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The effects of alternative positioning on preterm infants in the neonatal intensive care unit: A randomized clinical trial

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There is a paucity of studies that have investigated the developmental benefits of positioning in the neonatal intensive care unit. The purpose of this study was to investigate the effects of a new, alternative positioning device compared to traditional positioning methods used with preterm infants. In this randomized, blinded clinical trial, one hundred preterm infants (born $\leq$32 weeks gestation) from a level III neonatal intensive care unit in the United States were enrolled at birth. Participants were randomized to be positioned in the alternative positioning device or to traditional positioning methods for their length of stay in the neonatal intensive care unit. Infants were assessed using the *NICU Network Neurobehavioral Scale* between 35-40 weeks postmenstrual age. Clinical and feeding outcomes were also captured. Linear and logistic regressions were used to investigate differences in neurobehavioral outcome, feeding performance, and medical outcomes. Infants in the alternative positioning arm of the study demonstrated less asymmetry of reflex and motor responses on the *NICU Network Neurobehavioral Scale* ($p = 0.04$; adjusted mean difference = 0.90, 95% CI 0.05–1.75) than those positioned using traditional positioning methods. No other significant differences were observed. Reduction in asymmetry among preterm infants is an important benefit of alternative positioning, as symmetrical movement and responses are crucial for early development. However, it will be important to follow this sample of preterm infants to determine the effects of early positioning on neurodevelopmental outcome in childhood.

1. Introduction

Due to advances in perinatal and neonatal care, survival rates for preterm infants have increased (Field, Dorling, Manktelow, & Draper, 2008); however, the risk for neurodevelopmental impairment remains high (Bhutta, Cleves, Casey, Cradock, & Anand, 2002; Schmidhauser, Caflisch, Rousson, Bucher, & Latal, 2006). Preterm infants have an increased risk for cerebral palsy, motor problems, and cognitive delays (Aarnoudse-Moens, Smidts, Oosterlaan, Duivenvoorden,

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& Weisglas-Kuperus, 2009; Aarnoudse-Moens, Weisglas-Kuperus, van Goudoever, & Oosterlaan, 2009; de Kieviet, Piek, Aarnoudse-Moens, & Oosterlaan, 2009). These infants often exhibit neurobehavioral (self-regulation, state control, reflex development, muscle tone and movement) impairments that can be detected by term equivalent age while the infant is still hospitalized in the neonatal intensive care unit (NICU; Brown, Doyle, Bear, & Inder, 2006; Daily & Ellison, 2005; Korner, Constantinou, Singer, & Zeskind, 2001; Pineda et al., 2012). Additionally, preterm infants often experience feeding difficulties due to global neurodevelopmental impairment and problems with behavioral organization (Arvedson, Clark, Lazarus, Schooling, & Frymak, 2010; McCain, 2003). This can negatively impact sucking patterns and coordination of suck, swallow, breathe during oral feeding. Assessments for early neurobehavior and feeding have been developed for the high risk infant in the NICU, and early identification can inform the need for early therapeutic interventions.

One of the earliest neurodevelopmental interventions in the NICU is therapeutic positioning. The third trimester in the uterus, which is missed in part or whole by premature infants, promotes the ideal, flexed position when the infant is crowded by the uterine environment and experiences rapid brain growth, mediating flexion (arms and legs bent and trunk tucked forward) and midline orientation (Waitzman, 2007). Positioning in physiological flexion (flexion of the shoulders, hips, and knees, scapular protraction, and posterior pelvic tilt) is the ideal position of the newborn, as it promotes proper joint alignment and symmetry, supports neuromuscular development, and promotes self-soothing and behavioral organization (Aucott, Donohue, Atkins, & Allen, 2002). However, premature infants lack tonal responses and strength at birth, and they often assume extended (straight) positioning of the neck, back and extremities (Groot, 2000; Sweeney & Gutierrez, 2002). Extended positioning can affect acquisition of developmental motor skills, hinder self regulation (Hill, Engle, Jorgensen, Kralik, & Whitman, 2005), and may interfere with oral feeding skills. One study found that children born preterm were more likely to demonstrate extension in the trunk which interfered with sitting posture and significantly influenced mobility, promoted asymmetry, and decreased hand function at 1 year of age (Samsom & DeGroot, 2000). Goals of neonatal positioning with the preterm infant include not only promoting flexion, but also can include prevention of head flattening and external rotation of the hips and promotion of midline orientation to prevent asymmetrical posture and movement (Vergara & Bigsby, 2004). However, no research has been conducted investigating the effects of neonatal positioning on long term outcome.

