Neonatal Physical Therapy. Part II: Practice Frameworks and Evidence-Based Practice Guidelines

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Purpose: (1) To outline frameworks for neonatal physical therapy based on 3 theoretical models, (2) to describe emerging literature supporting neonatal physical therapy practice, and (3) to identify evidence-based practice recommendations. Key Points: Three models are presented as a framework for neonatal practice: (1) dynamic systems theory including synactive theory and the theory of neuronal group selection, (2) the International Classification of Functioning, Disability and Health, and (3) family-centered care. Literature is summarized to support neonatal physical therapists in the areas of examination, developmental care, intervention, and parent education. Practice recommendations are offered with levels of evidence identified. Conclusions: Neonatal physical therapy practice has a theoretical and evidence-based structure, and evidence is emerging for selected clinical procedures. Continued research to expand the science of neonatal physical therapy is critical to elevate the evidence and support practice recommendations. (Pediatr Phys Ther 2010;22:2–16) Key words: clinical practice guidelines, evidence-based practice, high-risk infant, neonatal intensive care units, neonatology, physical therapy, infant born preterm, reference standards/clinical

INTRODUCTION

Evidence-based practice guidelines are presented to support pediatric physical therapists (PTs) preparing for and practicing in the advanced subspecialty of neonatology. Theoretical frameworks, the emerging literature base, and evidence-based practice recommendations highlight this second article of a 2-part series on neonatal physical therapy practice. In part I, neonatal physical therapy clinical competencies, neonatal intensive care unit (NICU) clinical training models, and a clinical decision-making algorithm were described.1 The series was developed by a NICU Task Force of pediatric PTs with neonatal expertise appointed by the Section on Pediatrics, American Physical Therapy Association, and reviewed by an expert panel of neonatal practitioners representing diverse geographic regions of the United States. PRACTICE FRAMEWORK

The NICU Practice Guidelines are based on 3 theoretical concepts: (1) dynamic systems theory (DST) of development; (2) the International Classification of Functioning, Disability and Health (ICF); and (3) family-centered care. These concepts offer a theoretical structure for understanding and organizing neonatal physical therapy and provide a framework for optimizing functional movement and posture of infants to promote functional activities and development of the infant-family system. Dynamic Systems

In the dynamic systems model, all system components interact to produce meaningful, functional behavior.2 Multiple interacting systems and environments influence neonatal functional performance (Fig 1). In the NICU, dynamic system components include the following:
The infant’s biological makeup (ie, physiologic, behavioral, physical, social, and psychological elements); The sociocultural (ie, professionals and family) and physical environments in which neonatal movements and postural control develop; and The task or goal of the neonate, such as self-regulation of physiologic processes, behavioral state, posture and movement, and attention to and interaction with caregivers.3

Biological components of the infant do not act independently of each other or the physical and sociocultural environment in which a behavioral task is accomplished. For example, to conserve energy, the neonate needs to organize sleep-wake periods. If the nursery environment has continuous 24-hour bright lighting or if the neonates are awakened frequently during deep sleep, they may experience difficulty organizing biological systems to promote either sleep or alertness.

In a dynamic systems context, the need for function recruits and assembles the necessary and most available elements to complete the movement for a task performed within the immediate environment.3,4 For example, an infant may bring a hand to the mouth to suck on the fingers to console and decrease stress. If the infant is in the supine position and lacks strength to move against gravity, efforts to bring the hand to the mouth will not be successful. Repeated attempts to accomplish the movement by pressing the head and trunk against a firm surface (ie, the mattress) may contribute to disruption of physiologic systems leading to apnea or bradycardia. If attempts are continued, with time, this may result in an excessively extended posture.

As illustrated in Figure 1, any system component theoretically can facilitate or constrain an infant’s functional movement and postural control. In the previous example, the supine position constrains the infant’s ability to be successful in the hand-to-mouth task. The interaction between the environmental component and the infant’s neuromuscular system prevents the functional activity of engaging the hand in the mouth. A small change in one component may produce a large change in movement and postural control. By changing the infant’s position from supine to a supported side-lying position, the infant may then explore and practice strategies for bringing the hand to the mouth without the effects of gravity.

The infant’s attempts to initiate, practice, and learn a motor task (associative learning and memory) such as the hand-to-mouth maneuver, signal an optimal time for the neonatal PT, and other caregivers to facilitate this movement. According to DST, periods of learning are periods of transition. It is during these periods that the system(s) is most responsive to change, and motor learning can be optimized.4

Both the synactive theory of development7 and the theory of neuronal group selection (TNGS)6 are examples of dynamic systems models. These theories, described separately below, combine to provide a behavioral organization and a neuronal framework applicable to neonatal physical therapy practice.

Synactive Theory of Development. Als5,7 described a behavioral organization process of subsystem interaction and interdependence (synaction) as the neonate responds to the challenges of the extrauterine environment. In this dynamic systems model, physiologic stability is considered as the foundation system for organizing movement, behavioral state, attention/interaction, and self-regulation.

Als8 highlighted the infant’s behavior as a continuous expression of brain function available for observation by caregivers. Ongoing observations of infant behaviors at rest, during and after care procedures allow caregivers to interpret the infant’s adaptation to the new extrauterine environment. These systematic observations are the base for the Newborn Individualized Care and Development Program (NIDCAP) developed by Als8,10 and for her program of NIDCAP outcomes research on NICU developmental care.11-14

As shown in Figure 1, the neonatal PT can apply this model by observing infant communication through the (1) autonomic system (respiratory and heart rates, oxygen saturation, color, hiccoughs, sneezes, tremors, and startles), (2) musculoskeletal and neurologic systems (joint alignment, body posture, tone, and movement), (3) state system (range, robustness, attention, transitions, and capacity to orient to animate and inanimate objects), and (4) self-regulation of state, motor, and autonomic systems.15,16 By supporting organization of the motor system, the neonatal therapist also supports organization of the autonomic, state, and self-regulation systems, freeing the infant to attend and interact with parents and with the environment.

It is imperative that neonatal PTs focus not only on the physiologic and sensorimotor components of infant function but also on the maturation and organization of behavior in neonates. Three primary concepts guiding the clinical application of infant behavioral observation and providing a matrix...
for understanding behavioral organization in a developmental context are described in Table 1.

