Application of the NICU Practice Guidelines to Treat an Infant in a Level III NICU

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Purpose: The purpose of this case report was to determine how current physical therapy (PT) practice in the neonatal intensive care unit (NICU), with 1 infant, adhered to the neonatal PT decision-making framework that was developed as part of the NICU practice guidelines for clinical care. Summary of Key Points: Most PT interventions implemented in this NICU were supported by the algorithm, with some steps more readily implemented than others. Conclusions: This case report highlights the utility of the NICU clinical decision-making algorithm for not only assisting with developing an evidence-based PT plan of care for an infant at high risk but also its usefulness in revealing NICU programmatic and policy strengths and areas for improvement. Recommendations for Clinical Practice: The NICU developmental and therapeutic teams are encouraged to conduct similar endeavors to assess the quality of PT care in their NICUs. (Pediatr Phys Ther 2013;25:204–213) Key words: case study, infant/premature, male, neonatal intensive care unit, physical therapy modalities, practice guidelines as topic, quality of health care

BACKGROUND

Infants born preterm (less than 37 weeks of gestation) are at risk for a host of cognitive, neuromotor, and social-emotional difficulties,1 and early developmental and therapeutic interventions are recommended to mitigate neurodevelopmental risk. Developmental programs in the neonatal intensive care unit (NICU) have evolved,2 and the role of the physical therapist in the NICU3 has advanced tremendously.3 Presently, professional competencies5 and guidelines6 for delivery of physical therapy (PT) services in the NICU suggest that the role of the physical therapist working with neonates in the NICU includes not only the multidisciplinary task of providing individualized developmental care but also the provision of a number of discipline-specific direct therapy interventions.3,6

Neonatal physical therapists are experts in the neuromotor development of infants born preterm.3 Because of the immaturity of flexion patterns, extension patterns predominate and are characterized by difficulty achieving and maintaining flexed, midline orientation.7 Consequently, infants born preterm often present with retracted scapula, externally rotated and abducted lower extremities, and cervical spine extension, all of which interfere with self-regulatory skills of hand to mouth and midline, finger clasping, and foot bracing. These challenges, in the face of other self-regulatory difficulties (eg, the work of breathing, limited awake/alert state, ability to interact with caregivers), are associated with less optimal neurodevelopment.8 The role of the neonatal physical therapist is to support the infant’s functional movement patterns to allow for successful self-regulatory skills,3,5 improved activity and social participation, including optimal oral feeding and bonding with caregivers.9 To this end, successful self-regulatory skills are the foundation for optimal neurodevelopment, and early difficulties with self-regulation are associated with lower cognitive and poorer social skills at school-age10 and persistent neuromotor difficulties.11
Clinical Decision-Making Algorithm

To assist physical therapists in their work with neonates, the Section on Pediatrics of the American Physical Therapy Association convened a task force to develop guidelines for NICU practice. More recently, this task force published a clinical decision-making algorithm as a product of their work. This clinical decision-making algorithm can be used to guide physical therapists in their approach to clinical decision-making in the NICU while caring for newborns who are fragile. This article presents a case report retrospectively applying the clinical decision-making algorithm in the PT treatment of a boy born extremely preterm, who was seen in an urban level III NICU. Taking this one step further, the goal of this case report was to determine how PT practice in that NICU, with 1 patient, adhered to nationally published guidelines for clinical care. This case report was approached with an eye toward improving quality of neonatal PT care in this NICU and highlighting potential areas for future research and quality improvement initiatives in NICUs across the United States.

DESCRIPTION OF THE CASE

Baby W was a neonate born at the gestational age (GA) of 26 weeks, who presented with Apgar scores of 6 at 1 minute and 7 at 5 minutes following his birth. His birth weight was 1095 g, which was considered large for his GA of 26 weeks. Baby W’s mother was 40 years old at the time of his birth, gravida 3, para 3, and her second child was also born prematurely at 32 weeks. Although she was not placed on medical restrictions, his mother went into preterm labor secondary to a short, incompetent cervix, of which she was aware before the delivery. She underwent a cesarean delivery because of Baby W’s breech presentation. Baby W was immediately placed on a ventilator to sustain life because of respiratory distress upon delivery. One week after his birth and while still on the ventilator, he was diagnosed with a patent ductus arteriosus and underwent a ligation. The evening of the surgery, he had increased difficulty breathing on the ventilator and was diagnosed with a pneumothorax, leading to placement of a left chest tube. The next day, he was diagnosed with a bilateral subependymal hemorrhage, a left grade 3 intraventricular hemorrhage, and a 1-cm cerebellar hemorrhage. To assist with treating his chronic lung disease associated with preterm birth and weaning his ventilation requirements, Baby W underwent a course of corticosteroids, which allowed his ventilator settings to be weaned and within 7 days, he was weaned to a continuous positive airway pressure device for a few days before he was able to use a nasal cannula.

