Improving Neurodevelopmental Outcomes in NICU Patients

Leslie Painter, DNP, RNC-MNN, CCE; Stephanie Lewis, PhD, RN, CNE; Bernita K. Hamilton, PhD, RN

ABSTRACT

Background: Premature infants experience stressors such as external stimulation with sounds, light, touch, and open positioning in NICU that negatively affect outcomes.

Purpose: The purpose of this study was to measure the effectiveness of a developmental positioning intervention on length of stay, weight gain, and tone/flexion compared with neonates without structured positioning.

Methods: Study design was quasi-experimental with nonequivalent groups. A retrospective chart review of 50 neonates with the inclusion criteria of 34 weeks of gestation or less and no anomalies provided a preintervention sample. After the education in-service on positioning, a convenience sample of 27 infants was enrolled. Infant Position Assessment Tool was used as a visual guide for positioning and scoring by the researcher for intervention fidelity. Hammersmith scoring was completed by the occupational therapist prior to discharge.

Findings: The postintervention group was younger and sicker than the control group ($P < .05$). The postintervention sample ($M = 7.05$ where $7 = 29$ to <30 weeks of gestation) was younger than the preintervention sample ($M = 7.22$). The postintervention sample was smaller ($M = 1302.15$ g) than the preintervention sample ($M = 1385.94$ g). Results showed that the postintervention group had clinically significant weight gain and mean Hammersmith score (3.28) was higher showing positioning positively affected tone and flexion scores.

Implications for Practice: With greater structure and consistent attention to developmental positioning, outcomes are positively affected.

Implications for Future Research: Further research with larger sample sizes will identify stronger associations and relationships between positioning and outcome measures.

Key Words: developmental care, developmental positioning, neurodevelopment, NICU, premature infant, preterm infant positioning

The neonatal intensive care unit (NICU) is full of stimulation from many sources including positioning that differs from the intrauterine environment.[1] This external stimulation is a stressor to the infant and can produce physical and neurological responses and delays. Stress responses in the infant are manifested by an increased heart rate, decreased oxygen saturation, poor or lack of weight gain, and delayed development.[1] Preterm infants that experience more stress may spend more days in NICU. When born early, the infants require replication of the intrauterine environment as closely as possible to promote optimal outcomes.

Affecting about 10% of infants born in 2017,[2] prematurity is the leading cause of death for newborns in the United States and the cost to care for infants who survive is a staggering $26 billion annually.[3] The economic impact to the healthcare system is significant. An infant born less than 26 weeks of gestation may have a hospital bill that exceeds $250,000.[4] More importantly, premature infants can experience long-lasting physical challenges including lung problems, blindness, cerebral palsy, serious neurological deficits, neuromuscular delays, or even problems with cognition.[3]

During the second half of pregnancy, an infant experiences significant neurological development as well as physical flexion, midline positioning, and growth to prepare them for extrauterine life.[5] When born early or preterm, those processes are interrupted resulting in breathing and feeding difficulty, vision and hearing problems, and neurodevelopmental delays.[2] The earlier the birth occurs in the pregnancy, the more complications the preterm infant is likely to experience.

To decrease the incidence of some of the negative outcomes related to prematurity and developmental concerns, the environment of the NICU can be modified to better mimic the uterus. Developmentally appropriate care includes strategies to minimize the stress of the NICU environment by controlling stimuli, clustering care activities and procedures, and positioning the infant to provide an environment similar to the uterus.[6] Isolette covers to protect against external stimuli, clustering of care, and

Author Affiliations: School of Nursing, Troy University, Montgomery, Alabama (Drs Painter and Hamilton); and School of Nursing, Troy University, Phenix City, Alabama (Dr Lewis).

This study was conducted at Troy University.

The authors declare no conflicts of interest.

Correspondence: Leslie Painter, DNP, RNC-MNN, CCE, Troy University School of Nursing, Montgomery, AL 36104 (lpainter@troy.edu).

DOI: 10.1097/ANC.0000000000000583

swaddling and developmental positioning have positive effects on developmental outcomes in this population.[1,7]

Developmentally appropriate positioning assists the infant to sustain a more flexed, supported position with attention to midline posture and symmetry. This positioning provides boundaries for extremities to stay flexed and in the midline posture but allows for movement to benefit overall development.[8] The NICU patients with altered neurodevelopment are referred to physical and/or occupational therapy after discharge. This follow-up care is costly and can last months or even years to correct neurodevelopmental problems that were identified at discharge from their inpatient stay. Infants that are stressed and using additional calories in the NICU can lose weight or stop gaining, which extends their time in the hospital, increases cost, and affects outcomes. Additional training and education for NICU caregivers assist in achieving developmentally appropriate positioning with preterm infants.

