

Improving Developmental Positioning in a Level III NICU Using Evidence-Based Teaching and a Standardized Tool: An Evidence-Based Quality Improvement Project

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Disclosure. The author(s) have no relevant financial interest or affiliations with any commercial interests related to the subjects discussed within this article.

Column editor: Cindy C. Howe, MSN, RN

Funding. The author(s) received no specific grant or financial support for the research, authorship, and/or publication of this article.

ABSTRACT

Positioning and handling is a core measure of developmental care that has been universally difficult to implement in the technical NICU environment. Appropriate positioning has been shown to not only improve postural and musculoskeletal outcomes, but enhance sensory development, physiologic stability, thermal regulation, behavioral organization, sleep facilitation, and brain development. In order to improve the developmental positioning practices of bedside nurses in a level III neonatal intensive care unit, a quality improvement project was initiated. Guided by the Iowa Model for Evidence-Based Practice, this project included an evidence-based educational intervention and a standardized positioning assessment tool. After the intervention, there was improvement in knowledge scores, and positioning scores increased from an average of 8.81 +/- 0.19 to 10.93 +/- 0.15.

Keywords: education; evidence-based practice; NICU care; quality improvement; development

Throughout the last century, medical and surgical management of the preterm and critically ill newborn has been transformed by the introduction of lifesaving treatments and revolutionary medical interventions.¹ These advancements have significantly reduced mortality in this fragile patient population.² However, because they must complete their development outside the protective uterine environment, many

of these infants have impaired short- and long-term outcomes. Even in the absence of obvious impairments, there is now abundant evidence that these infants can have difficulties that persist into adolescence and young adulthood.³ To mitigate these unfavorable outcomes, caregivers must provide age-appropriate strategies to create a developmentally supportive environment for the preterm or sick newborn.¹ Developmental

Accepted for publication
May 4, 2022

care is a concept aimed at preventing or lessening the potential negative outcomes associated with an extended NICU stay.^{4,5}

BACKGROUND

The first framework for neonatal developmental care was created by Heidelise Als, and was based on her Synactive Theory of Development.^{6,7} This framework centers around recognizing and mitigating a neonate's stress behaviors. Building on Als' framework, Gibbons et al.⁸ created the Universe of Developmental Care Model. This model provides a practical basis for formulating care within the NICU's complex technical environment. In 2011, the National Association of Neonatal Nurses published the first guidelines for the practice of developmental care titled *Age-Appropriate Care of the Premature and Critically Ill Hospitalized Infant*.⁹ These guidelines identified 5 core measures to ensure that optimal, evidence-based developmental care was being provided within the NICU. More recently, Altimier and Phillips² expanded on previous literature and designed the Neonatal Developmental Care Model. This model identifies 7 core measures to help simplify essential concepts and provide practical guidance for staff on how to deliver neuroprotective, family-centered, developmental care. These 7 core measures are: (1) a healing environment, (2) partnering with families, (3) positioning & handling, (4) safeguarding sleep, (5) minimizing stress and pain, (6) protecting skin, and (7) optimizing nutrition.^{2,10}

For almost 4 decades, the philosophy of developmental care has evolved, through the efforts of numerous practitioners, researchers, and authors, who have made it their life's work to improve the outcomes for the preterm and critically ill neonate.¹¹ Yet, despite supporting evidence, implementation of developmental care within the NICU has been inconsistent across settings and caregivers.^{2,11} The struggle to consistently and reliably merge the tenets of developmental care with the medically-driven needs of the neonate is an ongoing challenge.¹ This article describes a project focused on appropriate positioning, which is one aspect of developmental care that has been historically difficult to implement in the technical NICU environment.^{1,2,4}

In 2018, our NICU in a medium-sized community hospital, began a large, multi-year Continuous Quality Improvement project titled the Very Low Birth Weight (VLBW) Project. In collaboration with a large nearby university, the VLBW project focuses on 2 aspects of neonatal care that urgently need improvement, especially as they pertain to the smallest and most fragile infants.¹² These 2 critical areas of focus are the neurological development of the infant and the psychosocial trauma the family inevitably experiences. These issues are inextricably interrelated such that the well-being of the infant is impacted at every step by the health, well-being, and caregiving capacity of the family. The first phase of the VLBW project focused on improving the developmental care practices within our NICU. Using the core measures

identified by Altimier and Phillips², nurses were assigned to 1 or 2 champion groups. Each group was tasked with designing and implementing an evidence-based plan for improved delivery of their assigned core measure. Here we describe the project for the champion group assigned to the core measure *positioning and handling*.

