A Review of the Amiel-Tison Neurologic Evaluation of the Newborn and Infant

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Because occupational therapists are becoming more involved in infant assessment and intervention, there is a need for objective, prospective, and serially applicable evaluation tools. Amiel-Tison's Neurologic Evaluation of the Newborn and the Infant provides such a tool for use in the first year of life. This evaluation was developed to detect transient and permanent abnormalities in an infant's neuromotor development. Its main focus is to examine active and passive muscle tone. The test has interobserver reliability, is reproducible, and can be readily learned by occupational therapists. Although the evaluation is not standardized, it is clinically useful in neonatal units, developmental clinics, and research settings. This evaluation detects transient neuromotor problems in the first year of life that are associated with significant behavioral, neurological, and intellectual deficits when the children reach school age. Using this test, occupational therapists frequently involved with the assessment and management of children can play a crucial role in the first year of life by diagnosing and documenting abnormalities.

In the past decade occupational therapists have become increasingly involved in assessing and treating infants in both neonatal intensive care units and developmental clinics. Although therapists provide various types of intervention for high-risk and disabled infants, little research has been done to assess the effectiveness of therapy with respect to the long-term outcome. This may be partially due to the lack of objective, prospective, and serially applicable evaluation tools. This paper describes Amiel-Tison's Neurologic Evaluation of the Newborn and the Infant (1), defining its clinical uses and reviewing the parts pertinent to therapists.

In the first 10 days of life, dysfunction of the nervous system can be detected; however, once these early days of life are past "the windows through which we look often close and the brain functions normally again and yet after several months dysfunction appears again" (2, p v). Thus, these first 10 days provide an opportunity to gather information regarding the infant's initial and future wellbeing. As neonatal care has improved, it is not uncommon for premature infants as small as 1,000 g to demonstrate age-appropriate neurologic maturation by the gestational age of 40 weeks (e.g., normal interactional patterns, pursuit of light, primary reflexes, and motor performance). During the first year of life, subtle and transient neuromotor abnormalities are becoming more apparent to investigators; often these are most pronounced between 6 and 8 months corrected postnatal age (1). There are many developmental (3-6), neurologic (7-16), and behavioral (16-19) examinations for infants. The developmental scales emphasize gross and fine motor development, cognitive, language, social-emotional, and self-care skills. In infants (0-12 months), performance on developmental tests, to a large degree, is a reflection of muscle tone and neuromotor maturity (1). Developmental tests provide useful

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information about functional skills; however, the examination of muscle tone, primitive or primary reflexes, and postural responses is usually ignored.

Direct examination of muscle tone provides an important dimension to the overall assessment of the infant. Abnormalities in muscle tone (e.g., hypotonicity, hypertonicity) may influence the development of new skills. Abnormal muscle tone may encourage the infant to use compensatory patterns of movement and thus compromise the infant's ability to experience normal patterns of movement and learning. An objective examination of muscle tone is important because it provides a crucial description of both the type of, and mechanism for, certain abnormal developmental patterns. A developmental evaluation supplemented with an objective examination of muscle tone, primitive reflexes, and postural responses may help therapists in delineating treatment goals.

Several studies have recognized that abnormalities in neonatal muscle tone and motor activities are highly prognostic of poor outcomes in children with mental and motor handicaps. In a large prospective study of 40,057 births, Nelson and Ellenberg (20) demonstrated that certain neonatal neurologic signs predicted late motor handicap. Abnormalities in muscle tone of the neck, trunk, and limbs indicated a 12- to 15-fold increased risk for developing cerebral palsy. Rosenblith (21) described significant relationships between examinations of neonatal muscle tone and all psychological criteria at the 4-year-old level. Parmelee and Michealis (14) emphasized the importance of repeated neurologic examinations and reported that a key prognostic sign for long-term outcome is how quickly the neonate recovers from impaired function during the first days or weeks of life. They consider recovery from abnormalities in muscle tone and integrated motor activities (e.g., head control, primitive reflexes), among other categories, to be the best indicators that satisfactory recovery will be likely to occur. The examinations used in these studies all limited their assessment of muscle tone to the neonatal period (13, 14, 19).