LITERATURE REVIEW

A search of the literature was conducted using PubMed, the Cumulative Index to Nursing and Allied Health Literature or CINAHL, Pro Quest, and the Cochrane Library. Key words used during the search included developmental positioning, neurodevelopmental outcomes, developmental care, preterm infants, NICU, and neonatal developmental care positioning. Availability of research on the effect of developmental positioning on flexion, tone, weight gain, and length of stay (LOS) is scant. A systematic review and meta-analysis of randomized controlled trials assessed the Newborn Individualized Developmental Care and Assessment Program (NIDCAP) and its effectiveness in improving preterm newborn outcomes.[9] The NIDCAP is a program that involves education, training, and certification for healthcare providers for assisting with developmental support, minimizing stress, and striving for a family-centered model to care for the premature newborn.[10] The NIDCAP process provides in-depth training for healthcare professionals. The substantial cost to the individual or organization to implement this program is often a barrier to more widespread use in NICUs. After a systematic review of 18 studies with 627 infants, the authors concluded that there was no statistically significant evidence that NIDCAP improves long-term neurodevelopmental outcomes or short-term medical outcomes.[9] The outcomes of death or major neurodevelopmental disability at 18 months' adjusted age or greater versus survival and no disability at the same age were not statistically significant between the NIDCAP and control groups. More research is needed in this area with the NIDCAP program.

What This Study Adds

- Continuation of the importance of developmental care in preterm infants to improve neurodevelopmental outcomes.
- Exploration of how an education in-service and positioning intervention affect length of stay, weight gain, and tone and flexion of preterm infants.

A research utilization project in 5 NICUs identified 16 potentially better developmental care practices. The practices were implemented at different centers with the ultimate goal of improving neurodevelopment of the premature infant.[11] The care practices included tactile stimulation, early exposure to maternal scent, minimal exposure to noxious odors, assessing noise level in the NICU and decreasing it, and preserving sleep states.[11] Although positioning is typically a part of developmental care, it was not included in this study. Findings were aggregated and single neurodevelopmental practices were implemented. Outcomes were not compared with previous outcomes of the patients. Caregiver and parent education on developmental provisions was identified as a critical factor for the success of any changes in the units.

Education of nurses on developmental positioning of premature infants and nurses' perceptions of their knowledge of those practices were evaluated over a period of 5 years. The nurses were assessed on their knowledge and ease of positioning the infants with a pretest and posttest after education. They were also formally educated with in-services, interactive computer education, workshops, and bedside consultation with a physical therapist.[12] The results of the formal education and its effects on the short-term quality of positioning were observed by the researcher using a tool to evaluate the positioning effectiveness with 4 items over a period of 5 years. The tool used was researcher developed with 14 questions regarding shift, nursing employment status, and education about positioning, as well as some short answer space provided. Full-time nurses ranked bedside consultation as more useful than any other means of education (Mann-Whitney U test= 142.0, P = .01). The results indicated a significant increase in the short-term quality positioning. However, after long periods of time with no education or bedside consultation from physical therapists, the positioning was less effective at each subsequent interval. The results of the study suggest the physical therapist in the role of consultant with informal bedside discussions and reflections assisted with positioning. Data revealed that physical therapy–led in-services and workshops were more effective than bedside consultation or audiovisual means. The ongoing education and reflection of developmental care processes should occur more frequently than annually to maintain knowledge and gains in consistent positioning. The findings suggest that without ongoing reflection by the nurses, the results and advancements in positioning achieved by education and consultation are lost.[12]