Baby W began feedings via a nasogastric tube within several days after birth. His nasogastric feedings progressed until he was on full nasogastric feedings approximately 2 to 3 weeks after birth. He continued this mode of feeding until 32 weeks GA when breastfeeding (after pumping) and small boluses of oral feeding (via a syringe and pacifier) were introduced while his mother held him close to her breast. At 34 weeks GA, breastfeeding (without initially pumping) was introduced; and by 36 weeks GA, Baby W was taking full oral feedings via breast and bottle.

Just before discharge from the NICU, Baby W had a repeat head ultrasound, which showed brain healing from the intraventricular, subependymal, and cerebellar hemorrhages, though some increase in intracranial pressure was noted. The increased intracranial pressure remained stable and never resulted in surgical intervention. Baby W was discharged and returned home with his mother and father at 36 weeks GA. Baby W’s medications at the time of discharge from the NICU included multivitamins, iron, and diuretic therapy for treatment of his chronic lung disease.

DESCRIPTION OF THE INTERVENTION

Application of the Clinical Decision-Making Algorithm

Observation. Baby W was referred for a PT examination on his 18th postnatal day, having received no therapy consultations before this date. The reason for referral was Baby W’s lack of physiological flexion, decreased ability to respond appropriately to sensory stimuli and handling, and immature prefeeding skills. The initial 20-minute observation occurred with Baby W in his isolette prior to his routine care. The purpose of the observation was to determine the infant’s ability to demonstrate age-appropriate self-regulation and responses to sensory information. Age appropriateness (ie, relative to GA) of the infant’s self-regulatory and sensory skills was determined through a combination of standardized measures, observation, and clinical judgment.

Self-regulation of the Autonomic System. Baby W’s heart rate was initially in the 160s but increased to the 180s during handling associated with his routine care. His respiratory rate was initially in the 50s but demonstrated both increases to the 60s and decreases to the 40s with his oxygen saturation decreasing to 80% with handling. Baby W’s heart rate, respiratory rate, and oxygen saturation returned to baseline when he was swaddled following routine care.

Self-regulation of the Motor System. During his care, Baby W was observed to have extension movement pattern dominance with poor ability to move against gravity (eg, active antigravity flexion patterns). His arms and legs appeared hypertonic while he was observed to have hypotonia in his hips, trunk, and neck, as evidenced by his limited ability to achieve and maintain a flexed, midline position while in a supine position without positional supports. When placed in a side-lying position, Baby W was observed to initiate some active flexion patterns with several attempts to bring his hand to his mouth.

Self-regulation of Behavioral State. His state of alertness, when not contained by boundaries or swaddling in a blanket, fluctuated between states 4 and 5 on the Neonatal Behavioral Assessment scale, with minimal to moderate stress (eg, sneezing, coughing, gaze aversion) noted with
increasing stimulation. His stress cues increased with more stimulation (eg, more handling, greater ambient noise, light), and he demonstrated increased tremulous movements like coughing, gaze aversion, and oxygen desaturations.

**Self-regulation of Responses to Stimuli.** Baby W appeared to have difficulty with self-regulation when a variety of environmental stimuli were presented, especially simultaneously (eg, ambient noise, light). He appeared to benefit from sensory modulation, as evidenced by greater autonomic stability and more consistent eye opening when light was shielded and environmental sounds were reduced. In this NICU, the developmental team designed and employed a sensory modulation scale (see Appendix 1). Possible scores were good +/−, fair +/−, and poor +/−. On the basis of Baby W’s response to sensory stimulation, his sensory modulation was fair minus. He demonstrated independent successful self-regulatory skills only 25% of the time while being observed during his routine care with typical environmental stimulation. However, with environmental modifications (eg, reduction of ambient noise and light, modulating handling to allow for breaks), he demonstrated successful self-regulation nearly 75% of the time.

**Caregiver Competencies.** Baby W’s mother was eager to perform skin-to-skin care (kangaroo care), and she expressed willingness to follow through with the therapy recommendations. With minimal parent education provided, she had a unique understanding of his needs and many of the interventions. His parents’ goal was to see him develop as typically as possible, given his preterm birth and brain bleeding, and they were willing to assist the nursing staff in carrying out his positioning recommendations and therapy needs any time they were present in the NICU.