NICU professionals have attempted to increase flexion of the premature infant through positioning aids (Vaivre-Douret, Ennouri, Jrad, Garrec, & Papiernik, 2004). Traditional positioning aids, such as swaddling and boundaries placed around the body, are used in the NICU to facilitate and maintain flexion and midline orientation. Swaddling is associated with improved neuromuscular development (Aucott et al., 2002; Short, Brooks-Brunn, Reeves, Yeager, & Thorpe, 1996), decreased startles, improved sleep (Gerard, Harris, & Thach, 2002), decreased stress, and improved self regulation during handling (Neu & Browne, 1997). Cloth boundaries around the infant relate to improved motor behavior and postural development (Vaivre-Douret & Golse, 2007), improved movement across midline, and decreased abrupt movements (Ferrari et al., 2007). Additionally, researchers using a traditional positioning protocol for preterm infants concluded that infants who were positioned appropriately had more variation in the velocity of movements and brought hands to midline more than infants who had not received a positioning protocol (Nakano, Kihara, Nakano, & Konishi, 2010).

In addition to use of blankets and boundaries, there are many commercially available products that are used to position preterm infants in the NICU. Commercially available positioning aids that have been used with preterm infants include, but are not limited to, the Snuggle Up (Phillips) and Bendy Bumper (Phillips), which aim to promote flexion and containment. The Sleep Sack (HALO) may also be used to aid temperature regulation and promote safe sleep practices. Currently, there is limited research on commercially available products, despite their widespread use.

Alternative positioning aids made of stretchable cotton that are designed to provide containment, while allowing the infant to move the extremities into extension followed by recoil back to flexion, have been introduced in the NICU. Although used in many NICUs across the United States and in Europe, no studies to date have examined the effects of these alternative positioning devices. However, results from a recent research survey indicated that the majority of nurses and therapists surveyed perceived that alternative positioning was the easiest type of positioning to use and the most beneficial for preterm infants (Zarem et al., 2013). The purpose of this trial was to compare the neurobehavioral and medical outcomes of preterm infants in the NICU positioned with the alternative positioning device compared to preterm infants positioned using traditional methods.

2. Materials and methods

2.1. Participants

This randomized clinical trial enrolled 100 consecutive admissions of preterm infants born $\leq$32 weeks gestational age. Infants with congenital anomaly were excluded. Infants were randomized to receive either the alternative positioning device or traditional positioning upon admission to the NICU. Following admission, but within the first week of life, parents gave informed consent to enroll their infant in the study. This investigation was approved by the Human Research Protection Office of the study site.

2.2. Study setting

This study took place in a 75-bed, level III NICU and in an affiliated 20 bed, Level II NICU, in an urban area of the Midwestern United States from January 2011 to December 2011.

2.3. Interventions

Infants were randomly assigned to be positioned using the alternative positioning device or traditional positioning methods for their entire NICU hospitalization. Prior to study initiation and over a period of 3–4 weeks, nursing staff who were responsible for day-to-day care of the infants were educated by members of the research team through presentations and bedside demonstrations on how to correctly position participants in each arm of the study. Parents, when present at bedside, were also instructed by members of the research team and by nursing staff. Ongoing education occurred as needed throughout the study. At each participant's bedside, signage was posted with positioning instructions, and a contact number was provided to call when there were challenges. Upon notification, the research team would go to the bedside and demonstrate proper positioning to nursing staff and parents.