Two studies evaluating positional support and specific products and their use had similar findings. One study was conducted to determine the effectiveness of 2 positional supports on neurobehavioral and postural development with 27 preterm infants.[13] Nurses were educated on the 2 positioning methods prior to initiation of the study. The infants were evaluated in 2 groups, the Coconou and the home-cocoon group, with a pre- and posttest on admission and just prior to discharge that evaluated physiologic, orthopedic, and postural positions. A single, trained, blinded examiner performed the evaluations without support around the infant. The home-cocoon group received standard preterm nursing care with soft rolled-up sheets positioned close to the infant to maintain hip flexion. The Coconou group used a commercially designed positioner to adjust the boundaries around the entire infant. The positioner was to minimize shoulder and hip abduction, prevent plagiocephaly, and maintain midline positioning. The Coconou group showed significantly better relaxation in the upper extremities, unclenched hands, as well as the ability to maintain the head at midline. The home-cocoon group showed no progress for head and arm relaxation and problems with leg positions. Results of this study indicated that positioning aids that firmly contain extremities, like the Coconou group experienced, but allow for movement as well as allowing for midline focus were better for development of the infant.[13]

In a second study of positioners, Hunter[16] implemented staff education and introduced a tortoise fluid–filled positioning system. After the second audit, it was determined that fewer infants were poorly positioned and scores improved. The researcher-created tool used specific criteria for scoring position with gestational age and corrected gestational. Nursing staff responded well to the education and implementation of the new equipment by self-reported questionnaire. Infants had improved sleep and appeared more settled. A major limitation of this study was lack of randomization and control in the design. The study design was descriptive and included an author-devised audit tool.[5]

Attitudes of healthcare professionals toward positioning of preterm infants were explored.[14] Findings included that neonatal nurses and speech, physical, and occupational therapists agreed that positioning is an important part of the care they provide for premature infants. Sixty-two percent of the nurses and 86% of the therapists identified the Dandle ROO as the best positioner. The other positioners studied were all rated lower by nurses and therapists. No other studies have been conducted to support evidence of 1 superior positioning method.[14]

In another study using a randomized blinded trial of 100 infants, the researchers evaluated the infants on the basis of traditional positioning methods versus an alternative positioning device.[15] The alternative positioning group had less unilateral reflexes and abnormal movements than those using the traditional positioning. Traditional positioning often uses some type of physical boundary around the body and often includes swaddling with a blanket. These aids have been proven to assist the infant to maintain a more flexed position and aid in neuromuscular development. Alternative positioning refers to positioning aids made of stretchable cotton designed to allow movement and extension of extremities but recoil occurs back to the flexed position. Other alternative positioning refers to awareness of midline development and avoiding prolonged extension of the muscles and joints in the preterm infant. One major benefit of the alternative positioning is the result of coordinated symmetrical movements in the preterm infant that are important for early development.[15]

Body of evidence suggested a relationship between developmental positioning and neurodevelopmental delays.[6,13,15] Strategies for positioning and educating staff have been inconsistent, resulting in unreliable outcomes.[11,12] Further research is needed to evaluate positioning in addressing developmental abilities to improve outcomes. Gaps in knowledge and research regarding neurodevelopmental positioning and tone and flexion specifically are present. Gaps in knowledge exist regarding the effects of developmental positioning on tone, flexion, LOS, and weight gain and how to share that information with caregivers. The purpose of this study was to measure effectiveness of a developmental positioning in-service and intervention on infant LOS, weight gain, tone, and flexion compared with infants without the intervention and nursing education.

METHODS

This study design was quasi-experimental. An education in-service was provided to staff nurses, occupational therapists, and neonatal nurse practitioners on developmental positioning and the use of the Infant Position Assessment Tool (IPAT) as a reference.

Preterm infants less than 34 weeks of gestation composed the project's sample. Exclusion criteria included any physical malformation, defect, or anomaly. The control or preintervention group was made up of 50 infants that had previously been patients in the NICU. The postintervention sample was recruited from all infants with English-speaking parents admitted to a level III NICU with 40 beds and an average daily census of 30 to 32 infants over a 6-month period of time. The inclusion criteria were the same for both groups, with the infants' gestation at birth of 34 weeks or less with no physical anomaly.

Institutional review board approval was granted from both the facility and the university for the project. The intervention was a caregiver education inservice and direct care intervention that was developed according to evidence-based literature. Prior to the recruitment of participants, education of the caregivers including nurses, nurse practitioners, and physical and occupational therapists occurred by direct means. Education occurred face-to-face for staff in 30-minute sessions. Handouts, PowerPoint, and question-answer sessions were held to specify developmental positioning with the resources available in the NICU. Blankets, long flexible positioners, Dandle ROO positioners, tortles, and gel-like positioners were demonstrated. The second part of the intervention included the use of the IPAT as a reference for caregivers to assist in positioning infants. The IPAT was explained and reviewed for understanding. A laminated copy of the IPAT was placed at every bedside for reference. A champion team of staff was identified to assist as needed with positioning on the unit. The participants were then recruited as they were admitted to the NICU fitting the inclusion criteria. Facility intraventricular hemorrhage precautions were strictly adhered to according to the unit's established policy for the first week after delivery.