Many of the neurologic (9, 10, 11, 15) and behavioral (17-19) examinations for infants are limited to the neonatal period. Although many examinations include an assessment of muscle tone and primary reflexes, few if any systematically assess active and passive muscle tone throughout the body and also have the virtue of being applicable throughout the first year of life. Being able to repeat examinations of muscle tone throughout the first year of life, therapists would be able to document changes in the infant's ability to function, possibly to anticipate future developmental problems (e.g., increased trunk and lower extremity tone, which indicate the infant's ability to sit normally, will be decreased), and to record data to document the effectiveness of therapeutic interventions.

The purpose of Neurologic Evaluation of the Newborn and the Infant is to assess the infant's changing neuromotor function from the neonatal period through 12 months of age. This evaluation is not intended for premature infants until they have reached a corrected age of 38-42 weeks gestational age. In keeping with other neonatal tests, corrected postgestational age is used for premature newborns during the first year of life (23). The corrected age is the chronological age minus the number of weeks or months the infant is premature. For example, at 16 weeks chronologic age, a 32-week gestational age premature infant (8 weeks premature) is 8 weeks or 2 months old by corrected age. The infant's neuromotor function is determined through monthly evaluation of the history, including sleep patterns and seizures, and examination of the skull, muscle tone, selected primary reflexes, spontaneous motor activities, resting postures, and

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classical neurologic items. The neurologic items include biceps reflex, ankle jerk, and ankle clonus (1, 23, 24). It should be noted that the main focus of her evaluation is the study of muscle tone. To the occupational therapist, the major value of this evaluation is the assessment of muscle tone; therefore, this paper deals primarily with this topic.

Muscle tone is both passive and active (1, 23). Passive tone is the muscle tone that develops in response to the examiner slowly moving the infant’s extremities and trunk through the normal range of motion arcs while the infant lies quietly. In contrast, active tone is observable when the infant moves spontaneously in response to stimuli. The examination of passive tone includes muscle extensibility and "flapping," which is the rapid shaking of distal extremities. Muscle extensibility is examined by moving the arms, legs, or trunk in a specified direction while the infant remains at rest. The measurements given for these items are represented as angles. The normal limits for each angle are wide. The lower extremities include angle measurements of hip extensors and adductors, knee flexors, and ankle plantar flexors. The examination of trunk flexors and extensors and shoulder retractors is accomplished through observation of certain anatomic reference points. During the examination of passive tone, one side of the body is compared with the other side to observe asymmetries (1, 23, 25, 26). Abnormalities in passive tone may affect the way a child positions himself or herself and later develops motor skills.

Active tone is observed as the infant moves spontaneously in response to a specific series of stimuli that activate patterns of posture or motor activity. The purpose of assessing active tone is to observe coordinated movement of muscle groups. In this evaluation, only a few items of active tone are given so as not to duplicate the developmental scales. These items include neck flexors and extendors, traction, and postural responses. To examine active tone, the child must be well enough to endure handling of the neck and trunk. The neurologic evaluation concludes with an assessment of primary and tendon reflexes and postural responses (1, 23, 26).

Three items, the scarf sign, the traction response, and assessment of active tone of the neck flexors and extensors (vida infra), were found particularly useful in assessing 800 infants (with a total of 1,920 examinations in a large research setting) over 2 years. These three items, which were found to be especially informative, will be discussed and briefly compared with other methods of testing. The research focused on the medical progression of the infants, and there was no intervention with occupational therapy. In an intervention setting, this evaluation could be useful in monitoring infants to determine when intervention is required, clarifying the results of developmental tests and documenting changes in the infant's neuromotor abilities.

The Scarf Sign. The scarf sign examines passive tone in the shoulder girdle (1, 23, 26). This is accomplished by positioning the infant in a semireclining position, which is supported by the examiner's palm. The infant's head is maintained in the midline to avoid eliciting an asymmetrical tonic neck reflex. The examiner takes the infant's wrist or hand and pulls the arm across the chest toward the opposite shoulder. In a normal newborn response, the elbow does not reach the midline (1, 23, 26) (see Figure 1). This item is not assessed in the developmental scales; however, the results of an abnormal scarf sign are often reflected as delayed developmental milestones. Shoulder girdle tone that is very increased or decreased delays midline hand play, reaching, and transferring skills. Increased tone frequently interferes with the hand-to-mouth pattern. Because this item is tested on both sides, it is useful in determining asymmetries (1, 23, 26). An isolated abnormal scarf sign is unusual because it is usually clustered with trunk and neck abnormalities.