Behavioral observation must guide examination, intervention, and parent teaching in neonatal physical therapy. Infant behavioral organization concepts are the cornerstone for understanding infant readiness to participate and maintain stability in all neonatal therapy contacts. Facilitating and supporting infant behavioral organization, reinforcing movement and postural components of infant self-regulation, and facilitating and supporting mutual affective regulation between parents and infants are priorities in neonatal therapy.

Theory of Neuronal Group Selection. Edelman’s theory on how the nervous system becomes organized, stores information, and creates new behavioral patterns is identified as the TNGS. The theory is based on biological research and behavioral observations. A key concept of the theory is that the brain operates as a selective system. In addition, the brain is strongly affected by signals from the body and the environment either during fetal development or development after birth. As a result, no 2 brains are alike, and each person’s brain is continually changing.

This theory has 3 main tenets for the development of the brain that are described in Table 2. Extensive evidence in adult animal models and humans is now available that the brain is a highly dynamic organ capable of structural and functional organization and reorganization in response to a variety of internal and external pressures. This neural plasticity is the mechanism by which the brain encodes experience and learns new behaviors.

### Table 1

**Guiding Concepts for Clinical Use of Infant Behavioral Observation to Support Development in Infants at High Risk**

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Description</th>
<th>Developmental Context for Infant at High Risk</th>
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</table>
| **Infant competency** | - Skills, abilities, predispositions uniquely suited to meet survival and emotional needs of newborn infant in neonatal period  
- Example: healthy newborn  
  Hears and locates sounds  
  Prefers mother’s voice  
  Sends clear signals of distress when needs support  
  Maintains prolonged periods of interactions with caregivers and parents | - Potential for similar competencies under specific conditions of on-going and carefully matched support from caregivers  
- Limited capacities for prolonged interactions  
  Responses often subtle and difficult to interpret  
- Example: infant at high risk  
  Responds to sound but does not always locate its source  
  Signs of distress subtle and include the following:  
  - Paleness  
  - Loss of muscle tone  
  - Drowsiness  
  - Alert for brief periods  
  Does best when caregivers limit sensory input to one modality (eg, visual only, no auditory) |
| **Behavioral states** | - Predictable and unique behavioral patterns creating matrix against which infant responses are understood  
- Healthy newborn  
  Behavioral states clear, robust, easy to identify  
  Transitions from one behavioral state to another smooth and gradual  
- Example: healthy newborn  
  Drowsy infant not as socially responsive as quietly alert infant  
  Crying infant tremor more than sleeping infant  
  Become drowsy as transition from alert to sleep state | - Behavioral states present but may not be fully developed based on gestational age  
- Behavioral states less clear and difficult to identify with rapid transitions and difficulty consoling  
- Require environmental and social adaptations and protection to support emergence of behavioral states  
- Example: infant at high risk  
  May not reach alertness allowing social responsiveness  
  May appear to be sleeping when feeding  
  May best reach quiet alert state in quiet, dark room when swaddled and held |
| **Self-regulation** | - Infant’s ability to organize, regulate and modulate autonomic, motor, and state systems influencing caregivers’ choices to best support development  
- Example: healthy newborn  
  Easily accomplish tasks of  
  Stabilizing breathing  
  Reducing number of startles and tremors  
  Maintaining temperature control  
  Feeding successfully | - Ability to self-regulate limited and influenced by environmental and social demands  
- Return to self-regulation costly in terms of energy expenditure and developmental experiences  
- Tasks of caregivers  
  Minimize periods of loss of self-regulation  
  Facilitate prolonged periods of self-regulation through well-timed, individualized, support to infant  
- Example: infant at high risk  
  Able to maintain regulated breathing  
  Pink color and tucked posture when swaddled  
  Loss of stability when unwrapped or turned prone to supine position without support |
Motor skill acquisition is associated with changes in gene expression, dendritic growth, synapse addition, and neuronal activity in the motor cortex and cerebellum (Fig 2). Practice of a newly learned behavior may be required to induce lasting neural changes. Some forms of plasticity therefore require not only the acquisition of a skill but also the continued performance of that skill over time. It is hypothesized that plasticity brought about through practice represents the instantiation of skill with neuronal circuitry making the acquired behavior resistant to decay in the absence of training.

Infants born preterm enter the world with a central nervous system that has had less time to mature within a protected uterine environment. The external NICU environment involves respiratory support, physiologic monitoring equipment, isolettes, absent postural containment provided by the uterus and amniotic fluid, aversive and painful stimuli, separation from parents, irregular patterns of handling from multiple caregivers, and unfiltered noise and light. Edelman hypothesized that when the brain is in unusual sensory circumstances, events of brain development are modified such as (1) preservation of cells that