Data Collection Tools

The IPAT was used by L.P. to document positioning throughout the infant's hospitalization.[17] This measurement occurred intermittently as a method to ensure intervention fidelity. Author permission was received to use the tool. This tool was developed by a team of 3 researchers and Children's Medical Ventures (Philips Corporation) to standardize best practices in positioning of neonates. The researchers also evaluated the effectiveness of the tool in teaching consistent positioning.[17] Philips Corporation has copyrighted the IPAT and permission was received from the original author and Philips to use the tool. There was no relationship between the makers of these positioners and the primary investigator. Validity of the tool was established using evidence from the research and clinical expert opinions. The tool was then used with a system-wide education program focused on developmentally supportive care. Interrater reliability scores were above 90% using Fleiss' κ methodology.[17] Multiple independent reviewers evaluated 5 infants and then compared results for consistency at different points in time. The educational program used with the IPAT tool was implemented at 6 NICUs with a statistically significant increase ($P < .0001$) in compliance with developmental positioning and IPAT scores.[17]

The outcome of interest, flexion, and tone scores was measured for each infant in numeric values at discharge. It is the standard procedure in the project setting for the occupational therapist to evaluate flexion and tone of every infant at discharge using the Hammersmith Neonatal Neurological Assessment tool developed by Dr Dubowitz. The first column that correlates with 32 weeks of gestation was assigned a value of 1, the second column, 33 to 34 weeks of gestation, was assigned 2, the third column, 35 to 37 weeks of gestation, 3, and the forth column correlates with term "gestation" and was assigned a value of 4. The final column was given a value of 0 as it correlated with abnormals in each of the areas assessed for tone and flexion. The Hammersmith Neonatal Neurological Examination is a reliable tool with interrater reliability scores of intraclass correlation coefficient greater than 0.74.[18] The Hammersmith scoring was completed by the occupational therapist in the NICU just prior to discharge of every infant.

Weights in the unit were daily on bed scales that are zeroed by the nurse before weighing an infant. Scales were calibrated daily within the unit. Weight gain as an outcome was measured at discharge, as well, from infants' charts. Length of stay was measured in days, as recorded in each infant's chart. Demographic data collected were the date of birth and discharge, infant sex, gestational age at delivery, birth and discharge weight, and medical diagnoses.

Data Analysis

Descriptive statistics, including frequency, percentage, mean, and standard deviation, were used to describe demographic characteristics of the pre- and postintervention groups. An independent t test and χ^2 test were completed to compare the gender breakdown, gestational age, and birth weight between the 2 groups for significant differences. Independent t test was also used to compare the outcomes of interest: the Hammersmith score, LOS, and weight gain. Finally, an analysis of covariance analysis was completed to determine the effect of confounding variables, gender, and birth weight on the outcomes of interest.

RESULTS

A convenience sample of 70 infants that fit the inclusion criteria was used for this study. All data were organized into a data set and analyzed using SPSS version 24 software. There were 2 groups, the control or preintervention group (N = 50) and a postintervention group (N = 20). Table 1 describes the frequencies for gender, birth weight, and gestational age. The participants ranged in age at the time of admission from 23 weeks to 34 weeks of gestation