The Iowa Model for Evidence-Based Practice was chosen as a framework for the execution of the positioning and handling project.¹³ The Iowa Model was chosen because of its clear and concise steps organized to guide nurses as they plan evidence-based practice change. In order to chronicle the development and implementation of our project, 6 steps of the Iowa Model have been used as subheadings within this article. They are: (a) identify the problem or trigger, (b) appraise, critique and synthesize the relevant research, (c) state the question or purpose, (d) design, plan, and pilot evidence-based change in practice, (e) integrate and sustain the change, and (f) disseminate the results.¹³

METHODS

This project took place in a 22-bed, level III NICU at a central California community hospital. In 2019, there were 258 admissions to the NICU, of which 85 were born <35 weeks gestation. The unit is staffed by 47 registered nurses, and 3 full-time and 3 per diem neonatologists.

The VLBW project obtained approval from the hospital's Institutional Review Board. The positioning and handling group's project was deemed a quality improvement component to the larger project, and received approval for data and image use by the hospital's Data Use Committee (19-51nq). Parental consent was obtained for photographs of infants.

Identify the Problem or Trigger

Our NICU has utilized educational interventions, positioning products, and policy changes over the last several years to improve the unit's use of developmental positioning. Generally, these measures demonstrated improvement, but they were short-lived and inconsistent among caregivers. Since the long-term outcomes of positioning and handling cannot be measured until years and even decades after the infant has been discharged, the Positioning Champion Team hoped to assure that evidence-based practice was being consistently performed by the NICU staff.

Assemble and Appraise the Evidence

The literature was appraised to obtain the most recent and robust interventions for developmental positioning and handling, and to ensure there was adequate evidence supporting its use.

Age-appropriate positioning for the preterm newborn involves keeping the infant in a flexed, midline, and contained position, mirroring how the baby would have been positioned in the womb.¹⁴ Utilization of positioning aids, blanket rolls, etc. can help maintain the infant in a position with optimal tone and posture (Figures 1 and 2).

Figure 1 ■ Infant positioned side-lying.



Developmental positioning has been shown to improve postural and musculoskeletal outcomes.^{1,2} An infant's motor interaction with the environment is instrumental for appropriate musculoskeletal growth and drives completion of the motor system.¹⁵ Appropriate positioning enhances sensory development, physiologic stability, behavioral organization, sleep facilitation, and brain development.¹⁰ Flexion and containment increases an infant's feelings of security, decreases stress, and reduces excessive energy expenditure.^{6,10} While it is fairly obvious how positioning affects musculoskeletal and sensory development, its benefits on the brain are a little less apparent.

An innate and fascinating feature of the human brain is high susceptibility to environmental influences, known as plasticity. Plasticity is thought to be one of the primary mechanisms through which humans adapt to change and demonstrate resilience.¹⁵ During the last 17 weeks of gestation, plasticity is greatest because the neurologic system is in a critical and rapid developmental period. This is when the basic architecture of the brain is being constructed via organization and integration of functional neuronal networks.^{16,17} Processes such as synaptogenesis, synaptic reorganization and pruning, and myelination of axons are fundamental to assuring mature brain function and neuronal connectivity. Although it is a great advantage for humankind, plasticity renders developing neurocircuitry more vulnerable to adverse events, such as chronic environmental stress. Stress can disrupt the structural connectivity of the brain which supports communication between critical brain regions.¹⁸ Appropriate positioning and handling is an intervention that can buffer the effects of the stressful NICU environment.¹⁶ The beauty of plasticity is that it works both ways. Although the developing brain is undoubtedly altered by stressful experiences, it is also shaped by positive experiences.^{15,17} There is a growing body of research highlighting the effects that caregiving and environment have on the developing neurological system.^{10,15,16} Family members should be coached in ways to support the infant and be the primary buffer to the infant's stress.^{15,16} Developmental strategies such as facilitated tucking, swaddling, hand containment, and keeping the infant

Figure 2 ■ Infant positioned prone.



flexed, contained, and midline are some of the many evidence-based interventions that can be implemented to moderate stress and are easily taught to parents.¹⁶

In nursing, it has been shown that standardized assessment tools assist in the transfer of knowledge, implementation of best practices, and are used to evaluate the effectiveness of interventions.¹⁹ This project's evidence search included looking for a reliable and validated measurement tool. The positioning assessment tool with the most supporting evidence was the Infant Positioning Assessment Tool (IPAT), created by Coughlin et al.²⁰ The IPAT is a pictorial tool that evaluates an infant's position in 6 areas of the body (head, neck, shoulders, hands, hips/pelvis, and knees/ankles/feet). A 2-point scoring system is used on each of the 6 areas of the body, with a score of 2 for ideal positioning, 1 for acceptable positioning, and 0 for unacceptable positioning.^{14,20} A full score of 12 indicates perfect positioning, scores of 9 to 11 are acceptable, as technology interfaces often prevent perfect positioning and symmetry. Scores below 9 indicate a need for improvement. After development of the IPAT, the authors utilized the tool along with an educational intervention at 6 NICUs. All of the NICUs demonstrated statistically significant increases in their mean IPAT scores 13 months after the education was completed.²⁰ The IPAT is pictured in Figure 3.



