Infants were placed in their assigned positioning whenever lying in the bed and when not being held or fed. If an infant needed to be removed from the assigned positioning for medical reasons or due to staff or parent compliance or error for greater than 2 h, staff recorded the time out of positioning in a bedside log. The research team also maintained a separate record of times out of the assigned positioning. Members of the research team checked that each participant was in the assigned positioning during random times at least 3 times per week to ensure that each infant was positioned correctly. The total number of times out of the assigned positioning for > 2 h was tracked.

2.3.1. Alternative positioning

The alternative positioning device used for this study was the Dandle Roo by DandleLion Medical, Danbury Connecticut, United States (Dandle Lion Medical, 2012, August 8). The Dandle Roo (Fig. 1a) is a structured blanket made of stretchable, organic cotton with adjustable straps for the upper extremities, a pouch for the lower extremities, and a head boundary. The pouch is made with a specific seam construction to hold the legs in a weight-bearing, flexed position, while allowing for movement with recoil back to flexion. A cloth roll is used for additional support, and a gel pillow aims to optimize head shaping. Infants assigned to the alternative positioning group were positioned in the Dandle Roo when lying in the isolette and graduated to the Dandle Wrap (Fig. 1b) when they were transitioned to an open crib. The Dandle Wrap is designed for larger infants and does not include the gel pillow, cloth roll, or head piece.

2.3.2. Traditional positioning

Traditional positioning consisted of any positioning devices or adaptations made to the isolette or crib without the use of the alternative positioning devices. In the study setting, this typically consisted of swaddling, the Snuggle Up (Phillips), Bendy Bumper (Phillips), the Sleep Sack (HALO), and/or use of blankets and cloth rolls in specific ways to facilitate containment and comfort (Fig. 2).

2.4. Randomization

Participants were randomly assigned following simple randomization procedures (computerized random numbers), which assigned infants to 1 of 2 treatment arms (alternative or traditional positioning methods). In order to maintain similar gestational ages throughout the two groups, participants were stratified by gestational age (<28 weeks and ≥28 weeks). Each stratum had an independent randomization scheme. Prior to the first participant being enrolled, the randomization assignment was determined and indicated in a sealed envelope.

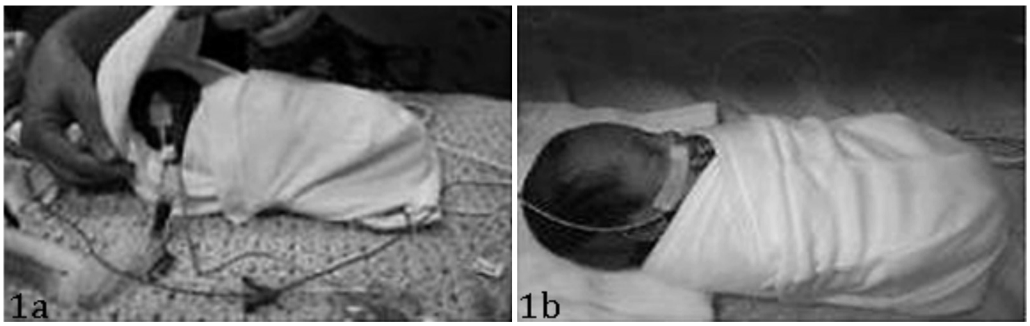

Fig. 1. (a and b) Dandle Roo and Dandle Wrap. Caption: Photos courtesy of DandleLion Medical (19).

Fig. 2. Traditional positioning.

