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

(diagnosis, learning disorders, occupational therapy, pediatric care, sensorimotor)

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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 well-being. 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 di-
mension to the overall assessment
of the infant. Abnormalities in
muscle tone (e.g., hypotonicity, hy-
pertonicity) may influence the de-
velopment of new skills. Abnormal
muscle tone may encourage the in-
fant to use compensatory patterns
of movement and thus compro-
mise the infant’s ability to experi-
nce normal patterns of move-
ment and learning. An objective
examination of muscle tone is im-
portant because it provides a cru-
cial description of both the type of,
and mechanism for, certain ab-
normal developmental patterns. A
developmental evaluation supple-
mented with an objective exami-
nation 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 out-
comes in children with mental and
motor handicaps. In a large pro-
spective study of 40,057 births,
Nelson and Ellenberg (20) dem-
strated 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) de-
scribed significant relationships
between examinations of neonatal
muscle tone and all psychological
criteria at the 4-year-old level. Par-
melee and Michealis (14) empha-
sized the importance of repeated
neurologic examinations and re-
ported 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 con-
sider 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) ex-
aminations for infants are limited
to the neonatal period. Although
many examinations include an as-
sessment of muscle tone and pri-
mary reflexes, few if any system-
atically 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 docu-
ment 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 Neurologic Evaluation
of the Newborn and the Infant
During the past 20 years Claudine
Amiel-Tison has assessed the neu-
rologic function of healthy and
high-risk premature, full-term,
and older babies at Baudelocque
Hospital in Paris. In early studies
(22), she roughly classified new-
borns with abnormal neurologic
signs as having mild or severe de-
viation from normal development.
As “normalization” was frequently
observed when looking carefully at
motor function, Amiel-Tison re-
alized the need for a precise and
orderly evaluation to detect mild
and transient along with perma-
nent neuromotor abnormalities in
the first year of life. Her method
was derived from that of Thomas
(7), which is used by neonatologists
to detect early signs of neu-
romotor dysfunction in the new-
born. Monthly evaluations are en-
couraged to observe transient neu-
romotor abnormalities in the
infant (1, 23, 24). “Detection of
such abnormalities would hold no
prognostic interest were it not for
the evolving correlation between
these findings and subsequent
learning disabilities” (1, p 12).

The purpose of Neurologic Eval-
uation 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 in-
fants until they have reached a
corrected age of 38–42 weeks ges-
tational age. In keeping with other
neonatal tests, corrected postges-
tational age is used for premature
newborns during the first year of
life (23). The corrected age is the
chronological age minus the num-
ber of weeks or months the in-
fant 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 cor-
rected age. The infant’s neuro-
motor function is determined
through monthly evaluation of the
history, including sleep patterns
and seizures, and examination of
the skull, muscle tone, selected pri-
mary reflexes, spontaneous motor
activities, resting postures, and
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 observed 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 extendors and adductors, knee flexors, and ankle planar flexors. The examination of trunk flexors and extendors 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 extendors (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 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-
ally reduced tone cannot lift from the table; the head lags, arms and legs remain extended, and the trunk may appear floppy. The traction response is always preceded by a palmar grasp; therefore, if a palmar grasp cannot be obtained, the traction response cannot be tested. However, the examiner should not assume that active tone is decreased throughout the body if a grasp reflex is not obtained (1, 23).

It is important to emphasize that the examiner does not hold the infant’s hands, because this would passively suspend the infant and thereby not assess active tone (1, 23, 26). The traction response is a dynamic maneuver, and a photograph rarely demonstrates all of the infant’s activity at one time (see Figure 2). This method is in contrast to that of Prechtl and Beintema (15) and Paine (13), who view the traction response as a passive maneuver. Because the infant is passively pulled toward a sitting position by the hands or wrists, only the amount of head lag and muscle tone in the arms and shoulders is determined.

Assessment of Active Tone. Assessment of active tone in the neck flexors and extensors, which stresses assessment of coordinated movement of muscle groups, is also useful. After the isolated neck 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).
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 (23) 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.)

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).

The infant does not have to be in a particular state of arousal or level of alertness, as in other neonatal neurologic (15) and behavioral (17) examinations. A "rough evaluation of alertness" is described for the entire test (1, 23). This is an advantage if a therapist...
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, existing 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-ea 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-
owing. Clinical signs of increased intracranial pressure included repeated seizures, coma, and brain edema, as shown on computerized axial tomography (CAT). The immediate outcome was neonatal death in 50% of the cases. If the child survived, the severe signs mentioned earlier persisted for at least several weeks.

The following are the preliminary results (30) of a long-term follow-up of full-term newborns. The infants were identified at birth as having abnormal neurologic signs by this evaluation and were classified into one of the groups mentioned earlier. In 1974-1975, 2,500 full-term newborns were evaluated at the time of birth. Forty-five of these infants were identified to have mild (n = 30), moderate (n = 14), or severe (n = 1) signs that persisted beyond the seventh day. Thirty-six of the infants were evaluated by the Amiel-Tison neurologic evaluation once a month within the first 6 months and once each 2 months thereafter up to 1 year of age. Psychomotor testing using a similar evaluation to the Bayley Scales of Infant Development (Brunet-Lezine Scale) was performed at least once between 6 and 12 months of age. The other nine babies were lost to follow-up. At the end of 1 year, 2 of the infants were confirmed to have cerebral palsy, 29 had transient neuromotor abnormalities that resolved no later than 9 months of age, and 5 were normal throughout the first year. The 29 infants who displayed transient neuromotor abnormalities all appeared normal at 1 year of age.

At 5 to 6 years of age, 15 of the 29 infants who demonstrated 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-

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Acknowledgments

The authors thank Dr. Claudine Amiel-Tison for her inspiration, continuing motivation, and superb qualities as a dedicated teacher; Dr. Steven Weinstein and the Institute for the rare opportunity to evaluate 800 newborns and young infants; and Elaine Sherman for secretarial assistance.

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