Figure 3 ■ Infant Positioning Assessment Tool (IPAT).

Infant Positioning Assessment Tool (IPAT)

Patient's name: _____ Birth gestational age/corrected gestational age: _____

Clinician's name: _____ Date/time of assessment: _____

Infant position: Supine Side-lying Prone

Indicator	0	1	2	Score
Head	 <p>Head rotated laterally (L or R) > 45° from midline</p>	 <p>Head rotated laterally (L or R) 30 - 45° from midline</p>	 <p>Head aligned (L or R) 0 - 30° from midline</p>	
Neck	 <p>Neck in hyperextension or hyperflexion</p>	 <p>Neck neutral</p>	 <p>Neck neutral, aligned, head slightly flexed forward 10°</p>	
Shoulders	 <p>Shoulders retracted</p>	 <p>Shoulders aligned, flat to surface</p>	 <p>Shoulders rounded forward towards midline</p>	
Hands	 <p>Hands away from body</p>	 <p>Hands touching torso</p>	 <p>Hands touching face</p>	
Hips/pelvis	 <p>Hips/pelvis abducted, externally rotated</p>	 <p>Hips/pelvis aligned but extended</p>	 <p>Hips/pelvis aligned and softly flexed</p>	
Knees/ankles/feet	 <p>Knees extended, ankles and feet externally rotated</p>	 <p>Knees, ankles, feet aligned but extended</p>	 <p>Knees, ankles, feet aligned and softly flexed</p>	
<p>12 = ideal cumulative score. 9 - 11 = acceptable cumulative score. ≤ 8 = need for repositioning.</p>				Total cumulative score

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Note: Permission to use the Infant Positioning Assessment Tool granted by Philips HealthTech, Cambridge, MA, USA.

Other researchers have emulated this strategy, and endeavored to improve NICU positioning and handling by combining the use of the IPAT with an educational intervention. Jeanson²¹ measured IPAT scores at baseline, and then again, after one-to-one bedside education. The IPAT mean score increased after education, although not enough to reach statistical significance. However, due to noticeable clinical improvements in positioning practices, Jeanson concluded that the IPAT paired with education was an effective tool for improving developmental positioning practices. Spilker et al.²² used the IPAT and bedside education to improve their staff's proficiency in, and utilization of, developmental positioning. After education, although their scores did not reach their desired goal of 10 to 12, the overall increase in mean IPAT scores was statistically significant. Charafeddine et al.²³ and Masri et al.²⁴ describe projects aimed at improving positioning practices in the NICU. Even though neither achieved their goal score of 9, both demonstrated statistically significant improvement in their mean IPAT scores. Painter et al.²⁵ describe a quasi-experimental study to evaluate the effectiveness of a positioning intervention in an NICU. The sample comprised 70 preterm infants currently in the NICU, and the control group was comprised of former NICU infants. Education on positioning and the IPAT was used to help the staff understand positioning goals and the best process through which to achieve them. At discharge there was an increase in the tone and flexion of infants in the intervention group as compared to the control group. In addition, there was a positive relationship between the use of positioning interventions before, versus after education.²⁵ This literature suggests that the IPAT paired with an educational intervention can be successful for positioning practice improvement.

State the Question or Purpose

The project's objective was decided. We aimed to improve the nurses' competency in, and utilization of, developmental positioning, as evidenced by the following post-intervention goals:

- a) an increase in nursing knowledge assessment scores,
- b) an increase in the mean score per the IPAT, and
- c) a mean IPAT score of 9 or above.