### TABLE 2

<table>
<thead>
<tr>
<th>Type of Selection</th>
<th>Timing</th>
<th>Processes of Development</th>
<th>Outcomes</th>
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<tbody>
<tr>
<td>Developmental selection (yields primary repertoires)</td>
<td>Occurs during fetal life</td>
<td>- Constrained by genes and epigenetic events of cell division, motion, and death and dependent on context and history</td>
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<td></td>
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<td>- Neurons branch in different directions creating immense, variable and diverse neural circuits</td>
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<td>- Neurons compete to make synapses</td>
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<td></td>
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<td>- Synaptic connections weakened or strengthened by experience, repetition and exploration in womb</td>
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<td>- Strengthened connections lead to selection of primary movement repertoires having value for survival of the species</td>
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<td></td>
<td></td>
<td>- Primary movement patterns not constraints but “prods” that start movement activity and self-organization process</td>
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<tr>
<td>Experiential selection (yields secondary repertoires)</td>
<td>Overlaps early period of primary repertoires and extends throughout life</td>
<td>- Postbirth, infant interacts with new environment</td>
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<tr>
<td></td>
<td></td>
<td>- Experience drives change and synaptic connections weakened or strengthened</td>
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<td></td>
<td></td>
<td>- Synaptic connections strengthened by experience, repetition, and exploration lead to selection of secondary repertoires that satisfy environmental constraints and evolved internal value system and support successful adaptive (goal directed) movements within task constraints</td>
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<td></td>
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<td>- Preferred adaptive movement patterns integrate with subsequent motor learning and adaptation</td>
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<td></td>
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<td>- Process maintains plasticity continuing throughout life</td>
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<td>Reentrant mapping</td>
<td>Occurs postnatally</td>
<td>- Maps</td>
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<td>- Link secondary repertoires forming higher Either strengthened or weakened dependent on current and past experiences order global mappings</td>
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<td>- Ensures linkage and integration of complex Link in different regions to form higher order, global mappings involving motor and sensory systems functions and behaviors</td>
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<td>- Coordinated in space and time through ongoing signaling across reciprocal connections</td>
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<td></td>
<td>- Continually modified during lifetime</td>
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<td>- Neural maps in cortex selected through current and past experience</td>
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<td>- Example: during early breast feeding, infant: Practices number of ways to suck and swallow</td>
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<td></td>
<td></td>
<td>- Perceives movement of lips, jaw, tongue, and throat and tastes milk</td>
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<td></td>
<td>- Perceives warmth of mother’s skin and hears her voice</td>
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<td>- Each somatosensory connection has its own map</td>
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<td></td>
<td>- Through repetition of sucking and swallowing, infant selects movement pattern most successful and perception-action system related to sucking and swallowing determined</td>
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otherwise would be eliminated, (2) elimination of cells that otherwise would be preserved, (3) modification of dendritic and axonal pruning events, and (4) changes in connectivity (synapses). Neuronal changes, such as these, were reported by Bourjeois et al in monkeys delivered prematurely. The number of visual cortical cells was unchanged, but the synapses were significantly different in size, type, and laminar distribution, with the extent of these differences related to varying levels of prematurity. Neuronal changes were also reported by Als et al in infants born preterm (28–33 weeks) who received the NIDCAP program from 72 hours of NICU admission to age 2 weeks corrected for prematurity compared with a control group receiving standard care. Both groups were assessed at corrected ages of 2 weeks and 9 months on health status, growth, and neurobehavior; brain neurostructure (MRI) and neuroelectrophysiology (EEG) were compared at the corrected age of 2 weeks. Results indicated consistently better neurobehavioral function at 2 weeks and 9 months corrected age and more mature fiber structure in the cortex at 2 weeks corrected age for of infants receiving the NIDCAP program.

Neonatal PTs are responsible for nurturing brain growth. Brain development depends on a complex interplay between genes and environmental experiences. Early sensory information and motor experiences may have an effect on the architecture of the brain. Early interactions not only create a context but also directly affect the way the brain is "wired." Because each infant has unique brain maturational levels at the time of birth, the same extraterine environment and caregiving experiences may have different effects on brain structure.

Neonatal therapy examination and intervention strategies should therefore be carefully modulated and paced to protect the architecture and maturation of the infant’s brain.

International Classification of Functioning, Disability and Health

The ICF is compatible with the dynamic systems model of development and learning. The ICF model represents interactive, complex relationships between an individual’s health and the contextual factors of the environment and the person. This framework, adopted by the House of Delegates, American Physical Therapy Association, 2008 typifies PT practice and provides a structure for understanding and organizing practice. Within this framework, the neonatal therapist addresses the (1) functional and structural integrity of the body parts and systems, (2) promotion of age-appropriate postural and movement activities, and (3) appropriate interaction among the neonate, family, and professionals in the NICU. The neonatal therapist also considers impairments, activity limitations, and participation restrictions or changes in physical function or health resulting from injury, disease, or other causes.

Three components of function are (1) body and body parts, such as the ability of the neonate to control the physiologic function of breathing; (2) infant as a whole using the motor system to accomplish a task, such as bringing hands to the mouth or grasping a caregiver’s finger; and (3) infant in the NICU, home, and community environments performing social functions such as interacting with caregivers during feeding in the NICU, home, or daycare center (Fig 3). These 3 components of function are essential to support the neonate’s physiologic, behavioral, physical, social, and psychological well-being and to promote a meaningful life for the infants and their families.

Three components of disease or active pathology, impairment, activity limitation, and participation restriction resulting from injury, disease, or other causes are also depicted in Figure 3. Impairment is a loss or abnormality of

Fig. 2. Neural events underlying motor map organization and reorganization and motor learning. Motor experience such as hand-to-mouth behavior induces a set of neural signaling pathways that activates gene expression within the motor cortex, which precedes synapse formation which in turn precedes motor map reorganization leading to learned sucking behavior. Adapted with permission from Klein. The picture of infant depicting hand-to-mouth behavior is reprinted with permission from VandenBerg et al.

Fig. 3. International Classification of Functioning, Disability and Health (ICF). Adapted with permission from the International Classification of Functioning, Disability and Health.
body structure or of a physiologic or psychological function. Examples in the neonate include the inability to control the physiologic systems resulting in apnea or restricted joint mobility contributing to decreased movement. Activity limitation is a restriction of the ability to perform a physical action, activity, or task in an efficient, typically expected, or competent manner. In the neonate, activity limitation may occur when the infant is unable to produce the antigravity, midline movement to bring hands to the mouth for sucking, a strategy often used for self-regulation. Participation restriction is the inability to participate in age-specific or gender-related roles in a particular social or physical environment. In the NICU, examples are feeding and attention/interaction activities such as auditory attention and visual interaction with caregivers during feeding.

The 2 contextual factors in Figure 3 are environmental (external influence on function) and personal (internal influence on function). Personal factors are the characteristics of the individual that are not part of a health condition or health state. These factors influence the relationships among body functions and structures, activities, and participation and can either constrain or promote function.

Examples of environmental factors in the NICU are light and noise. Excessively high noise and light levels in the NICU may impede the infant’s physiologic, motor, or behavioral self-regulation; dimming the lights and decreasing the noise may promote physiologic, motor, or behavioral stability.

Examples of personal factors of infants born preterm are sensitivity or irritability to internal and external stressors (e.g., pain, hunger, and handling) leading rapidly to overstimulation, agitation, or exhaustion, which may impede the infant’s ability to self-calm or self-regulate the physiologic, motor, or state systems. Swaddling or the flexed, tucked side-lying position with the hands or fingers near the face and mouth may decrease physiologic distress, improve motor organization, and increase self-regulatory behavior.

The scope of the ICF framework and emphases on context and function can guide neonatal therapists in visualizing the complexity of the infant’s internal and external environment and in anticipating how neonatal therapy procedures will support or overload infant and family functioning.