TABLE 1. Characteristics of the Preintervention and Postintervention Samples

	Preintervention N = 50		Postintervention N = 20		
Variable	**n**	**%**	**n**	**%**	***P***
Gender					$P < .05$[a]
Males	16	32	12	60	
Females	34	68	8	40	
Birth Weight in grams	*M* = 1386	SD = 444.52	*M* = 1302	SD = 561.18	$P < .05$[b]
501-1000	11	22	7	35	
1001-1500	22	44	5	25	
1501-2000	15	30	5	25	
2001-2500	1	2	3	12	
2501-3000	1	2	0	0	
Discharge Weight in grams					
1501-2000	9	18	4	20	
2001-2500	29	58	7	35	
2501-3000	9	18	5	25	
3001-3500	2	4	2	10	
3501-4000	1	2	1	5	
4001-4500	0	0	1	5	
Gestational age at birth in weeks	*M* = 7.22	SD =2.57	*M* =7.05	SD =3.50	$P < .05$[c]
23 to <24 (1)	0	0	1	5	
24 to <25 (2)	2	4	3	15	
25 to <26 (3)	3	6	0	0	
26 to <27 (4)	4	8	1	5	
27 to <28 (5)	5	10	3	15	
28 to <29 (6)	3	6	0	0	
29 to <30 (7)	11	22	2	10	
30 to <31 (8)	2	4	0	0	
31 to <32 (9)	7	14	1	5	
32 to <33 (10)	10	20	8	40	
33 to <34 (11)	3	6	0	0	
34 0/7 (12)	0	0	1	5	

[a] $P < .05, \div \chi^2_{70} = 4.667.$
[b] $P < .05, t_{68} = -0.660$
[c] $P < .05, t_{68} = 0.225$

(N = 70). The preintervention group (N = 50) was composed of 32% males and 68% females and the postintervention group (N = 20) had 60% males and 40% females. The most common diagnoses were prematurity and respiratory distress in both groups (see Table 1).

Descriptive Statistics

Table 1 displays the mean, standard deviation, and the range of gestational age at birth and birth weight for both the preintervention and postintervention samples. The postintervention sample (*M* = 7.05 where 7 = 29 to <30 weeks of gestation) was younger at birth than the preintervention sample (*M* = 7.22 where 7 = 29 to <30 weeks of gestation). The postintervention sample was slightly smaller in grams at birth (*M* = 1302.15) than the preintervention sample (*M* = 1385.94). Variance tests between groups are addressed under inferential statistics. Independent samples *t* tests were used to detect statistically significant differences between the preintervention and postintervention groups' variable of birth weight and gestational age (Table 1).

The descriptive statistics for the outcomes measures of LOS, weight gain, and tone and flexion scores reflected on the Hammersmith tool are noted in Table 2. The weight gain in the postintervention group was greater than in the preintervention group especially considering they were born earlier and weighed less to start.

The postintervention group had only IPAT scores assigned and those scores ranged from 7.2 to 11, with a minimum of 1 and a maximum score of 12 in relation to positioning at the time of the evaluation of the postintervention group. The mean IPAT score was 9.29 (*M*= 9.29, SD = 0.88). Infant Position Assessment Tool scoring that resulted in higher totals indicated that the premature infant was positioned more appropriately for neurodevelopment. This scoring was used to evaluate intervention fidelity and the nurses were able to achieve better positioning with these infants.

TABLE 2. Descriptive Statistics for Outcomes in Variables

Variable	*M*	SD
Length of stay		
Preintervention	52.88	26.7
Postintervention	68	42.75
Weight gain		
Preintervention	939.24	405.67
Postintervention	1281	575.1
Hammersmith scores		
Preintervention	3.23	0.205
Postintervention	3.28	0.52

Although the sample size for the postintervention group was small, the descriptive statistics results for these variables appeared significant and thus, inferential statistics were completed. Data revealed that the postintervention group was significantly younger and sicker than the control group. See Table 3 for independent samples *t* test of preintervention and postintervention group variables.

Inferential Statistics

Length of Stay

The mean LOS increased from the preintervention group (52.88 days) to the postintervention group (68 days). This change was not statistically significant. However, it was expected that the LOS would decrease with implementation of the positioning intervention (Table 3).

Weight Gain

Total weight gain decreased from the pre- to postintervention groups (pre: 939.24 g; post: 889.64 g). Again, this change was not statistically significant and the direction of this change was unexpected (Table 3).

TABLE 3. Independent *t*-Test Results for Pre- and Postintervention Groups: LOS, Weight Gain, Mean Hammersmith Score ($N = 70$)

	M	SD
Length of stay		
Preintervention (N = 50)	52.88	26.7
Postintervention (N = 20)	68	42.75
Weight gain		
Preintervention (N = 50)	939.24	571.52
Postintervention (N = 20)	889.64	889.64
Hammersmith scores		
Preintervention ($N = 50$)	3.22	0.21
Postintervention (N = 20)	3.28	0.52
$t_{68} = -1.471$, $P > .05$		
$t_{68} = -1.592$, $P > .05$		
$t_{68} = -0.597$, $P > .05$		

Tone and Flexion (Hammersmith)

The mean Hammersmith score for the preintervention group was slightly lower ($M = 3.22$) than for the postintervention group ($M = 3.28$). Although not statistically significant, there was a clinically significant positive correlation between IPAT scores and Hammersmith scores (see Table 1).