2.5. Outcomes

Between 35-40 weeks PMA, infants underwent neurobehavioral testing using the *NICU Network Neurobehavioral Scale* (*NNNS*) by a single, certified blinded rater. This rater is a PhD educated, national board certified occupational therapist with over 20 years of experience evaluating preterm infants. The evaluation was conducted approximately 25 min prior to a scheduled hands-on care time. Five minutes before the evaluation, a member of the research team removed the infant from the assigned positioning and removed signs at the bedside that identified the positioning arm to ensure that the evaluator was blinded to group assignment. Feeding assessment with the *Neonatal Oral Motor Assessment Scale* (*NOMAS*) was also conducted and scored by the same rater. Additional clinical outcomes, such as days to achieve full oral feeds, days on the ventilator, days on oxygen, and post menstrual age at discharge were collected from each infant's medical record.

2.5.1. Neurobehavioral assessment

The *NNNS* is a 115 item neurobehavioral assessment tool developed to assess high risk infants (Lester & Tronick, 2004), which requires certification. This tool is a comprehensive assessment available for use with preterm infants (Sullivan, Miller, Fontaine, & Lester, 2012). The 115 items from the *NNNS* were scored and entered into a computer program syntax, which appropriately weighs each item and generates 13 summary scores: habituation, orientation, tolerance of handling, quality of movement, self regulation, non-optimal reflexes, stress signs, arousal, hypertonia, hypotonia, asymmetry, excitability, and lethargy. Habituation was not assessed as part of this study, as these items involve testing the infant before he/she is unwrapped and awake, and the blinding procedure prior to *NNNS* evaluation often resulted in waking the infant. Internal consistency of each subscale is moderately strong ranging from 0.56 to 0.85 (Ferrari et al., 2007; Lester & Tronick, 2004; Lester et al., 2002; Vaivre-Douret & Golse, 2007). Each summary score is on its own scale and ranges, means and standard deviations for full term infants are available for comparison. Higher scores indicate more of the given construct, with higher scores indicating better performance for orientation, tolerance of handling, quality of movement, self regulation, and arousal. Lower scores indicate better performance for non-optimal reflexes, stress signs, hypertonia, hypotonia, asymmetry, excitability, and lethargy. The 12 subscale scores were used as dependent variables.

2.5.2. Feeding assessment

The *NOMAS* (Palmer, Crawley, & Blanco, 1992) is a feeding assessment that consists of 28 observations of normal and abnormal jaw and tongue movements that are observed during the first two minutes of an oral feeding. Infant feeding is categorized as: normal (able to coordinate suck, swallow, breathe), disorganized (unable to coordinate suck, swallow, breathe), or dysfunctional (displaying tongue and jaw movements that disrupt feeding). The *NOMAS* has modest internal consistency (Cronbach's $\alpha > 0.70$) and convergent validity (Spearman's $r = 0.51–0.69$; Howe, Sheu, Hsieh, & Hsieh, 2007). Raters must be certified to administer the *NOMAS*. The categorical score generated from the *NOMAS* was used as a dependent variable. The *NOMAS* is one of the only assessments available to assess neonatal feeding in high risk infants in the NICU.

2.5.3. Clinical outcomes

Postmenstrual age (PMA) at discharge (in weeks), days of ventilation, days of supplemental oxygen, days to full oral feeds, and length of stay (in weeks), in addition to the treatment for necrotizing enterocolitis (a common disorder of prematurity in which there is death of intestinal tissue; stress is thought to play a role), confirmed sepsis, and brain injury were collected from each infant's medical record. To conduct sub-analyses, younger gestational age was dichotomized as infants born <28 weeks gestation, with older gestational ages being those born ≥28 weeks gestation. Infants with brain injury were those with any of the following: grades III–IV intraventricular hemorrhage (bleeding into the ventricular system in the brain), cystic periventricular leukomalacia (damage to cells in the brain's white matter leaving empty areas which fill with fluid), or cerebellar hemorrhage, which were defined by routine cranial ultrasound or magnetic resonance imaging.

2.6. Sample size

Power calculations based on the *NNNS* outcome estimated a minimum needed sample size of 86 (43 infants per group) to detect a medium effect with 80% power and $\alpha = 0.05$. A medium effect was chosen, as it was felt that neonatal positioning would not result in large effects, and smaller effects could be related to the variability in medical course of the sample. To account for attrition, 100 infants were enrolled in the study. To recruit this number of participants, a 12-month inclusion period was anticipated.