**Family-Centered Care**

Collaborative partnerships with families and neonatal practitioners are the cornerstone for caregiving success in neonatal physical therapy. Building parent and professional partnerships and adapting the care and teaching to family priorities, learning styles, emotional stresses, and cultural variables are essential considerations for making interventions effective. Centering neonatal physical therapy care on family needs requires understanding and empathy for the complex stresses and losses parents are experiencing as they cope with new roles as parents of medically fragile infants in the NICU environment. Although the NICU experience for parents may vary depend-

**PHYSICAL THERAPY IN THE NICU: EVIDENCE FOR PRACTICE**

A key competency in providing care in any physical therapy setting is critical appraisal of relevant research and the application of evidence to practice. In this section, an overview of recent evidence is provided for the developmental and therapeutic interventions in the NICU setting where neonatal therapists may participate in a variety of service delivery approaches involving program development, consultation, and direct therapy services. Program development services may focus on recommendations for advancing developmental care for all infants in the NICU with policy and training implications. Consultative services may include making infant-specific recommendations, which are updated at regular intervals, but the intervention is provided by the infant’s primary caregivers. Direct neonatal physical therapy services are provided to address an infant’s specific musculoskeletal, neuromuscular, or neurobehavioral needs. Family education is an important component of both consultative and direct therapy services and includes discharge teaching for coordination of follow-up through interdisciplinary clinics and local early intervention programs. This literature overview and...
evidence-based recommendations are intended for all service delivery models used by the PTs in NICU settings.

Examination

A range of tests and measures are available for examination of neonates. Many instruments, potentially useful in neonatal physical therapy practice for selected infants, are identified in the examination and evaluation competency in Part I of the NICU Practice Guidelines. Critical components in the examination competency for neonatal PTs are (1) determining infant readiness to begin neurologic and neuromotor examination and (2) monitoring and modifying changes in physiologic and behavioral stability during and after examination procedures. Significantly greater physiologic cost (increased heart rate and mean arterial pressure) and behavioral stress (increased finger splay, arm salute, hiccoughs, yawns, and mottled skin color) were demonstrated by neonates at 30 to 35 weeks post-conception compared with infants born at term during neurologic examination procedures administered by a neonatal PT. Greater physiologic and behavioral stress was demonstrated by both groups of neonates during the neuromotor items compared with neurobehavioral items.

Risk management considerations for presumed benign neurologic examination procedures are raised from this preliminary research. For infants born at less than 35 weeks of gestation, the reliability, diagnostic benefit, and physiologic cost of neurologic examination, especially neuromotor items, must be scrutinized, and infants with borderline stability should be excluded from evaluative handling. At any gestational age or acuity level, nonhandling observation of an infant’s movement, posture, behavioral organization, and physiologic stability (particularly during routine nursing care) are advised for determining baseline function and for collaboration with neonatal nurses and neonatologists on optimal timing for evaluative handling.

Intervention

Developmental Care. This caregiving approach is designed to promote the neurobehavioral and physiologic organization of an infant’s autonomic, motor, state/attention, and self-regulation systems as the infant matures. A variety of general environmental, behavioral, and care strategies can be used to modulate neonatal physiologic and behavioral changes during each episode of care and accommodate the varying maturation and acuity levels of infants.

Individualized developmental care is developmental care designed and updated for each infant in addition to a generalized developmental care plan for all infants. For example, in a NICU where general developmental care principles are applied, overhead lights may be dimmed, isolettes covered, and caregiving procedures clustered. In a nursery providing individualized developmental care using a NIDCAP approach, each infant’s needs are evaluated and a specific developmental plan developed and evaluated on an ongoing basis.

In a Cochrane review of developmental care including 36 randomized clinical trials (RCTs) of both general and individualized developmental care, some benefits and no harmful effects were reported from neonatal developmental care for infants born prematurely. The benefits of individualized developmental care documented in small RCTs included reduced incidence of necrotizing enterocolitis and chronic lung disease following NIDCAP interventions, improved behavior in preschool-age children who received NIDCAP-based care in the NICU, and faster transition to all nipple feedings following a daily combination of vestibular, tactile, auditory, and visual stimulation. The results of these small RCTs are encouraging and suggest a positive, short-term effect of developmental care on the behavior of infants born preterm. Larger scale RCTs are needed to confirm these preliminary, positive findings.

Two large RCTs conducted in The Netherlands with infants born at less than 32 weeks of gestation have called into question the benefit of basic developmental care (isolette covers to filter light and sound and flexed, midline, nested body positioning procedures). In the first study, no group differences in respiratory support, neurologic status, or growth were documented at term equivalent age between infants receiving standard newborn care compared with infants receiving basic developmental care in the NICU. In the second study, basic developmental care was compared with the NIDCAP approach (weekly, individualized behavioral observation, and developmental care plan updates) to determine short- and long-term effects. No group differences between individualized (NIDCAP) and basic developmental care were found in respiratory support, intensive care duration, growth and development at term equivalent age, and growth, cognitive, or motor development at 1 or 2 years of age. Although these studies question the effect of individualized versus basic developmental care on neurodevelopmental and growth outcomes, neither of the RCTs included measures of behavior, self-regulation, feeding, or family coping which may have differed between groups.

In contrast, Peters et al recently reported reduced length of intensive care stay and incidence of chronic lung disease in a well-designed and controlled intervention study of NIDCAP effects. Preliminary data from individualized developmental care (NIDCAP) procedures indicated reduction in the rate and severity of mental disability. In combination, these studies suggest that individualized developmental care may decrease potential medical complications and varied short-term outcomes such as length of stay, level of alertness, and feeding progression. Further research prioritizing long-term motor and cognitive outcomes will offer expanded analyses on the efficacy of basic and individualized developmental care. Larger longitudinal RCTs are needed to determine how individualized developmental care affects behavior, emotional stability, and parent-child interactions (Table 3).
Infants born preterm have immature musculoskeletal systems that are influenced by positioning. During fetal development, the uterine walls provide containment, facilitate trunk and extremity flexion, and provide reactionary forces in response to fetal movements. Infants born preterm must cope with gravity, a lack of fluid to support movement, and no reactionary forces to support bone and joint formation. Exposure to prolonged atypical positioning in the NICU has been associated with torticollis, positional plagiocephaly, reduced movement quality, and lower extremity malalignment. Developmentally supportive positioning may enhance the development of normal skeletal alignment and provide opportunities for normal movement patterns. Therapists can play a vital role in program development and consultation relating to positioning. As experts in the musculoskeletal system, PTs with neonatal training have the expertise to establish positioning guidelines for NICUs, aid in staff development, and consult on individualized positioning for infants. Because neonatal PTs do not position infants each time they need to be moved, a primary role of the therapist is to collaborate with and support caregivers in positioning infants to prevent secondary complications.