INTERVENTION

Design and Pilot the Practice Change

In May of 2019, the Positioning Champions received education on infant positioning from a developmental positioning product representative. This education was done in small groups of 3 to 5 nurses and allowed for hands-on practice, discussion, and feedback. Following the team's education, a tutorial and 8 question multiple choice test were created aiming to disseminate the knowledge obtained from the champions' education and from the abundant articles read on the subject matter. A second goal of the tutorial was to give the nurses a chance to become familiar with the IPAT and the positioning products available in our unit. In creating

the tutorial, it was crucial to choose learning strategies that were evidence-based. In the same way that it is essential for patient care to be based on best evidence, strategies used to educate nurses must also be based on best evidence.²⁶ The evidence-based learning strategies gleaned from available literature and utilized in this project are as follows:

- **Use active learning:** There is a growing body of research highlighting how active learning strategies can promote deeper levels of information processing than those achieved through traditional passive learning approaches. Defined as learning activities that engage students, active learning encourages students to think deeply about what they are doing.²⁷
- **Educate in small groups and allow hands-on practice:** Delivering education in small groups and with hands-on practice are active learning strategies that have been recommended to improve the education and competency of healthcare employees. Small-group education fosters a safe environment to practice skills, ask questions, receive feedback, and reinforce theory.^{28,29}
- **Share the rationale:** An important step in practice change or improvement, is sharing information and helping the staff understand the rationale behind the change.³⁰
- **Champion Evidence-Based Practice (EBP):** EBP has long been accepted as the best approach to healthcare, and it has been shown that nurses in the clinical setting are persuaded by the evidence. Yet integrating EBP into clinical practice can be challenging. Education needs to strengthen beliefs about the value of EBP.^{31,32}
- **Make the intervention feasible:** Implementation of the intervention needs to be realistic; nurses need to feel they are capable of adding it to their practice. Education should address ways that nurses can embed the intervention into their daily cares.³³
- **Focus on outcomes:** Ownership is key to successful integration of EBP into practice, and nurses have been shown to be persuaded by patient outcomes. It is important to show the patient outcomes from the literature that have been proven to occur after the intervention.³³
- **Address barriers:** Barrier assessment is essential when attempting to implement EBP. Barriers cited from the literature should be addressed and discussed.³²

Pretests were completed by the nursing staff in May and June of 2019. Between July 1, 2019 and September 1, 2019, staff nurses were provided with the 15- to 20-minute tutorial, utilizing the evidence-based strategies listed above. Following the tutorial, nurses were asked to complete a posttest that was identical to the pretest. All NICU nurses ($N = 41$) actively working between July 1, 2019 to November 16, 2019 were educated on developmental positioning. Six nurses were on maternity, medical, or family leave during this time. The Positioning Champions ($n = 10$) were educated as indicated above, prior to developing the educational intervention. The remaining nurses ($n = 31$) were provided with the tutorial and took the pre- and post-education tests.

Baseline observations per the IPAT were performed from April 1, 2019 to June 21, 2019. To eliminate interrater bias, one member of the positioning team did all the IPAT observations for the project. These observations were performed randomly, at the rater's convenience. On days when workflow allowed, the rater scored all infants currently in the NICU, whose gestational age at birth was <35 weeks. The rater was diligent about observing some infants on dayshift and some on nightshift. The shift on which an infant was scored, was based on the rater's availability and on infant status (e.g. if an infant was having a procedure, being held, or engaged in hands-on care, they were not scored at that time). An infant was never scored more than once per day, and they were not scored during, or immediately after cares were done. A total of 85 observations were done on 19 infants. The gestational age range of these infants was 23 weeks to 34 weeks (mean 31 weeks).

To validate competency, the rater and another member of the positioning champion team observed and scored a small sample of infants, simultaneously, yet independently. A total of 10 infants were observed on 4 separate occasions during a 5-week time span. These infants were not a part of the pre-or post-education dataset, yet they possessed the same inclusion and exclusion criteria (i.e. <35 weeks gestation at birth and not observed during or immediately after cares). These infants were selected at random from the NICU census on days when it was convenient for the 2 raters to perform the observations. The absolute difference in the raters' scores never varied by more than 1 interval (IPAT scores can range from 1 to 12). The mean IPAT score given by the project's rater was 9.5 or 79.2% (9.5/12), and the mean IPAT score given by the comparable rater was 9.7 or 80.8% (9.7/12). This showed an absolute difference between raters of 1.6%, indicating they concurred 98.4% of the time.

After education, IPAT data were collected in a manner identical to the pre-education data, and by the same, single rater. The post-education observations were done from September 11, 2019 to November 16, 2019. A total of 94 observations were done on 18 infants. The gestational age range of these infants was 24 weeks to 34 weeks (mean 32 weeks).

RESULTS

Analyses were conducted using R version 4.0.3 (R Core Team) and SciPy version 1.6.3 on Python. Nurse knowledge scores were subjected to a paired samples *T*-test to assess for significant improvement in knowledge among nurses who underwent training. IPAT data were subjected to an independent samples *T*-test to test for significant improvement in positioning following education.