2.7. Statistical analysis

Statistical analysis was performed using the Statistical Analysis System (SAS) software program. First, homogeneity of groups was determined by investigating differences in gestational age at birth, race, sex, maternal marital status, length of stay, and time out of the assigned positioning using independent samples *t*-tests and chi square analyses ($\alpha < 0.05$). Factors that were different across groups were controlled for while investigating neurobehavioral and medical differences across treatment arms using linear and logistic regression modeling ($\alpha < 0.05$). Sub-analyses were conducted to investigate the effects among infants born at younger versus older gestational ages, as well as among infants with and without brain injury, using stepwise Bonferroni adjustment due to multiple comparisons.

3. Results

Consecutive inborn admissions meeting inclusion criteria were recruited for the study from January 2011 to November 2011. See Table 1 for sample characteristics. Fifty one percent ($n = 51$) were randomized to the alternative positioning group, and 49% ($n = 49$) were assigned to the traditional positioning group. Of the 100 infants enrolled, 4 expired and 4 withdrew, leaving 92 infants. Gestational age at birth ranged from 23 to 32 weeks with a mean of 28.7 ± 2.7 weeks gestation. Mean length of stay was 10.0 ± 6.0 weeks. Average days intubated was 8.5 ± 17.0. There were 42.4% ($n = 39$) of infants who were male, 59.8% ($n = 55$) of infants who were African American, and 81.5% ($n = 75$) of infants who were born to a single mother.

There were no significant differences in baseline or acquired conditions across groups (see Table 1), except gestational age at birth ($p = 0.02$). Subsequently, gestational age at birth was controlled for in all statistical analyses. The number of times that the infant was not in the assigned positioning (due to nursing compliance, error, or medical reasons) ranged from 0-7 with a mean of 0.87 (1.6). Seventy percent ($n = 65$) of infants did not have any documented times out of the assigned positioning. The number of times outside of the assigned positioning also differed across groups ($p = 0.02$); therefore, number of times out of the assigned positioning was controlled for in the statistical model. Due to the potential impact of length of stay (amount of positioning treatment), analyses were re-run controlling for length of stay, and the findings remained largely unchanged.

Infants in the alternative positioning group demonstrated less asymmetry [adjusted mean difference 0.90 (0.05, 1.75); $p = 0.04$] during neurobehavioral testing. Analyses were re-run controlling for PMA at the time of assessment, and the findings remained unchanged. No other significant differences in *NNNS* summary scores, *NOMAS* scores, or acquired medical factors were detected between positioning arms (Table 2).

On sub-analysis, infants who were born ≥ 28 weeks gestation who were positioned in the alternative positioning demonstrated less asymmetry [adjusted mean difference 2.15 (0.94–3.37); $p = 0.01$], compared to infants in traditional positioning. Infants without brain injury who were positioned in the alternative positioning demonstrated less asymmetry

Table 1
Baseline and acquired factors of the sample.

	Traditional positioning ($n = 44$) Mean (*SD*) or *n* (%)	Alternative positioning ($n = 48$) Mean (*SD*) or *n* (%)	*p* Value[†]
Baseline factors			
Gestational age at birth (Weeks)[a]	29.4 (2.8)	28.0 (2.5)	0.02[*]
Race (African American)	25 (56.8%)	30 (62.5%)	0.67
Sex (male)	17 (38.6%)	22 (45.8%)	0.53
Single parent household	36 (81.8%)	38 (79.2%)	0.8
Acquired factors			
Necrotizing enterocolitis	3 (6.8%)	4 (8.3%)	0.9
Confirmed sepsis	12 (27.3%)	14 (29.2%)	0.9
Brain injury	10 (22.7%)	7 (14.6%)	0.4
Out of positioning for >2 h on at least one occassion[a]	7 (15.9%)	20 (41.7%)	0.02[*]

[a] Gestational age at birth and number of times out of positioning were controlled for in the multivariate model when investigating differences across treatment groups.
[*] $p < 0.05$.
[†] *p* values were derived from chi square and independent samples *t*-tests investigating differences across groups.