Infants born preterm are frequently cared for in multiple positions for respiratory support and skin care. Although these varied positions are counter to the American Academy of Pediatrics recommendations for a preferred supine sleeping position to reduce the risk of sudden infant death syndrome, the infants remain continuously monitored in the NICU setting. In an updated statement, the American Academy of Pediatrics advised that all infants transition to the supine sleeping position by hospital discharge and encouraged detailed discharge instruction on sudden infant death syndrome prevention including supine sleeping without soft bedding. The evidence in these practice guidelines relating to prone sleeping position and use of nests or blanket rolls may not be appropriate for infants approaching discharge.

Although physiologic benefits contribute to the frequent use of the prone position in the NICU, neonates may develop “flat” trunks, hyperextended and excessively rotated cervical spines, and abducted hips when lying in the prone position, which may contribute to prolonged atypical postures in infancy. Clinicians frequently modify the prone position to improve posture while retaining physiologic benefits. The use of a horizontal positioning roll under the pelvis to elevate the hips and support hip flexion may lead to plagiocephaly, and to increased cervical and thoracic extension. In contrast, the use of a vertical positioning roll on the torso parallel to the spine (alone or in combination

### TABLE 3
Developmental Outcomes with Developmental Care

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>Intervention</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>Westrup et al&lt;sup&gt;55&lt;/sup&gt;</td>
<td>11 experimental and 15 control; &lt;32 weeks of gestation; randomized</td>
<td>NIDCAP or standard of care</td>
<td>At 63 mo, the NIDCAP group had fewer children with behavioral impairments than the control group. No differences in coordination or cognition</td>
</tr>
<tr>
<td>Maguire et al&lt;sup&gt;57&lt;/sup&gt;</td>
<td>98 basic developmental care, 94 control all born &lt;32 weeks of gestation; randomized</td>
<td>Basic developmental care = isotope cover and positioning nest</td>
<td>No differences in NICU variables including length of stay or weight gain. No difference in neurologic examination at term</td>
</tr>
<tr>
<td>Maguire et al&lt;sup&gt;57,58&lt;/sup&gt;</td>
<td>84 interventions; 84 controls (isotope covers and nesting); &lt;32 weeks of gestation</td>
<td>Intervention = NIDCAP assessment weekly and individual care plan</td>
<td>No difference in respiratory support, length of stay, growth, or neurodevelopment at term No difference in motor or cognitive abilities on the Bayley Scales or growth at 1 or 2 y</td>
</tr>
<tr>
<td>Peters et al&lt;sup&gt;13&lt;/sup&gt;</td>
<td>56–NIDCAP; 55–basic developmental care; born &lt;32 weeks of gestation</td>
<td>NIDCAP: trained nursing care &gt;80% time and biweekly NIDCAP assessments</td>
<td>Length of stay significantly less in NIDCAP group (74.9 vs. 84.0 days) Decreased rate of severe disability in NIDCAP group. No group difference in scores on Bayley scales of infant development for motor or cognitive outcomes Fewer infants in NIDCAP group had chronic lung disease</td>
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</table>

**Direct Intervention.** Direct therapy service refers to service provided by a neonatal therapist at regular intervals to address a specific impairment or activity limitation. Direct therapy includes, but is not limited to, handling to promote movement or postural control, joint alignment and range of motion, cranial shaping, feeding performance, environmental modulation, and behavioral stability during caregiving. Research on direct therapy services is limited to preliminary results with a strong need for replication using larger samples and randomization.

**Body positioning.** Infants born preterm have immature musculoskeletal systems that are influenced by positioning. During fetal development, the uterine walls provide containment, facilitate trunk and extremity flexion, and provide reactionary forces in response to fetal movements. Infants born preterm must cope with gravity, a lack of fluid to support movement, and no reactionary forces to support bone and joint formation. Exposure to prolonged atypical positioning in the NICU has been associated with torticollis, positional plagiocephaly, reduced movement quality, and lower extremity malalignment. Developmentally supportive positioning may enhance the development of normal skeletal alignment and provide opportunities for normal movement patterns. Therapists can play a vital role in program development and consultation relating to positioning. As experts in the musculoskeletal system, PTs with neonatal training have the expertise to establish positioning guidelines for NICUs, aid in staff development, and consult on individualized positioning for infants. Because neonatal PTs do not position infants each time they need to be moved, a primary role of the therapist is to collaborate with and support caregivers in positioning infants to prevent secondary complications.

Infants born preterm are frequently cared for in multiple positions for respiratory support and skin care. Although these varied positions are counter to the American Academy of Pediatrics recommendations for a preferred supine sleeping position to reduce the risk of sudden infant death syndrome, the infants remain continuously monitored in the NICU setting. In an updated statement, the American Academy of Pediatrics advised that all infants transition to the supine sleeping position by hospital discharge and encouraged detailed discharge instruction on sudden infant death syndrome prevention including supine sleeping without soft bedding. The evidence in these practice guidelines relating to prone sleeping position and use of nests or blanket rolls may not be appropriate for infants approaching discharge.

Although physiologic benefits contribute to the frequent use of the prone position in the NICU, neonates may develop “flat” trunks, hyperextended and excessively rotated cervical spines, and abducted hips when lying in the prone position, which may contribute to prolonged atypical postures in infancy. Clinicians frequently modify the prone position to improve posture while retaining physiologic benefits. The use of a horizontal positioning roll under the pelvis to elevate the hips and support hip flexion may lead to plagiocephaly, and to increased cervical and thoracic extension. In contrast, the use of a vertical positioning roll on the torso parallel to the spine (alone or in combination
with a horizontal roll under the pelvis) has been associated with improved scapular position and hip flexion.67

In the supine position, infants born preterm may have increased hip and shoulder abduction and external rotation. Two small studies advocated use of body positioning “nests” to encourage flexion of the extremities and midline head position.63,68 In a pilot study of 10 infants, smooth, midline movements of the extremities were observed when infants were in a supine nest with extremity flexion support compared with the supine position without the nest.62 Although this study provided preliminary evidence that flexed, supine positioning provided opportunities for practicing flexed, midline motor patterns commonly seen in infants born at term gestation, no follow-up observations of the neonates were reported regarding effects on movement after the nest was discontinued.62 Varied positioning including supine, prone, and side-lying positions has been found to reduce the negative consequences that may arise from infants remaining in a single position.65,68

Swaddling with hands to mouth and lower extremity flexion while the infant is positioned in prone, supine, or side lying has been reported to improve neuromuscular development at 34 weeks post-conception.70

Although these studies provide preliminary evidence for the use of positioning strategies to encourage extremity flexion, no recent studies have addressed the effects of positioning devices on movement quality, muscle imbalances, postural control, or long-term musculoskeletal changes.