On average, nursing knowledge improved significantly from pre-education intervention ($M = 7.30$, $SE = .16$), to post-education intervention ($M = 7.78$, $SE = .10$), $t(26) = -2.80$, $p < .01$, 95%CI (-.83, -.13). The mean IPAT score significantly improved from pre-education

intervention ($M = 8.81$, $SE = .19$), to post education intervention ($M = 10.9$, $SE = .15$), $t(117) = 8.78$, $p < .001$, 95% CI (1.6195, 2.5605). The post-education mean IPAT score achieved the project's goal of greater than 9.

DISCUSSION

This project demonstrated that evidence-based teaching coupled with a standardized assessment tool, improved the NICU nurses' knowledge and utilization of developmental positioning. Using a validated tool provided clarity and increased consistency in care. Seeing the IPAT audits being done served as a reminder to staff to utilize correct positioning practices and provided additional education and reinforcement in the form of direct feedback. The tutorial was interactive so that learners could actively participate and provide input. The evidence-based educational component was developed and disseminated by bedside nursing staff, which made the content more relevant to the learners.³⁰ Peer to peer education created an openness that may not have been present in a classroom setting. This may have contributed to nurses being more receptive to new ideas. The safety of a small group (groups of 1 to 3) allowed the learners to become active participants in developing their own skills and perspectives.²⁹ Education of 100% of the nursing staff was crucial to the success of the project.

Integrate and Sustain the Practice Change

Sustaining these practice changes is the ultimate goal and challenge of this project. These improvements require ongoing evaluation, and all of the NICU team members' awareness to promote true integration of the practice into daily care. Our plan for sustainability includes the following items that have already been implemented:

- The developmental positioning policy was updated to include all of the tenets of best practice learned during this project.
- The Positioning Champions will continue to support and encourage the use of developmental positioning and handling.
- The tutorial with small-group teaching and hands-on practice will be repeated every other year, and with new staff members during orientation. On the "off" year, a positioning and handling PowerPoint will be presented at a staff meeting.
- One month before the biyearly tutorial occurs, a pretest will be given to the nursing staff. The posttest will follow the tutorial.
- The tutorial and PowerPoint will be reviewed at least once per year, to assure the evidence is current, and to add new information as it arises.
- Colorful IPAT posters have been hung at each bedside.
- IPAT audits will be repeated every other year on a convenience sample of infants to assure that goals are continuing to be met. These will be done before and after the biyearly tutorial in the same manner as the project. This

data will be assessed, and plans for improvement made as needed.

Several other ideas to support sustainability that we hope to implement include:

- Implementation of a developmental newsletter focused on all tenets of developmental care. For example, the newsletter might contain short teaching bullets and reminders, humor, puzzles, reviews of evidence and practices, and new literature on developmental care.
- Respiratory therapists and physicians will be included in the education.
- The tutorial and accompanying PowerPoint will be updated to include more information on handling, more parent teaching strategies, and better guidelines for transitioning infants to “Back to Sleep” protocol.
- A developmental journal club will be organized to support developmental practice improvements and encourage staff members to champion EBP and developmental care.

These sustainability measures have the goal of keeping the NICU caregivers cognizant of developmental positioning. It is hoped that staff enthusiasm might be cultivated for development of similar projects, and that our NICU team will become EBP champions, who look to the literature to guide their practice.

Disseminate the Results

The sharing of important information about research results, QI projects, and EBP initiatives enriches the nursing profession, and benefits humanity.³⁴ This foundational spirit of sharing is a key element of nursing practice. Project implementation and results have been shared in several outlets, both internal and external to the hospital. First, results were shared during a staff meeting, making sure to thank the nurses and praise them for this obvious improvement in nursing practice. Next, we designed and displayed a poster at our hospital’s Magnet Celebration. After, we presented a poster at a national neonatal nursing conference. Lastly, the writing of this manuscript is our continued attempt to disseminate the results of the project. While the combination utilized (IPAT and education), has been implemented with varying amounts of success over the last few years, we hope that bringing strong evidence into our educational component may strengthen this time-tested duo.

CONCLUSION

This evidence-based quality improvement project was done to improve the developmental positioning practices utilized in our Level III NICU. This was achieved by using an educational intervention and a validated positioning assessment tool. Results of the project demonstrated statistically significant improvements in both nursing knowledge and nursing infant positioning practice.

ACKNOWLEDGEMENTS

We gratefully thank Cottage Children’s Medical Center NICU staff; VLBW and Parental Support Project Leadership: Steven Barkley, MD, Katherine Chung, MD, Jennifer Ferrick, MSN, RN, Liz Lundquist, RN, and George HS Singer, PhD; The James S. Bower Foundation; and the University of California, Santa Barbara.

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