The Traction Response. The traction response is an assessment of active tone. To evaluate the traction response, the examiner first elicits a palmar grasp then pulls the infant forward as the infant lifts himself or herself on the examiner's fingers. In the newborn, this one maneuver can grossly screen reflex activity, symmetry, and active muscle tone throughout the neck, trunk, and extremities. It is usually absent after the first 2 months of life. It can no longer be accurately tested once general relaxation of flexor tone begins and active voluntary grasping begins, replacing the palmar grasp reflex (1, 23). When active tone is excellent, a generalized contraction of the flexor muscles in the upper extremities is provoked and the infant completely lifts himself or herself from the table holding onto the examiner's index fingers. The infant also clears both feet from the table, the knees flex, and the head moves forward in line with the body. An infant with glob-
Flexors and extensors are examined, the balance between the two groups is assessed. Both groups test the infant in a sitting position, rocking him or her forward and backward about the vertical axis. A normal newborn infant will show a balance between groups. Using this method, the observer can precisely determine abnormalities in muscle tone in either group. When the technique is performed correctly, an abnormal response at any age is alarming (1, 23).

In contrast, other well-known methods (3, 4, 5, 13, 15, 17) of testing head control in a young infant include bringing the infant from a supine to a sitting position, by pulling the hands or placing the infant in a prone position. By pulling an infant to sitting, the examiner allows the infant to build up tone in the arms and shoulder girdle. Therefore, the examiner is not only testing head control but also a palmar grasp and traction response; the examiner is also eliciting a muscle contraction in the upper extremities. Head lag tested by the pull-to-sit method may not mean hypotonia of neck flexors but could mean increased tone of neck extensors. Alternatively, the infant is often placed in ventral suspension or in a prone position to evaluate head and neck lifting. The infant with increased neck extensors may appear to have good neck lifting. This method of testing neck extensors allows distinction between normal and diminished extensor axial tone; however, it is difficult to evaluate an increase in neck extensor tone. This may help answer the disparity often seen between poor head control when pulled to sit and apparent maturation of neck extensor muscles when lying prone (27).

Figure 1
A normal newborn scarf sign. Note relationship of elbow and umbilicus.
ever, it can serve as an excellent supplement to an occupational therapist's neurodevelopmental assessment of an infant. Those with a thorough understanding of normal infant development and muscle tone can learn the evaluation rapidly. Because of extensive handling of the infant and lack of standardization, the examiner must be skillful in maintaining high levels of cooperation from the infant, because this may influence test results. (Videotapes of examination techniques are available from Case Western Reserve University, Health Science Communication Center, Cleveland, OH 44106.)

The examination requires no special equipment and can be done in a limited space (e.g., isolette, crib, examining table). Depending on the baby's cooperation, an experienced examiner can administer and interpret the evaluation within 10 min. The examination form can be completed while testing. In the manual, the examination technique and possible responses have been analyzed for each item. The order in which the items appear in the manual corresponds to a logical sequence for a physical examination; however, this can be altered, depending on the baby's responsiveness. The evaluation provides information regarding the infant's neuromotor function and does not include items of language, cognition, or social and fine motor control (1, 23, 24, 25).

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Test Manual and Procedures
Amiel-Tison's current manual (1) includes instructions for the administration and interpretation of the evaluation, extensive detail on normal and abnormal muscle tone evolution, case studies, and a record form to be used for monthly evaluations. The original manual offers useful information such as the method to determine corrected age in premature infants, how the technique of examination was chosen, and how Amiel-Tison defined an "at risk" population.

Amiel-Tison's evaluation was designed for neonatologists; however, it can serve as an excellent supplement to an occupational therapist's neurodevelopmental assessment of an infant. Those with a thorough understanding of normal infant development and muscle tone can learn the evaluation rapidly. Because of extensive handling of the infant and lack of standardization, the examiner must be skillful in maintaining high levels of cooperation from the infant, because this may influence test results. (Videotapes of examination techniques are available from Case Western Reserve University, Health Science Communication Center, Cleveland, OH 44106.)

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has a tight schedule; other neonatal examinations require the neonate to accommodate to the test. Neonates in critical care are often simultaneously undergoing many tests, and therefore evaluation tools should be flexible. Amiel-Tison proposed that the evaluation be done during routine office visits, when infants are not always in an optimal state for testing. Obviously, a state of “quiet alertness” is optimal for most neurologic examinations. This evaluation cannot be used if the infant is in the extreme of states (i.e., asleep or screaming) (1, 23, 28).