Joint range of motion. Passive range of motion in the extremities has been advocated as an intervention to increase bone mineral density; however, a recent Cochrane review of 6 RCTs found only a small, transient increase in weight gain and bone mineral density immediately after a protocol of passive range of motion to multiple joints in all extremities 5 times per week for 3 to 4 weeks with no difference reported at 12 months of age.71 The Cochrane review panel concluded that this evidence was insufficient for implementing range of motion in infant born preterm to improve bone density and weight gain.71

Therapeutic neuromotor handling. The use of therapeutic handling or therapist-provided, hands-on intervention to advance motor development of infants born preterm while in the NICU was investigated in 2 small studies with similar approaches to intervention.72,73 Girolami et al73 included infants born preterm with atypical or asymmetrical movement responses on the Neonatal Behavioral Assessment Scale (NBAS). Cameron et al72 selected infants at high risk of disabilities based on birth weight (<1500 g) and gestational age (<32 weeks) but with no evidence of a movement abnormality. In both studies, intervention was provided 5 days per week focused on midline hand skills, trunk and extremity flexion, and postural (neck/trunk) control. Girolami et al73 reported improved Supplemental Motor Test scores including enhanced antigravity and midline movements before NICU discharge. Cameron et al72 found no group differences on the Alberta Infant Motor Scales at 4 months of corrected age; however, no post-intervention comparison was conducted before NICU discharge. The findings from these 2 studies suggest that infants with a high risk birth history, but no atypical or disorganized movement, are not likely to need direct physical therapy services, but infants at 35 weeks post-conception with asymmetrical or atypical development may benefit from therapeutic neuromotor handling.73 Additional RCTs with rigorous subject selection, discriminative and evaluative measures to determine eligibility and outcomes, and detailed intervention methods are needed to expand the evidence regarding therapeutic handling in the NICU for infants with atypical movement.

Multimodal sensory stimulation. Because infants born preterm are exposed to excessive overhead light, loud noises, and noxious procedures in intensive care environments, techniques to limit the consequences of negative stimuli are often included in developmental care plans,31 and provision of positive sensory experiences (tactile, vestibular, auditory, and visual) has been encouraged in some settings. A 2006 Cochrane review, which summarized evidence for sensory intervention, indicated that a program including a combination of sensory stimuli may enhance state regulation, speed transition to full nipple feedings, and shorten length of hospital stay, whereas tactile stimulation alone may improve short-term growth and reduce length of stay.74 All studies included in the review had small samples, and many had methodologic limitations including wide variations in sensory conditions. Two recent, small RCTs extended the Cochrane review findings. A study comparing massage (tactile), massage plus kinesthetic stimulation (passive joint motion), and no intervention found no group differences in weight gain or length of stay for infants born weighing less than 1500 g.74 In an RCT including massage as one component of a multimodal stimulation intervention for infants between 31 and 34 weeks post-conception, infants exhibited reduced heart rate, increased visual-auditory orientation, and increased sensorimotor skills after the intervention. In addition, after the multimodal interventions, infants had increased body length and decreased length of stay compared with infants without intervention.75

In combination, the 2006 Cochrane review and these recent RCTs suggest that a multimodal approach to intervention may improve sensorimotor development, increase weight gain, and reduce length of stay in selected infants born preterm. Neonatal PTs must scrutinize these data and continue to explore appropriate thresholds and types of sensory stimuli for neonates. White-Traut et al76 cautioned that multimodal sensory stimulation may be contraindicated for infants with periventricular leukomalacia. Additional research is needed to determine the physiologic and behavioral readiness of infants born preterm for multimodal intervention in the NICU and developmental outcomes after NICU discharge (Table 4).

Support of infant feeding. Feeding is a functional activity of the highest priority for infants and caregivers and as such is an integral part of neonatal PT practice. Minimal
evidence is currently available to support oral-facial stimulation to hasten feeding progression in neonates. In a small RCT reported by Fucile et al., a decrease in transition time (days) to all oral (nipple) feedings was documented in infants receiving an oral stimulation program compared with controls. No differences occurred, however, in hospital stay or in postconceptual age when all oral feedings were achieved. Researchers affirmed in 2 recent small RCT reported by Fucile et al., a decrease in transition time (days) to all oral (nipple) feedings was documented in infants receiving an oral stimulation program compared with controls. No differences occurred, however, in hospital stay or in postconceptual age when all oral feedings were achieved. Researchers affirmed in 2 recent