**Additional Diagnostic Procedures.** In addition to observing Baby W’s motor system, the physical therapist examined Baby W’s extremity range of motion, reflexes (eg, sucking, rooting, and hand grasping for robustness and symmetry), and the quality of Baby W’s tone. Baby W’s nervous system immaturity precluded conducting a formal cognitive evaluation. Instead, a modified neurobehavioral examination was conducted using principles from the Neonatal Behavioral Assessment Scale and Newborn Individualized Developmental Care and Assessment Program. For example, the therapist observed Baby W’s ability to visually fixate and track the physical therapist’s face and voice.

**Identify Strengths and Challenges.** The initial examination was performed at 28+/− weeks gestation, on the 18th postnatal day.

**Body Function and Impairments:** The following impairments were noted: limited endurance and autonomic stability for handling and routine care without pacing and activity modulation; predominant extension patterns, limited antigravity flexion and midline-orientation patterns; limited ability to achieve and maintain an age-appropriate awake or alert state; and difficulty with age-appropriate visual fixation on caregiver’s face.

**Activity Limitations:** The following activity limitations were noted: limited and inconsistent independent self-regulatory skills, immature social interaction skills, immature oral feeding skills, and disorganized sleep-wake cycles.

**Participation Restrictions:** The following participation restrictions were found: difficulty with parent bonding and inability to engage in typical newborn feeding.

**Infant-Focused Family-Centered Goals.** On the basis of the results of the examination, short-term goals (6–8 weeks) were developed to address the clinical impression and prognosis of Baby W. These goals were written as part of Baby W’s PT plan of care. While every effort was made to incorporate the family’s priorities and concerns into the PT goals, PT goals in this NICU are written as part of the clinical service delivery and outside the scope of early intervention under the Individuals with Disabilities Education Act. The short-term goals were stated as follows:

1. Baby W will demonstrate age-appropriate autonomic regulation during routine care and PT sessions with minimal pacing or activity modulation and environmental modifications.
2. Baby W will consistently and independently demonstrate active flexion and midline presentation movement patterns in right or left side-lying position.
3. Baby W will achieve and maintain an awake or alert state to demonstrate age-appropriate nonnutritive sucking (eg, on his pacifier) for the first 10 to 15 minutes of his gavage feeding with minimal environmental modifications.
4. Baby W will demonstrate age-appropriate visual fixation on his parent’s face while swaddled and held in a supportive position.

The long-term goals that were written for discharge and postdischarge were as follows:

1. Baby W will demonstrate an appropriate developmental level for his corrected GA.
2. Baby W will consistently demonstrate successful self-regulation during social interaction and family caregiving routines.
3. Baby W will take all feedings orally, demonstrating age-appropriate suck-swallow-breathe coordination, with appropriate efficiency to complete the oral feeding within 30 minutes, while maintaining autonomic stability.

**Perform Evidence-Based Interventions.** In accordance with the NICU clinical decision-making algorithm, Baby W’s plan of care for PT was designed using evidence-based treatments and techniques to address family, infant, and therapist strengths and challenges. Specific evidence-based interventions are described below (see also Tables 1 and 2).

**Coordination, Communication, and Documentation:** Baby W’s team included neonatologists and neonatal nurse
### TABLE 1
Progression of Specific Physical Therapy Evidence-Based Interventions During Baby W's Stay in the Newborn Intensive Care Unit