Table 2
Neurobehavioral and medical outcomes for alternative and traditional positioning.

	Traditional ($n = 44$) Mean ± *SD*	Alternative ($n = 48$) Mean ± *SD*	†Mean difference (95% CI)	†Adjusted mean difference (95% CI)
NNNS				
Orientation	3.76 ± 1.19	3.53 ± 1.01	0.23 (−0.026, 0.71)	0.16 (−0.36, 0.67)
Tolerance of handling	0.65 ± 0.13	0.71 ± 0.14	−0.06 (−0.12, 0.00)	−0.04 (−0.10, 0.02)
Quality of movement	3.03 ± 0.77	3.11 ± 0.71	−0.08 (−0.38, 0.23)	−0.04 (−0.037, 0.28)
Self regulation	4.36 ± 0.84	3.92 ± 0.88	0.44 (0.08, 0.79)*	0.30 (−0.06, 0.67)
Sub-optimal reflexes	6.59 ± 2.51	7.52 ± 2.16	−0.93 (−1.90, 0.04)	−0.53 (−1.45, 0.39)
Stress	0.39 ± 0.09	0.40 ± 0.13	−0.01 (−0.06, 0.04)	0.00 (−0.05, 0.05)
Arousal	3.69 ± 0.95	3.77 ± 1.02	−0.09 (−0.50, 0.32)	−0.14 (−0.57, 0.28)
Hypertonia	1.55 ± 1.27	1.71 ± 1.29	−0.16 (−0.69, 0.37)	−0.06 (−0.61, 0.49)
Hypotonia	1.07 ± 0.97	1.13 ± 1.23	−0.06 (−0.52, 0.41)	0.08 (−0.41, 0.56)
Asymmetry	1.13 ± 1.23	2.56 ± 1.90	0.57 (−0.26, 1.41)	0.90 (0.04, 1.75)*
Excitability	5.34 ± 2.47	6.33 ± 2.99	−0.99 (−2.13, 0.15)	−0.95 (−2.16, 0.26)
Lethargy	7.50 ± 3.13	7.38 ± 2.96	0.13 (−1.14, 1.39)	0.39 (−0.89, 1.68)
Medical				
PMA at discharge (weeks)	39.11 ± 4.55	39.14 ± 3.86	−0.03 (−1.77, 1.72)	1.32 (−0.24, 2.88)
Days of ventilation	39.14 ± 3.86	9.23 ± 17.62	−1.57 (−8.65, 5.51)	4.28(−1.55, 10.10)
Total O2 days	34.00 ± 43.49	49.88 ± 53.19	−15.88 (−36.11,4.36)	6.20(−6.15, 18.54)
Days to full oral feeds	50.55 ± 28.22	61.63 ± 33.20	−11.08 (−24.20, 2.24)	0.94 (−5.30, 7.17)
Length of stay (weeks)	9.32 ± 6.37	10.69 ± 5.67	−1.37 (−3.86, 1.13)	1.11 (−1.43, 3.65)

* $p < 0.05$. Gestational age at birth and number of times out of positioning were controlled for in the multivariate model investigating differences across treatment groups.
† Mean differences and confidence intervals were derived from linear and logistic regression modeling investigating differences across groups.

[adjusted mean difference 1.30 (0.34–2.26); $p = 0.01$], compared to those in traditional positioning. Infants with brain injury also demonstrated less self regulation [adjusted mean difference 0.90 (0.25–1.58); $p = 0.01$] in the alternative positioning group, compared to those using traditional positioning.