### TABLE 4

Direct Interventions in the NICU

<table>
<thead>
<tr>
<th>Study</th>
<th>Subjects</th>
<th>Intervention</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaivre-Douret et al&lt;sup&gt;35&lt;/sup&gt;</td>
<td>30 infants per group; 31–34 weeks post-conception; low medical risk</td>
<td>Control: prone position with horizontal hip roll; intervention: varied positioning</td>
<td>Control group had greater spinal extension, plagiocephaly, and abnormal postures at term than the intervention group</td>
</tr>
</tbody>
</table>
| Monterosso et al<sup>37</sup> | 3 groups: 41 w/PN; 39 w/PR; 43 Combined PN + PR; <31 weeks post-conception at enrollment | PN were in prone position only when in nappy  
PR and PR + PN were rotated between prone position + turn from prone position with each nappy change; 21–48 days | Use of the PR without the PN resulted in increased hip flexion, decreased hip adduction, and less scapular retraction resulting in a less “flattened” resting posture compared with prone positioning alone |
| Ferrari et al<sup>62</sup> | 5 boys; 5 girls GA at birth 25–31 weeks; all infants had normal development at 2 years of age | Each infant was placed in an oval nest created with 2 rolled blankets; extremities placed into semiflexed adducted position; movements compared with and without the nest | Assessment of General Movements was completed both in and out of the nest; nested positioning increased the number of movements across midline at all ages; fewer stiff extremity or “freezing” postures were also noted when the infants were in the nest |
| Short et al<sup>70</sup> | Infants with birth weights of <1250 g infants; 24 swaddled, 26 standard positioning | Swaddled: mean of 21 hours per day swaddled in varied positions with extremities flexed and hands to mouth  
Standard positioning: swaddled only to calm mean duration 1.6 hours per day | Swaddled infants scored higher in muscle tone and motor subscale, behavioral scale, and total score on the Morgan Neonatal Neurobehavioral Examination completed by a blinded therapist  
Enhanced extremity flexion and midline alignment documented in swaddled infants |
| Girolami et al<sup>73</sup> | Infants born <35 weeks of gestation; <1800 g AGA; required to have at least 3 medical and 3 asymmetric or abnormal responses on the NBAS at 34–35 weeks of age; 10 IPT controls, 9 IPT interventions and 8 IFTs | 14–28 treatment sessions; 12–15 minutes 2 times per day; handling and movement to simulate every day activities of infants and encourage head and trunk control | Infants in the intervention group had more advanced antigravity movements such as hands to midline, pelvic tilt, and leg flexion. Statically higher score on the elicited items in the IPT Treatment group  
Assessments were completed using the Supplemental motor test, precursor to the Test of Infant Motor Performance; no infant follow-up was reported |
| Cameron et al<sup>72</sup> | Infants <32 weeks of GA and birth weight <1500 g; 28 IPTs with treatment; 32 IPTs with no treatment | Daily therapy sessions in the NICU once stable (34–35 weeks of gestation) lasting <10 min.  
Parent education on play activities and home program. Midline activities and flexor strengthening | No group differences in Alberta Infant Motor Scale percentile rank at 4 mo GA. No measurement of abilities at NICU discharge or for inclusion in study |
| Vaivre-Douret et al<sup>73</sup> | 49 infants divided in 4 groups born at 31–34 weeks; low risk | Control = nothing 3, other groups have Sensori-Tonico-Motor Touch (STM touch) each with a different type of oil. Twice daily for 15 min. | The infants in the multimodal (STM touch) groups grew more and had reduced length of stay than controls. The STM group had higher SaO2 and lower HR after intervention  
Group with Isio 4 oil had greater weight gain, and more aleriness |
| Massaro et al<sup>74</sup> | 60 infants: 20 controls; 20 massages; 20 massage and KS. All infants <1500 g birth weight and stable to start intervention at 7–9 days of life | Massage = 6 strokes in prone position  
KS = passive motions of extremities in supine position administered after prone massage | No group differences in weight gain or length of hospital stay |

PN indicates postural nappy; PR, postural roll; GA, gestational age; STM, Sensori-Tonico-Motor Touch; KS, kinesthetic stimulus; AGA, appropriate for gestational age; IPT, infants born preterm; IFT, infants born full term; NBAS, Neonatal Behavioral Assessment Scale.
RCTs that oral-facial stimulation did not decrease the postconceptual age at which infants attained a daily sched-
ule of all oral feedings.83–85 Kirk et al83 reported decreased postconceptual age (6 days) when all oral (nipple) feedings were reached by 51 infants in a histori
cal control design with feedings initiated and advanced ac-
cording to behavioral cues. McCain84 demonstrated a similar
decrease (5 days) to all oral feedings when infant arousal cues and nonnutritive sucking behaviors were used as indicators of
readiness to feed in an RCT of 81 infants in 2 NICUs.

Neonatal PTs can support behavioral readiness and feeding progression by teaching parents to interpret and value infant behavioral cues and by supporting infant phys-
iological and motor organization. Consistent with DST, in-
fants who are organized and practice feeding while main-
taining behavioral and physiologic stability are more likely
to be successful feeders.

Adjoint interventions. Neonatal massage as a single
modality has been advocated to reduce stress levels and
improve infant-parent attachment in the NICU environ-
ment86; however, a 2004 Cochrane review of massage in
neonates stressed the need for additional research before integration of massage into routine care.87 Supporting an
infant’s body with hand swaddling (facilitated body tuck)
without massage88 and skin-to-skin holding by parents89
provide human touch and are less likely to contribute to
potential overstimulation in neonates who are vulnera-
tle.90 Similarly, the Cochrane review on the efficacy of
chest physical therapy with neonates indicated that addi-
tional research was required before inclusion into routine
neonatal care related to reported adverse effects of bruising,
rib fractures, and intracranial lesions.91

Neonatal hydrotherapy for neonates who are medically
stable with movement impairment was introduced in a mul-
tiple case series92 in which adequate physiologic tolerance
(7% increase in mean arterial pressure and 7% increase in
heart rate) was documented and a hydrotherapy protocol was
detailed. In a later study, effects of hydrotherapy (immersion
in swaddled and semiflexed position) before feeding indi-
cated improved feeding efficiency and short-term mean daily
weight gain in 31 infants born preterm (32–36 weeks post-
conception) with no difference found between high- and low-
risk groups.93 Further investigation of neonatal hydrotherapy
effects on breast-feeding proficiency, bone density, gastroin-
testinal reflux patterns, and behavioral organization may ex-
pand future clinical use of this aquatic intervention in the
NICU setting for stable neonates.

Parent Education in the NICU

Parent and caregiver teaching is a primary role of ther-
apists in the NICU. Research on educating parents to in-
terpret the meaning of their infant’s behavioral cues and
developmental status has been shown to reduce parental
stress94 and improve parental mental health.95 Derived pri-
amarily from the NBAS or NIDCAP models, the following
instruments have been developed to attune parents to their
infant’s capabilities: (1) Mother’s Assessment of the Behav-
ior of the Infant,96 (2) Family Administered Neonatal Ac-
tivities,97 (3) Creating Opportunities for Parent Empower-
ment,93 and (4) Newborn Behavioral Observation System.16
A meta-analysis by Das Eiden et al98 indicated that NBAS-
based interventions during the neonatal period have a
small to moderate beneficial effect on the quality of later
parenting.