<table>
<thead>
<tr>
<th>Gestational Age, wk</th>
<th>Evidence-Based Interventions</th>
<th>Treatment Strategies</th>
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<tbody>
<tr>
<td>29</td>
<td>Positioning recommendations were posted at the bedside and updated weekly as needed. Sensory and self-calming activities, &quot;passive resistive&quot; range-of-motion exercises, joint compression exercises, and oral motor exercises (nonnutritive). Encouraging parent-infant bonding and parent education. Treatment frequency was 3 to 4 times weekly for 15 to 20 minutes per session.</td>
<td>Positioning included use of equipment to promote physiological flexion and midline postures. Sensory exercises included facilitating hands to midline, hands to mouth, sensory exploration of the face, sucking on hand or pacifier, and facilitative tucking. Self-calming techniques included facilitating hand to mouth and sucking on hand or pacifier. &quot;Passive resistive&quot; range-of-motion exercises such as facilitation of bicep recoil and hip flexion recoil were used in combination with joint compression to promote bone mineralization and muscle development. Encouraging activities to assist the baby’s bonding with parents included promoting kangaroo care and partnering with parents for Baby W's sensory activities. Parent education included strategies to promote Baby W's development and the role of physical therapy in Baby W’s NICU care.</td>
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<td>30</td>
<td>The activities described earlier were continued. In addition, a massage protocol was introduced this week. Treatment frequency continued as noted earlier.</td>
<td>Oral activities began with a dry pacifier shortly after extubation. The pacifier was dipped in his mother's breast milk and offered to the baby. Once the baby was comfortable with this activity (which occurred rapidly for this baby), a single drop of milk was placed on the pacifier and offered to the baby. The baby again was comfortable with this activity; therefore, a drop of milk was placed in the corner of his mouth while sucking on the pacifier. Each day, the baby was offered another drop; by the end of the week, the baby was able to tolerate taking 1-2 cc of milk orally, one drop at a time, while sucking on the pacifier. Activities to assist with increasing lower extremity flexion included gently flexing and extending the baby’s legs as well as providing facilitation of hip and knee flexion and lower extremity tucking in neutral position with an abdominal curl. Facilitation of these flexion activities was performed in both side-lying and supine positions.</td>
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<tr>
<td>31</td>
<td>The activities described were continued. In addition, oral motor activities were introduced. The frequency continued as noted earlier.</td>
<td>A massage protocol of 15 minutes, 3 times daily for 5 consecutive days, was added to promote additional parent education of appropriate handling of infant.</td>
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<td>32</td>
<td>“Passive resistive” range of motion and joint compression were discontinued. Sensory, self-calming, massage, oral motor, and parent education or handling were continued. In addition, activities to promote increased lower extremity flexion were introduced. In addition, breastfeeding (after pumping) was introduced to Baby W under the guidance of the lactation nurse.</td>
<td>Activities to assist with increasing lower extremity flexion included gently flexing and extending the baby’s legs as well as providing facilitation of hip and knee flexion and lower extremity tucking in neutral position with an abdominal curl. Facilitation of these flexion activities was performed in both side-lying and supine positions.</td>
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<tr>
<td>33</td>
<td>No changes were made to the activity progression this week.</td>
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<tr>
<td>34</td>
<td>Continue with previous activities. In addition, activities to increase flexion in trunk and neck were introduced. In addition, bottle-feeding began during this week, using a slow-flow nipple. Physical therapy was increased to 4 to 5 times weekly for 15 to 30 minutes per session.</td>
<td>Activities to promote trunk and neck flexion were performed in supported-sitting position with the baby swaddled. Facilitation of anterior neck muscles and abdominal neck muscles were performed by gently rocking the baby back in supported-sitting position and allowing facilitation of righting reactions with additional support and assistance to complete activity. Also, rocking the baby side to side in this position assisted with development of oblique muscles and lateral neck muscles. Bottle-feeding began this week by introducing nutritive sucking with larger amounts of fluid and a slow-flow nipple. Pacing techniques were used to facilitate age-appropriate suck-swallow-breathe coordination and successful feeding experiences. Treatment frequency was increased to facilitate feeding progression.</td>
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<tr>
<td>35</td>
<td>No changes were made this week. Progression with bottle and breast-feeding were continued.</td>
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<tr>
<td>36</td>
<td>Preparing for discharge began in this week.</td>
<td>A home program of flexion activities, self-calming and soothing techniques, and massage were included with the parent teaching. These included sensory exploration of the hands and face, thumb abduction, massage, gentle lower extremity bicycling, sitting exercises to encourage head and trunk control, trunk flexion, midline activities, flexion and extension movements, and prone position activities. All PT activities were to be incorporated into the daily play routine 2 to 3 times daily. A commercially available slow-flow nipple or bottle system was trialled with success and incorporated into the discharge recommendations.</td>
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Abbreviation: NICU, Neonatal Intensive Care Unit.
TABLE 2
Gantt Chart Describing Baby W’s Physical Therapy Treatment Progression in the Neonatal Intensive Care Unit

<table>
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<tr>
<th>Postconception age, (wk)</th>
<th>28</th>
<th>30</th>
<th>31</th>
<th>32</th>
<th>33</th>
<th>34</th>
<th>35</th>
<th>36*</th>
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<tr>
<td>Chronological age, (d)</td>
<td>18</td>
<td>27</td>
<td>34</td>
<td>41</td>
<td>48</td>
<td>55</td>
<td>62</td>
<td>74</td>
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<tr>
<th>Therapeutic Intervention</th>
<th>Postconception age, (wk)</th>
<th>28</th>
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<th>31</th>
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<th>33</th>
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<th>36*</th>
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<tr>
<td>Positioning recommendations</td>
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<td>Sensory and self-calming strategies</td>
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<td>Passive resistance range of motion</td>
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<td>Joint compression</td>
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<td>Prefeeding oral motor activities during gavage feedings</td>
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<td>Parent education and encourage parent-infant bonding</td>
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<td>Massage protocol</td>
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<td>Oral motor activities with small boluses (drops up to 2 mL) of breast milk</td>
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<td>Activities to encourage lower extremity flexion</td>
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<td>Breastfeeding after pumping</td>
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<td>Activities to encourage flexion of upper extremities and and trunk</td>
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<td>Bottle-feeding initiated with slow-flow nipple</td>
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<td>Increased frequency of bottle-feeding with pacing techniques</td>
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<td>Discharge education with parents</td>
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*Physical therapy treatment began at 28 5/7 weeks postconception age and lasted until 36 5/7 weeks gestation; age when the patient was discharged home from the NICU.