Gender differences were measured with a χ^2 test and revealed a statistically significant difference in the boys and the girls in the pre- and postintervention groups. Boys who are born earlier are often sicker and stay longer. If the study was carried out over a longer period of time, the difference between the number of girls and boys in each group might have been less significant. The postintervention group had a mean IPAT score of 9.29, with a standard deviation of 0.88 and a range of 7.2 to 11.

Confounding Variables

An analysis of covariance was completed to determine the effect of gender, birth weight, and gestational age on the outcomes of interest. There was a significant effect ($P = .043$) on the Hammersmith scores by the intervention after controlling for gender and gestational age. The effect size of the positioning intervention was large ($\eta = 0.994$) while gender and gestational age had just a moderate, nonstatistically significant effect (Table 4).

DISCUSSION

The literature describes positioning as important to the preterm infant's growth and development and long-term well-being.[11] The developmental positioning in-services and IPAT used in this study contributed to the understanding of positioning goals in this NICU and the best process through which to achieve them. The results of the Hammersmith scoring tool used by the occupational therapist at discharge revealed a clinically significant increase in tone and flexion in the intervention group. The IPAT and Hammersmith scores had a positive correlation showing that attention to developmental positioning does affect tone and flexion. The literature shows a relationship between education of caregivers on positioning and the prevalence of neurodevelopmental outcomes. This study addressed the education aspect and found a relationship between the intervention of positioning and outcomes after educating the nurses and other NICU caregivers on positioning options and goals. The results support the literature findings that education and positioning affect long-term outcomes.

Limitations of this study included a variety of factors. Small postintervention sample size was a limitation. Parental consent to evaluate infants with the IPAT was

TABLE 4. Tests of Between-Subjects Effects

	Mean Hammersmith: Source					
Dependent Variable	**Type III Sum of Squares**	***df***	**Mean Square**	***F***	**Significance**	**Partial η^2**
Corrected model	5.151[a]	17	0.303	25.604	.038	0.995
Intercept	1.958	1	1.958	165.468	.006	0.988
Gender	0.047	1	0.047	4	.184	0.667
Admission gestational age	0.053	1	0.053	4.5	.168	0.692
Post-intervention IPAT tool mean	4.042	15	0.269	22.772	.043	0.994
Error	0.024	2	0.012			
Total	220.444	20				
Corrected total	5.175	19				

[a]*R^2 = 0.995 (adjusted R^2 = 0.957).*

Summary of Recommendations for Practice and Research

What we know:	• Neurodevelopment is interrupted with premature deliveries. • Environmental stimuli can be harmful to growth and neurodevelopment and affect length of stay. • Education of caregivers in NICU is essential to ensure developmental positioning understood. • Environmental stimuli can be minimized with decreased noise, light, stimulation. • NICU stays and care after discharge by PT/OT are costly.
What needs to be studied:	• Effect of teaching caregivers about positioning and how they position after. • How often education needs to happen with hospital staff to ensure adherence to attention to developmental positioning.
What can we do today:	• Realize that preterm infants are at risk for deficits. • Provide developmentally appropriate care to all preterm infants all of the time. • Position infants purposefully in a flexed, midline position, with attention to neurodevelopment.

challenging to obtain. The NICU also experienced low census during the collection of data phase of the study. The significant results could be a type 2 error due to inadequate sample size. Getting nurses to commit to be a champion of positioning was challenging. Resources on all shifts to ask about positioning were scarce.

Implications for Practice

In this pilot project, LOS, weight gain, and tone and flexion scores were evaluated for infants before and after the intervention. With greater structure and consistent attention to interprofessional NICU teams' approaches to developmental positioning with any resources that are available, outcomes are positively affected. Annual or more frequent education to identify positioning practices and enhance current knowledge of positioning and its importance in neurodevelopment of preterm infants is warranted to assist caregivers.