4. Discussion

The key finding of this study is that neonatal positioning of the preterm infant in the NICU can have important developmental effects. Preterm infants positioned in alternative positioning during NICU hospitalization demonstrated less asymmetry by hospital discharge, compared to infants positioned with traditional positioning methods. This is the first study to report the effects of alternative positioning on the preterm infant in the NICU.

Less asymmetry on the *NNNS* reflects differences in the strength of reflexes, muscle tone, and power of active movements on each side of the body. Having symmetrical muscle tone, reflexes, and responses bilaterally is important for early development (Neu & Browne, 1997; Zlatanović, Lazić, Marinković, & Stanković, 2010). Positioning of the preterm infant in the NICU has been cited as an important factor in shaping and aligning the musculoskeletal system, which may have implications for later motor development (Sweeney & Gutierrez, 2002). Previous research has demonstrated improvements in midline orientation and movement patterns among infants positioned in a nest, swaddled, and positioned in the Coconou (Ferrari et al., 2007; Vaivre-Douret & Golse, 2007). This study further contributes to the literature on the benefits of different methods of neonatal positioning by demonstrating an advantage of alternative positioning.

Early reflex development and movement patterns rely on the position of the head, and although not fully ascertained, it is suspected that the improved symmetry may be related to improvements in maintaining the head in midline orientation. The alternative positioning used in this study aims to maintain the infant in a symmetrical, flexed and midline oriented position. Midline head orientation can also be important for preventing hemodynamic changes in the brain that can be implicated in adverse outcome (Ancora et al., 2009). While the long term effects of neonatal positioning are important to investigate, there is currently no available research on long term outcomes. Further research is warranted to establish the contribution of flexed positioning with midline head positioning versus midline head positioning alone to advance the understanding of advantageous neonatal positioning. This cohort will be followed until age 3, and long term effects of neonatal positioning will then be investigated.

The benefits of less asymmetry in infants positioned in alternative positioning were also appreciated on sub-analyses, investigating the effects in infants who were born at later gestational ages and who were free of brain injury. This may demonstrate the importance of neonatal positioning, even in low risk groups of preterm infants. In contrast, infants with brain injury who were in the alternative positioning arm of the study demonstrated less self regulation, which was an unexpected finding. Although the finding of decreased self regulation on the *NNNS* is concerning, self regulation was not assessed outside of the neurobehavioral testing. One study found that infants with brain injury cried less when swaddled (Lester & Tronick, 2004; Ohgi, Akiyama, Arisawa, & Shigemori, 2004), therefore it is possible that infants were comfortable and regulated between care times, but demonstrated poorer self regulation on examination when removed from the confines of optimal positioning. More research is needed to better define optimal positioning for infants with brain injury.

Several possible limitations to this study should be noted. Despite randomization, gestational age at birth was different across groups and, therefore, was controlled for in all statistical models. A difference in number of times outside of the assigned positioning for >2 h was also significant between the two groups. Infants could not be placed in the alternative positioning during periods of acute medical observation and phototherapy, which could have contributed to more time out of the assigned positioning. However, time outside of positioning was also observed in the infants in the traditional positioning arm. Alternative positioning was introduced at the study site approximately 6 months prior to the study start date, and many staff had formed opinions about what type of positioning was best for preterm infants and may have had difficulty following the study protocol. Therefore, ongoing staff education and support with positioning interventions was provided throughout the study. In addition, this study is limited due to its use of medically fragile preterm infants, in which there can be confounding medical complications that are associated with neurobehavioral status. Although there were no differences in medical factors across groups, future research could better isolate the effects of specific interventions through the study of low risk preterm infants. In addition, these findings may not generalize to NICUs with less acuity. It also remains unclear how less asymmetry at one time point prior to NICU discharge translates to later function. It will be important to follow this cohort and determine short term neurodevelopmental outcome in early childhood.

5. Conclusion

The findings of this study suggest that the effects of positioning are evident before NICU discharge and that effective positioning can reduce asymmetry in preterm infants. More research is needed to better define what types of positioning are developmentally beneficial for preterm infants in the NICU across hospitalization.

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