practitioners, nurses, physical therapists, nutritionists, respiratory therapists, and lactation consultants. To assist with the coordination of care and communication across Baby W’s NICU team, written bedside recommendations were hung on his isolete. Regarding compensatory strategies during Baby W’s stay in the NICU, a sign was posted at the bedside recommending a developmental diaper change16,17 (eg, in side-lying position or supported-supine position with his arms swaddled and hands in midline and avoiding excessive leg lifting), a swaddle bath18 (ie, maintaining flexed, midline position with a blanket), and a decreased stimulation19-21 (eg, reducing light with an eye cover and speaking softly) when performing care to avoid loss of self-regulation. In addition, the protocol for “passive resistive” range of motion and joint compression22,23 was also posted, with the recommendation to complete these activities once daily during Baby W’s care. Finally, PT recommendations for Baby W’s oral motor development (eg, pacifier dips and syringe feedings)24 were posted when appropriate.

To facilitate communication among team members, the physical therapist updated bedside recommendations as Baby W’s PT treatments progressed (see Tables 1 and 2). In addition, the physical therapist participated in biweekly discharge and feeding rounds to discuss Baby W’s progress and to update his plan of care with other members of his team.

Parent education and involvement in therapy sessions occurred throughout Baby W’s stay, and they were a part of the PT plan of care. Parental involvement included activities such as promoting kangaroo care, holding Baby W at the bedside, partnering with parents for Baby W’s sensory activities, and continuous parent education regarding strategies to promote Baby W’s development and the role of PT in Baby W’s NICU care. At 36 weeks gestation, the physical therapist initiated a discharge plan that included parental education about developmental milestones and newborn neurobehavior related to crying and sleeping,23 a home program to promote age-appropriate sensory, self-regulatory, social interaction and feeding skills.26,27

**Positioning:** To compensate for decreased flexor tone, the physical therapist recommended flexion positions using boundaries to keep hands in midline, head near midline, legs flexed, and trunk flexed7,18,28,29 Also, the physical therapist implemented additional positioning aids (eg, gel cushions) to promote more optimal cranial molding7 and prevent plagiocephaly and torticollis. The positional boundaries were also used to assist with age-appropriate responses to sensory stimuli (ie, the boundaries provide proprioceptive input).

**Joint Range of Motion:** “Passive resistive” range-of-motion exercises and joint compression were performed for 5 to 10 minutes daily to encourage muscle development and bone strength to prevent fractures, contractures, and to encourage movement22,23,30

**Therapeutic Neuromotor Handling:** The physical therapist incorporated several therapeutic neuromotor activities into Baby W’s PT plan of care, including “passive resistive” range of motion,22,23 massage,31,32 and activities to promote active flexion movements of the upper and lower extremities and trunk.

The physical therapist introduced “passive resistive” range of motion and joint compression, beginning at 28 weeks GA (Tables 1 and 2). In addition, PT treatment sessions promoted active flexion movement patterns26 and later included a massage protocol31 (30 weeks GA; see Tables 1 and 2) to reduce stress behaviors, increase...
relaxation, and encourage flexion activities. Specifically, as per previously published protocol, Baby W's mother or a member of his primary care team, guided by the physical therapist, performed massage for 15 minutes, 3 times daily for 5 consecutive days. At the end of the 5 days, consistent with previously published results, Baby W demonstrated less stress neurobehavior and, therefore, the massage protocol continued until Baby W's discharge.

In addition, Baby W's physical therapist incorporated activities to promote active flexion of the extremities (32 weeks GA; see Tables 1 and 2), in particular the lower extremities. Also, the physical therapist discontinued passive flexion activities (described earlier in this section). This decision was made to correspond to the neurodevelopmental progression of active flexion emerging in the lower extremities at around 32 weeks GA. Following the introduction of active lower extremity flexion activities, the physical therapist added activities to promote more active flexion of the upper extremities and emergence of active flexion of the head, neck and trunk (34 weeks GA; see Tables 1 and 2). Similar to the progression described for the lower extremities, this decision was made to follow the neurodevelopmental progression of active flexion emerging in the trunk at about 34 to 35 weeks GA.