Each item of passive and active tone and reflexes is recorded on a grid. There are four 3-month periods in the evaluation. Each item is compared with normal development and is grouped according to the normal pattern for each 3-month period. Abnormal findings are recorded in a shaded area, making it simple to assess the infant’s overall performance (1, 23). Figure 3, for example, demonstrates the record form for evaluation of knee flexors, recorded as the popliteal angles. The examiner enters the angle in the block corresponding with the appropriate month of age on the form, from which asymmetries can be readily detected.

Amiel-Tison recommends monthly evaluations during the first year of life to provide information about transient and permanent abnormalities, thus demonstrating the developmental progression for any given child. This is important, as passive tone evolution varies considerably among infants. Transient abnormalities are frequently noted by muscle tone imbalances of the trunk and neck, increased lower extremities tone, persisting primary reflexes, and delayed postural responses (1, 23, 24, 25).

Transient abnormalities may disappear anytime within the first 8 to 9 months of age, as the central nervous system matures. However, two favorable patterns are frequently observed: 1) normalization around 3 to 4 months, which includes the brisk disappearance of hyperexcitability, the acquisition of perfect head control, and the relaxation in limbs; and 2) normalization around 8 to 9 months, after a period of anxiety, which concerns a transient diplegic- or hemiplegic-like syndrome. If monthly evaluations are not possible, the most information for the identification of transient abnormalities can be obtained during the second, seventh, and twelfth months corrected age (1, 23, 24, 25).

**Scoring**

A rigid numerical scoring system was not devised for the evaluation because items may be weighted differently, depending on the month in which the child is tested. It is suggested that a neurologic evaluation, not a score, should allow an assessment of the infant. A score does not necessarily guarantee objectivity, especially when adding items of different value.

It is important to note how the baby’s muscle tone clusters in the upper and lower halves of the body along with the evolution of the axial tone (1, 23, 24, 25). One worrisome pattern of tonal clustering and imbalance in the first 3 months is excessive hypotonicity in the neck flexors and upper extremities (i.e., no resistance to scarf sign) and hypertonicity in the lower extremities. In most cases, these signs disappear during the third month corrected age (1).

Other common examples of tonal clustering between 4 and 9 months of age include persistence of hyperexcitability and primary reflexes, no relaxation of passive tone in the lower extremities, an imbalance of axial tone with hypotonia of the trunk flexors, and hypertonia of the trunk extensors (1). Because of the transient nature of many muscle tone abnormalities the examiner does not classify infants as being abnormal until the fourth 3-month period.

At the end of each 3-month period, the examiner can make clinical impressions in the areas of hyperexcitability, lethargy, and passive and active tone abnormalities. At the end of the first year, a summary page allows the examiner to
describe abnormal patterns of neuromotor function as transient, persistent, or nonexistent (1, 23, 25). With this type of summary record, the examiner has an infant's monthly neuromotor progression and can observe patterns and trends of the overall neuromotor evolution; this can then be compared to the development of a larger group of children.

**Standardization**

The Amiel-Tison neurologic evaluation has not been standardized. The range of normal muscle tone development and the acceptable limit for any item is based on findings reported in the literature. No normative data are provided. Although standardization is needed, it will not solve the problems of individual differences and isolated abnormalities observed in the normal evolution of muscle tone, reflexes, and postural responses (1, 23). Amiel-Tison cautions that "it is important to consider the normal range as a rough guideline; tone evolution is a continuous process, which, for didactic reasons, has been indicated in a discontinuous way for each 3-month period" (23, p 28).

**Reliability**

Interobserver reliability was assessed in two ways (1, 23). First, each infant was assessed by two independent observers. Agreement was excellent for the scarf sign (90%) and the dorsiflexion angle (80%), acceptable for the popliteal angle (73%), and less acceptable for the heel-to-toe maneuver (66%) and adductors angle (50%). Because of the poor reliability of the adductors angle, a second examination of this angle was done by one person, with five independent observers concurrently estimating the angle. This examination yielded improved reliability (90%). It appears that the difficulty did not lie in the visual examination of the angle but was dependent on the patience and experience of the examiner (1, 23, 25). The manual does not report interobserver reliability on active tone items or items that evaluate asymmetries.

