and rapid angle should be measured. A difference of more than 10° indicates an abnormal exaggerated stretch reflex (Fig. 2).

![Diagram of various angles and movements for neurological evaluation](image)

Fig. 2. Normal pattern of passive tone within first year of life. (Adapted from Amiel-Tison C. A method for neurological evaluation within the first year of life. Curr Probl Pediatr 1976;7:1; with permission.)
Developmental screening tools

Numerous developmental tools can be used for screening infants and young children. It is important that the screening tool be easy to administer and is accurate between evaluations. The aim of a developmental screening tool is to identify children who need a more comprehensive evaluation. Some of the more well-known tools include the Denver Developmental Assessment, the Capute Scales (Cat/Clams), and the Bayley Infant Neurodevelopmental Screener. If a child was born more than 2 weeks before the expected date of delivery, the adjusted age should be used. A developmental quotient can be calculated for each domain. For example, at a chronologic age of 13 months a child is not able to perform a specific age-appropriate developmental task but is able to accomplish the tasks at the 10-month level. The child is functioning at 77% of the expected level. A developmental quotient of 70% indicates a significant delay.

The Denver Developmental Screening Test [53] was designed as a screening tool for apparently normal children from birth to 6 years of age. It has 125 well-standardized, easily administered test items in a one-page format. This test encompasses four general areas of development: fine motor, gross motor, personal and social skills, and language. The items are arranged in these four sections. When two or more delays are noted (ie, the child refuses an item or it falls completely to the left of the age line), the child is considered to have failed the screening and more definitive developmental assessment must be undertaken. The Denver-II screening test is known to have modest sensitivity and specificity depending on the interpretation of questionable results.

The Capute Scales [54] are an assessment tool that examines visual motor and problem-solving and language abilities. CLAMS stands for clinical linguistic and auditory milestones. It was developed, standardized, and validated for language development from birth to 36 months of age. The CAT (clinical adaptive test) examines problem-solving items from birth to 36 months. Items are recorded as “yes” for pass and “no” for failed. If two consecutive months are scored as “yes,” a basal age is determined. Items at the next higher level are then administered until two consecutive levels of “no” responses are obtained.

The Bayley Infant Neurodevelopmental Screener [55] is a tool to assess children in blocks of age from birth until 24 months of age. It is used primarily as a screening instrument; however, it also can be used as a surveillance instrument. Each group of items assesses fine motor, gross motor, language, and social interactive and play skills. The child receives a point if the item is accomplished and a zero if it is not. The child is placed in one of three categories: low, moderate, or high risk for developmental delay. This screening tool is easy to administer and takes approximately 10 minutes to administer, and the administration format is easy to follow.

Recently, screening tools have been developed that respond to parental concerns. By using these tools, parents become active participants in the care of their child. These concerns have proven to be highly predictive of true problems [56,57]. These parental report questionnaires have good psychometric
properties and have been standardized on diverse populations and provide accurate information about development. They have the added benefit of requiring much less direct time from the primary care provider. Some of the instruments include the Parents’ Evaluation of Developmental Status [58], Ages and Stages Questionnaires [59], and the Child Development Inventories [60].

Summary

Early identification of infants at risk for developmental delay is of the utmost importance to initiate appropriate intervention. Although early detection can be a challenge, the primary care practitioner is in the ideal position to recognize and refer these children. Early recognition requires an in-depth knowledge of the child’s history, general physical examination, and developmental level and an understanding of the expected developmental precursors of a skill. Referral to appropriate interventional resources leads to a formalized developmental and neurologic evaluation. If necessary, the development of an interdisciplinary comprehensive plan of remediation can occur and a definitive diagnosis can be made. If no significant problem is found, a decision to provide expectant observation is warranted.

References

[53] Frankenburg WE, Dodds JB. The Denver Development Assessment (Denver II). Denver: University of Colorado Medical School; 1990.