Multimodal Sensory Stimulation: The primary goals of the sensory activities were to (1) mitigate stressful environmental stimuli and (2) promote age-appropriate sensory responses. The former goal was achieved through this NICU's lighting policies (see Appendix 2) and PT recommendations placed at Baby W's bedside (described earlier). To promote age-appropriate sensory skills, specific sensory exercises (eg, facilitating hands to midline and mouth, tactile exploration of face as tolerated, opportunities for nonnutritive sucking, and facilitation of tucking movements [29 weeks GA; see Tables 1 and 2]) were used in all of the weekly treatments in an effort to assist with self-calming and reorganization.

Support of Oral Feeding: To address Baby W's immature oral feeding skills and offer him opportunities for successful, pleasant oral feeding experiences, the physical therapist introduced several oral motor activities (29-31 weeks GA; see Tables 1 and 2), such as hands to mouth and nonnutritive sucking during gavage feedings. As Baby W's oral motor skills improved, the physical therapist encouraged Baby W to engage in nutritive sucking with either a pacifier dipped in breast milk or small boluses (ie, 2 mL) of breast milk introduced into the front of the mouth using a syringe (31-32 weeks GA; see Tables 1 and 2). Because of Baby W's oral feeding immaturity, his primary care team decided to wait to begin bottle-feeding with Baby W until breastfeeding was established and Baby W was deemed by the physical therapist to be developmentally ready to bottle-feed (32-34 weeks GA). When bottle-feeding commenced, the physical therapist initiated pacing techniques in combination with the use of a slow-flow nipple to reduce the fluid rate from the bottle into Baby W's mouth to assist with development of age-appropriate suck-swallow-breathe coordination.

Summary of the Progression of Physical Therapy Interventions: Baby W's PT sessions progressed from 15 to 20 minutes per session 3 to 4 times per week to 5 times per week (Tables 1 and 2). The initial frequency and intensity were based on his neurobehavioral immaturity and poor tolerance for handling. To this end, during the initial PT sessions, Baby W was seen by physical therapist inside his isolette to minimize environmental stimulation and maximize his success at self-regulation. Physical therapy intervention focused on parent and staff education, positioning, and gentle encouragement of flexion patterns to promote self-regulation during routine care. As Baby W's repertoire of self-regulatory skills improved, PT treatment frequency and intensity increased to match his developmental maturity and address new activities and social participation.

During this time (around 34-35 weeks GA), the majority of the PT sessions were conducted outside the isolette as tolerated. On days when Baby W was demonstrating more fragility and difficulty with self-regulation, PT sessions occurred inside the isolette to mitigate environmental stimulation and task requirements to promote Baby W's self-regulatory capacities. The PT plan of care between 32 and 36 weeks GA focused on flexion movement activities in the supine position, introduction of the supported-upright position, and oral motor activities to support the development of bottle-feeding. Physical therapy sessions at the “bedside” also allowed for greater social interaction activities, including visual and auditory fixation and tracking with decreasing positional supports and environmental modifications. Thus, within and across PT treatments, the physical therapist constantly monitored Baby W's neurobehavioral cues and neurodevelopmental level to guide progression of postural and movement demands, oral feeding, and social interaction.

Environmental Modifications: The NICU where Baby W was receiving care has policies for positioning and lighting, which were used with Baby W. A detailed explanation of this NICU's lighting and positioning policies are given in the Appendices.

DESCRIPTION OF OUTCOMES
Reexamination of Challenges

A reexamination occurred 5 days before discharge. In addition to the physical therapist reexamination of Baby W's movement and self-regulation, the physical therapist also used the Morgan Neonatal Neurobehavioral Examination (MNNE) to evaluate Baby W's neurodevelopmental level. The MNNE is a routinely used impairment-level examination used to identify asymmetries, abnormal tone, and atypical behavioral patterns and reflexes.

Goal Achievement

This patient was discharged from the NICU to home at 36 weeks 5 days' GA, which was considered an early discharge. He was given a referral to early intervention PT on the basis of his eligibility for early intervention services.
due to his history of preterm birth. His main goals in the NICU were met at discharge, with the exception of asymmetry in his neck and left leg extension.