Emerging research on parents’ preferred instruc-
tional method in the NICU indicates support for multi-
modal (discussion, demonstration, video, and written)
instruction.99–102 Effects of NICU parent education pro-
grams specifically designed to promote infant motor or-
ganization and development have not been reported but
parent-delivered motor programs after NICU discharge are
supported.103,104 Additional research with both par-
ent and infant outcome measures is needed to further
investigate the efficacy of parent education and parent-
delivered intervention in the NICU.

EVIDENCE-BASED PRACTICE RECOMMENDATIONS

Implementation of clinical procedures with research
evidence and participation by practitioners in clinical studi-
ies in the NICU are critical to the advancement of neonatal
physical therapy. As the state of our science expands, the
evidence base to support neonatal physical therapy prac-
tice will continue to emerge. Practice recommendations,
rated according to a 5-level hierarchy of evidence (Table
5), are outlined in Table 6 to guide neonatal PTs in design-
ing plans of care. The evidence levels range between I and
V with the majority of practice recommendations graded at B level evidence (consistent levels II to III). 105

**CONCLUSIONS**

As specialists in movement and postural control, neonatal PTs have a unique window of opportunity to shape the musculoskeletal system and motor organization of infants requiring intensive care and to support parents and caregivers in optimizing infant brain development during the NICU stay. Guiding this advanced practice are clinical training models, clinical competencies, and a decision-making algorithm described in Part I and a theoretical framework, literature base, and evidence-based practice recommendations detailed in Part II. The science of this pediatric subspecialty is evolving with many areas of new and continued research needed to advance the rigor of evidence and to expand these neonatal physical therapy clinical guidelines.

**ACKNOWLEDGMENTS**

The authors express appreciation to medical illustrator Thomas Pierce, BA, for graphic expertise; Marie Reilly, PT, PhD, and Beth McManus, PT, MPH, ScD, for content review; and Erin Sundseth Ross, PhD, CCC-SLP, for consultation and expertise on neonatal feeding.

**TABLE 5**

Hierarchy of Evidence 105

<table>
<thead>
<tr>
<th>Level</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level I</td>
<td>Randomized controlled trials (RCTs) or systematic reviews of RCTs</td>
</tr>
<tr>
<td>Level II</td>
<td>Small RCTs, cohort studies, or systematic reviews of cohort studies</td>
</tr>
<tr>
<td>Level III</td>
<td>Case-control studies or systematic reviews of case-control studies</td>
</tr>
<tr>
<td>Level IV</td>
<td>Case series (no control group)</td>
</tr>
<tr>
<td>Level V</td>
<td>Opinion of experts or authorities</td>
</tr>
</tbody>
</table>

**TABLE 6**

Evidence-Based Recommendations for Neonatal Physical Therapy

<table>
<thead>
<tr>
<th>Type</th>
<th>Recommendations</th>
<th>Level of Evidence</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevention</td>
<td>● Collaborate with caregivers to reduce risk for skull deformity, torticollis, and extremity malalignment through diligent positioning for symmetry and neutral alignment</td>
<td>Level II</td>
<td>Van Vlimmeren et al 63</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level II</td>
<td>Vaire-Douret et al 65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level II</td>
<td>Monterosso et al 67</td>
</tr>
<tr>
<td>Examination</td>
<td>● Conduct baseline observation to determine physiologic and behavioral stability (readiness) for evaluative handling</td>
<td>Level II</td>
<td>Sweeney 52</td>
</tr>
<tr>
<td></td>
<td>● Provide continuous physiologic and behavioral monitoring during and after evaluative handling to determine adaptation to evaluative handling and to signal the need for modification of pace and sequence, given expected physiologic changes, particularly during neuromotor test procedures</td>
<td>Level II</td>
<td>Sweeney 53</td>
</tr>
<tr>
<td>Intervention</td>
<td>● Collaborate with caregivers to create a developmentally supportive environment with modulated stimulation from light, noise, and handling</td>
<td>Level I</td>
<td>Symington et al 54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level II</td>
<td>Westrup et al 55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level I</td>
<td>Peters et al 51</td>
</tr>
<tr>
<td></td>
<td>● Support body position and extremity movement (1) supine position: semiflexed, midline alignment using blanket for swaddling containment or “nest” of positioning rolls; and (2) prone position: vertical roll under thorax; horizontal roll under hips</td>
<td>Level II</td>
<td>Vaire-Douret et al 59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level II</td>
<td>Monterosso et al 59</td>
</tr>
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<td></td>
<td></td>
<td>Level II</td>
<td>Short et al 60</td>
</tr>
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<td></td>
<td></td>
<td>Level II</td>
<td>Ferrari et al 62</td>
</tr>
<tr>
<td></td>
<td>● In selected neonates with movement impairment or disorganization, consider therapeutic handling carefully graded in intensity and paced to facilitate head and trunk control, antigravity movement, and midline orientation</td>
<td>Level II</td>
<td>Girolami et al 73</td>
</tr>
<tr>
<td></td>
<td>● Consider gradual exposure to multimodal stimuli for stable neonates approaching hospital discharge</td>
<td>Level I</td>
<td>Symington et al 54</td>
</tr>
<tr>
<td></td>
<td>● Provide opportunities for independent oral exploration through positioning with hands to face, and for nonnutritive sucking to improve state organization and readiness to feed</td>
<td>Level I</td>
<td>Pinelli et al 80</td>
</tr>
<tr>
<td></td>
<td>● Determine readiness for and advancement of oral feeding trials using infant behavioral cues</td>
<td>Level II</td>
<td>Kirk et al 83</td>
</tr>
<tr>
<td></td>
<td>● Encourage parental involvement with feeding and provide interventions for physiologic stability (pacing and slowed flow rate)</td>
<td>Level II</td>
<td>McGrath et al 85</td>
</tr>
<tr>
<td></td>
<td>● Consider hydrotherapy before feeding for stable infants with movement impairment</td>
<td>Level IV</td>
<td>Sweeney 83</td>
</tr>
<tr>
<td>Education</td>
<td>● Educate parents on behavioral cues and developmental status to mitigate parental stress and to improve parental mental health outcomes</td>
<td>Level II</td>
<td>Kaaresen et al 94</td>
</tr>
<tr>
<td></td>
<td>● Implement multiple methods of instruction for parents and caregivers (demonstration, discussion, video, and written materials)</td>
<td>Level I</td>
<td>Melsyk et al 95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Level V</td>
<td>Dusing et al 100</td>
</tr>
</tbody>
</table>
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Pediatric Physical Therapy

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