No information on test-retest reliability is provided in the manual; however, we provided this reliability as follows. Selected items of both active and passive tone were taught to a small research nursing staff at the Sudden Infant Death Institute at the University of Maryland Hospitals, Baltimore, Maryland, as part of a larger research project involving Sudden Infant Death Syndrome. Training was provided in administration techniques, not in clinical interpretation of results. The nursing staff achieved 90% reliability on all items. Test-retest reliability done on a weekly basis revealed that reliability was maintained at this level 1 year.

**Research**

Over the past decade, Amiel-Tison has studied infants using her evaluation. We feel that her research provides interesting insights into the clinical and research relevance of evaluation, a summary is useful.

To develop monthly follow-up criteria, Amiel-Tison classified newborns into three groups (mild, moderate, or severe) according to the findings of Amiel-Tison's evaluation (24, 29). Full-term newborns with a normal evaluation need not be followed. Infants with neurologic abnormalities that persist beyond the seventh day of life need to be followed through the first year of life (24, 25). These infants will demonstrate transient or permanent neuromotor abnormalities. Infants who show severe signs at birth have a poor outcome. Amiel-Tison proposes that infants who demonstrate subtle or transient neuromotor abnormalities (mild and moderate signs) in the first year of life will have problems in language development, behavioral disorders, fine motor deficiencies, and decreased intellectual functioning (1, 24, 25, 29). The classification is as follows.

**Mild Signs: Grade I.** The main neurologic findings were hyperexcitability, which included jitteriness, poor sleep patterns, high-pitched cry, sustained clonus, generalized hypertonia (passive and active tone), normal responsiveness, and the presence of primary reflexes. Clinical signs of increased intracranial pressure, which included hypertonia of neck extensors, were seen in 40% of infants. The immediate outcome of 50% of the cases was a normal neurologic examination by the seventh day.

**Moderate Signs: Grade II.** The main neurologic findings were lethargy, disturbances in muscle tone (passive and active tone), depressed responsiveness, and depressed primary reflexes. Isolated seizures may or may not have been observed. Clinical signs of increased intracranial pressure were observed in 70% of infants, with progressive central nervous system depression seen within the first few days. A normal neurologic examination by the seventh day was exceptional.

**Severe Signs: Grade III.** These newborns were too sick to be tested. The infants displayed generalized hypotonia and no primary reflexes, such as sucking or swal-
sient neuromotor abnormalities in of age.

The 29 infants who displayed transient neuromotor abnormalities in the first year of life were available for follow-up. Ten of these children showed mild signs at birth, and five showed moderate signs. A control group of 15 children (5 to 6 years old) was selected. These children were born at the same hospital and assessed by the same team of doctors. Their medical charts confirmed normal neurologic status within the first week of life. Both patient and control groups were extensively tested. Included were behavioral and developmental histories, questions about family life, neurologic examination, motor performance tests, and an IQ test. The neurologic tests included an examination of such items as cranial nerves, visual fields, muscular force and resistance, passive tone of knee flexors, and extensibility of fingers. Motor performance examination included items similar to those described by Ayres (31) such as imitation of postures, finger identification, and finger-to-nose and balance tests.

Although the follow-up numbers are small, these data (see Table 1) demonstrate that of the 15 infants identified in the first year of life as having transient neuromotor abnormalities and an abnormal neurologic evaluation after the seventh day, 66% placed below the norm on a large battery of tests. A matched control group of 15 children were significantly different, scoring only 13% below the norm on these tests (chi-square test, p < .005). Ellison (32) recently described similar findings in a larger cohort of infants. Another interesting observation during the Amiel-Tison, Dube, et al. (30) study was that independent walking was achieved by 13 months of age in all infants of the control group. Only 8 out of 15 children in the patient group achieved independent walking by this age (chi-square test, p < .01). These results demonstrate that this evaluation can define a category of children at high risk for subsequent deficits in intelligence and motor development.

Summary

Neurologic Evaluation of the Newborn and the Infant is a well-designed and comprehensive examination of muscle tone, primary reflexes, postural responses, and classical neurologic items during the first year of life. Although this evaluation has not been standardized, therapists may find it a valuable supplement when assessing an infant. The evaluation's purpose is to identify the transient and permanent neuromotor abnormalities in the first year of life. Preliminary data suggest that this evaluation identifies transient neuromotor abnormalities in the first year of life that are associated with significant behavioral, neurologic, and intellectual deficits when the children reach school age. Therapists may find this tool helpful in doc-
umenting an infant's progress and guiding therapeutic goals. Furthermore, this evaluation shows promise as a research method to assess the effectiveness of therapeutic interventions used with infants.

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