**Follow-up**

Baby W began PT through the part C early intervention program at 38 weeks GA in his home 1 time weekly for 6 weeks, during which time he met all milestones expected of him (on the basis of the early intervention provider notes shared by his family). At 6 weeks following the start of early intervention, he was reexamined and his PT session frequency was decreased to every other week for an additional 6 weeks since he was no longer 23% or more developmentally delayed. At 12 weeks post-NICU discharge, he was placed on hold or temporarily discharged from early intervention home care, having obtained age-appropriate milestones for his adjusted age.

**DISCUSSION**

This case report describes the retrospective application of the neonatal PT clinical decision-making algorithm to the PT treatment in an urban level III NICU of a little boy born at 26 weeks GA. Several lessons were learned.

In terms of the specific processes of the decision-making algorithm, some steps were more readily implemented than others. For example, neonatal physical therapists in this NICU typically take a patient history, perform an initial observation, and conduct a PT examination. However, when comparing the treatment of this baby in the case report, along with the current PT practice in the NICU, with the recommendations for implementing additional diagnostic procedures, areas for care improvement were revealed. For example, reflecting on the MNNE, there is minimal research on the benefits of using this examination as compared with other examinations. In the literature, popular developmental tests include the Assessment of Preterm Infants' Behavior (APIB), the Test of Infant Motor Performance (TIMP). However, compared with the MNNE, the APIB and the TIMP are designed for experienced clinicians. Moreover, these tools require specialized training, and for the APIB specifically, clinicians must be trained to become reliable in administration. Therefore, in accordance with the clinical decision-making algorithm, further investigation would be beneficial to determine whether one of these tools would be more useful for understanding the infant's limitations and the need for PT.

In the direct intervention step of the decision-making algorithm, most of the PT interventions implemented in this NICU, both generally and specifically for Baby W, were supported by evidence. For example, the benefits of developmentally supportive positioning and oral motor or feeding techniques, kangaroo care, infant massage, and parent education have a strong evidence base. Other PT direct interventions implemented in Baby W's PT plan of care were less well supported by the clinical decision-making algorithm. For example, the efficacy of "passive resistive" exercise and joint compression to support bone and muscle development is unclear. There are several articles that support the use of this exercise technique in the NICU, secondary to the bone and muscular benefits derived. However, recently, a Cochrane review concluded that the evidence supporting "passive resistive" range of motion for increasing bone density and weight gain was insufficient because most studies contained small sample and effect sizes, suggesting no difference in bone density at 12 months of age. Following this case report, the practice of "passive resistive" range of motion and joint compression has been reevaluated, and the PT team has decided to discontinue the general use of the "passive resistive" range of motion and joint compression for all infants born preterm and instead use it only on a subset of infants cared for in the NICU on a short-term basis.

Reflecting on the extent to which the NICU policies facilitated implementing the clinical decision-making algorithm, several lessons were learned. This NICU has policies considered developmentally supportive for cycled lighting, promotion of kangaroo care, and developmentally supportive feeding (eg, promoting breastfeeding and waiting to initiate bottle-feeding until the infant is developmentally ready).

One challenge to initiating the clinical decision-making algorithm was determining the frequency and intensity of PT treatment. There is a debate on the frequency of therapy in the NICU, although given the successful outcomes in this patient, the frequency will most likely need to be determined by a skilled clinician and adapted to each patient. There is conflicting evidence on when to begin therapy in the NICU for those supporters of hands-on treatment. The ranges include postnatal day 5 to 7 for "passive resistive" range of motion to obtain maximal benefit, 28 to 33 weeks GA for a Newborn Individualized Developmental Care and Assessment Program (NIDCAP) assessment, 33 weeks GA to begin flexion exercises, and 35 weeks GA for those infants with asymmetrical or atypical development with a high-risk birth history. More evidence needs to be collected through a blinded, randomized study with key outcomes such as length of stay or long-term disability to determine the most effective course of treatment. This patient began therapy when he was stable, was monitored throughout the course of the treatment to ensure safety, and progressed through an exercise program as tolerated. He also demonstrated good progression of his milestones up through 6 months chronological age, considering his high-risk birth.

Physical therapy frequency and intensity includes consideration of when PT should be initiated for which groups of infants. Reflection on Baby W's reason for referral to PT (ie, intraventricular hemorrhage and tone abnormalities) and when PT was initiated (ie, day 18 of life) brings to light a need for further neonatal PT program development. For example, the NICU multidisciplinary care team (eg, medicine, nursing, rehabilitation, nutrition, respiratory therapy, and lactation consultation) would benefit from clearly defined PT referral criteria. For example, some
NICUs have a “blanket” referral for PT for all infants born younger than 32 or 28 weeks GA (ie, to coincide with state part C eligibility criteria and local policy), whereas other NICUs have stricter protocols for determining appropriateness of an NICU PT referral. The application of the clinical decision-making algorithm highlighted the need for a matrix justifying frequency and intensity of PT treatment on the basis of the available evidence.