References

1. National Perinatal Association (2010). Position paper: NICU developmental care. http://www.nationalperinatal.org/resources/Documents/Position%20Papers/NICU%20Development%20Care%20pdf.pdf. Published 2010. Accessed February 2018.
2. Centers for Disease Control and Prevention (n.d.). Births and Natality. https://www.cdc.gov/nchs/fastats/births.htm. Published 2018.
3. March of Dimes. The global problem of premature birth. http://www.marchofdimes.org/mission/the-global-problem-of-premature-birth.aspx. Accessed February 2017.
4. Kornhauser M, Schneiderman R. How plans can improve outcomes and cut costs for preterm infant care. *Manag Care.* 2010;19(1):28-30. https://www.managedcaremag.com/archives/2010/1/how-plans-can-improve-outcomes-and-cut-costs-preterm-infant-care.
5. McKinney E, James S, Murray S, Nelson K, Ashwill J. *Maternal-Child Nursing*. 4th ed. St Louis, MO: Elsevier Saunders; 2013.
6. Legendre V, Burtner PA, Martinez KL, Crowe TK. The evolving practice of developmental care in the neonatal unit: a systematic review. *Phys Occup Ther Pediatr.* 2011;31(3):315-338. doi:10.3109/01942638.2011.556697.
7. Symington A, Pinelli J. Developmental care for promoting development and preventing morbidity in preterm infants. *Cochrane Database Syst Rev.* 2006;(2):CD001814. doi:10.1002/14651858.CD001814.
8. Hunter J, Lee A, Altimier L. Neonatal intensive care unit. In: Case-Smith J, O'Brien JC, eds. *Occupational Therapy for Children and Adolescents.* 7th ed. St Louis, MO: Elsevier Mosby; 2015:595-634.
9. Ohlsson A, Jacobs SE. NIDCAP: a systematic review and meta-analyses of randomized controlled trials. *Pediatrics.* 2013;131(3):e881-e893. doi:10.1542/peds.2012-2121.
10. Newborn Individualized Developmental Care and Assessment Program [NIDCAP]. NIDCAP mission and vision. http://nidcap.org/en/about-us/nfi/mission/.
11. Laudert S, Liu WF, Blackington S, et al. Implementing potentially better practices to support the neurodevelopment of infants in the NICU. *J Perinatol.* 2007;27(suppl 2):S75-S93. doi:10.1038/sj.jp.7211843.
12. Perkins E, Ginn L, Fanning JK, Bartlett DJ. Effect of nursing education on positioning of infants in the neonatal intensive care unit. *Pediatr*

Phys Ther. 2004;16(1):2-12. doi:10.1097/01.PEP.0000112916.38869.5E.
13. Vaivre-Douret L, Golse B. Comparative effects of 2 positional supports on neurobehavioral and postural development in preterm neonates. *J Perinat Neonatal Nurs*. 2007;21(4):323-330. doi:10.1097/01.JPN.0000299790.47161.5c.
14. Zarem C, Crapnell T, Tiltges L, et al. Neonatal nurses' and therapists' perceptions of positioning for preterm infants in the neonatal intensive care unit. *Neonatal Netw*. 2013;32(2):110-116. doi:10.1891/0730-0832.32.2.110.
15. Madlinger-Lewis L, Reynolds L, Zarem C, Crapnell T, Inder T, Pineda R. The effects of alternative positioning on preterm infants in the neonatal intensive care unit: a randomized clinical trial. *Res Dev Disabil*. 2014;35(2):490-497. doi:10.1016/j.ridd.2013.11.019.
16. Hunter A. The use of clinical audit in successfully implementing a change of clinical practice in developmental positioning. *Infant*. 2015;11(5):155-159. Retrieved from http://web.a.ebscohost.com.libproxy.troy.edu/ehost/pdfviewer/pdfviewer?sid=c5a845cf-75e8-4ec4-8f87-a038c4b1e041%40sessionmgr4007&vid=8&hid=4101.
17. Coughlin M, Lohman B, Gibbins S. Reliability and effectiveness of an infant positioning assessment tool to standardize developmentally supportive positioning practices in the neonatal intensive care unit. *Newborn Infant Nurs Rev*. 2010;10(2):104-106. doi:10.1053/j.nainr.2010.03.003.
18. Eeles AL, Olsen JE, Walsh JM, et al. Reliability of neurobehavioral assessments from birth to term equivalent age in preterm and term born infants. *Phys Occup Ther Pediatr*. 2016;37(1):108-119. doi:10.3109/01942638.2015.1135845.