An additional challenge to implementing the clinical decision-making algorithm was writing PT goals that most appropriately capture the family’s strengths, priorities, and concerns while still meeting rehabilitation departmental guidelines for goal-writing in an acute care clinical setting.

Finally, this case study was conducted in an academic hospital where a neonatal PT program exists. Despite the strengths of this program, this case study outlined several areas for improvement. Indeed, previous research suggests that only 2 of 3 NICUs in this country have similar neonatal developmental and/or therapeutic programs, and of those, fewer than 1 of 3 have a sufficient operating budget. Moreover, recent evidence suggests that more frequent, higher-quality developmental and therapeutic care practices are associated with improved neurobehavioral outcomes of infants born preterm. Thus, the lessons learned in the application of the neonatal PT clinical decision-making algorithm in this case study, combined with recent evidence suggesting both the variability and importance of developmental and therapeutic programming in the NICU, underscores the utility and clinical relevance of this case study. Physical therapists who work in an NICU where the neonatal PT clinical decision-making algorithm is not being used should pay special attention to this case study and conduct similar endeavors to improve the quality of patient care.

CONCLUSION

As the field of neonatal PT grows, evidenced by the presence and growth of neonatal PT fellowship programs, along with growth in developmental science and outcomes research for infants at high risk, it will be imperative for physical therapists who treat in the NICU to participate in NICU quality improvement activities (eg, creating evidence-based protocols for initiating and progressing infants in the NICU, developing evidence-based clinical pathways or care plans, and documenting outcomes of infants who receive PT). This case report highlights the utility of the NICU clinical decision-making algorithm for not only assisting with developing an evidence-based PT plan of care for one infant at high-risk but also highlighting NICU programmatic and policy strengths and areas for improvement. The NICU developmental and therapeutic teams should conduct similar endeavors to ensure that they are providing the highest-quality therapeutic interventions for this vulnerable population.

REFERENCES


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**APPENDIX 1**

**Modified Sensory Modulation Scale**

<table>
<thead>
<tr>
<th>Categorization</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td><strong>Good</strong></td>
<td>The baby is able to tolerate hands-on stimulation with minimal to no stress cues. The baby demonstrates the ability to self-calm 90% or more of the time without shutting down or becoming overstimulated.</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td>The baby is able to tolerate hands-on stimulation with minimal stress cues. The baby demonstrates the ability to self-calm 75% to 90% of the time without shutting down or becoming overstimulated.</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>The baby is able to tolerate hands-on stimulation with minimal to moderate stress cues. The baby demonstrates the ability to self-calm 75% of the time with no more than one period of shutting down or becoming overstimulated.</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>The baby is able to tolerate hands-on stimulation with minimal to moderate stress cues. The baby demonstrates the ability to self-calm 50% of the time with no more than one period of shutting down or becoming overstimulated.</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>The baby is able to tolerate hands-on stimulation with minimal to moderate stress cues. The baby demonstrates the ability to self-calm 50% of the time with more than one period of shutting down or becoming overstimulated.</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>The baby is able to tolerate more than 5 minutes of hands-on stimulation secondary to significant stress or inability to maintain a period of quiet alert or calm state.</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>The baby is unable to tolerate a hands-on assessment and may require an observation assessment secondary to severe stress.</td>
</tr>
</tbody>
</table>

*In an effort to categorize the ability of the baby to tolerate hands-on stimulation during the assessment, this scale was designed by physical therapists in the neonatal intensive care unit where the second author is affiliated. Portions were adapted from the Brazelton Scale.*

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APPENDIX 2
Lighting and Positioning Protocols

The standard lighting protocol began alternating between light and dark at 32 weeks corrected gestational age in the isolette, using 417 lux of light, and alternating the isolette flaps up and down for 6 hours (when he was in the bassinette, there were no rotating flaps). The protocol continued with lights off for 3 hours, then lights on again for another 3 hours, with complete darkness at night for 12 hours.

Positioning protocols begin after an infant is stable and off phototherapy lighting which is usually around the fourth to seventh day of life. The infant is placed in supine, side-lying, or prone position in flexion boundaries, using a snuggly, bendy bumper, and squishon (all available through Children's Medical Ventures [Royal Philips Electronics of the Netherlands, Amsterdam, the Netherlands]) along with a foot roll if needed to decrease plantar flexion and scissoring. The infant is positioned within boundaries of support until 1 week before discharge when he or she starts sleeping on his or her back in compliance with recommendations for back to sleep in a blanket swaddle.