Newborn & Infant Nursing Reviews 15 (2015) 6–16

Contents lists available at ScienceDirect

Newborn & Infant Nursing Reviews

journal homepage: www.nainr.com

Articles

The Wee Care Neuroprotective NICU Program (Wee Care): The Effect of a Comprehensive Developmental Care Training Program on Seven Neuroprotective Core Measures for Family-Centered Developmental Care of Premature Neonates

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ARTICLE INFO

Keywords:
Neonatal intensive care
Neuroprotection
Developmental care
Premature
Infants
Core measures
Nurse training
Education

ABSTRACT

The impact of neuroprotective care on preterm infants has been investigated at length, yet professional development and training related to this type of care has not been extensively examined. The Wee Care Neuroprotective NICU program (Wee Care; Philips Healthcare, Andover, MA), a comprehensive developmental care training program (Philips Healthcare) is an evidence-based total change management program designed to optimize the neonatal intensive care unit (NICU) environment and caregiving practices. The Wee Care Neuroprotective NICU program is based on a recently developed Neonatal Integrative Developmental Care Model (© Koninklijke Philips N.V., 2014. All rights reserved).), which utilizes a holistic approach in describing seven core measures for neuroprotective family-centered developmental care of premature neonates of the lotus flower. The seven core measures are depicted on petals of a lotus as the Healing Environment, Partnering with Families, Positioning and Handling, Safeguarding Sleep, Minimizing Stress and Pain, Protecting Skin, and Optimizing Nutrition. The overlapping petals of the Neonatal Integrative Developmental Care (IDC) model IDC model demonstrate the integrative nature of neuroprotective care (Fig. 1). Items on the inside of the lotus flower represent core measure 1, the Healing Environment; which highlight the significance of the developing sensory system, as well as the physical environment in which the neonate now lives. The aim of this quality improvement project was to determine the effect of the comprehensive Wee Care Neuroprotective NICU program (Wee Care) on seven neuroprotective core measures for neuroprotective family-centered neuroprotective developmental care of premature neonates. The sample consisted of 81 hospital NICU sites from 27 US states as well as Belgium and the Netherlands which had implemented the Wee Care comprehensive neuroprotective care training program and had completed pre- and post-site surveys. A secondary data analysis of the extant Wee Care database of pre and post-testing surveys was done to evaluate the training program. The results demonstrated that the Wee Care Neuroprotective NICU training program was effective in improving seven neuroprotective core measures for family-centered developmental care of premature neonates. Each core measure as well as the overall composite core measures score (core measures 1–7) showed statistically significant improvement post training ($p < .001$). The positive impact of the Wee Care program was independent of the level of NICU, the type of hospital, the presence of a labor and delivery service, or the program year of implementation. The Wee Care Program has been shown to be beneficial based on seven neuroprotective core measures for neuroprotective family-centered developmental care of premature and sick neonates. The transformational training program incorporates evidence-based literature, and standardizes clinical practices for all staff, therefore enhancing consistency in quality. The program improves overall neonatal care and practices and should be widely implemented in NICU's wanting to enhance neuroprotective care of premature and/or sick infants.

Neuroprotective developmentally supportive care includes creating a healing environment that manages stress and pain while offering a calming and soothing approach that keeps the whole family involved in the infant's care and development.[1–3] Neuroprotective developmental care is grounded in support by research from a number of disciplines including nursing, medicine, neuroscience, and psychology.[4–7] Improvements in health outcomes, lengths of stays, as well as hospital costs have been documented when neuroprotective education and subsequent change of care practices were implemented.[4–10] Although there

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http://dx.doi.org/10.1053/j.nainr.2015.01.006

is evidence demonstrating that a comprehensive program that addresses neonatal intensive care unit (NICU) design, experience design and workflow, unit policies, staff training, and transformational change within a quality improvement framework can positively impact preterm infant brain development and long-term outcomes, a review of this literature reveals a lack of research addressing professional development on this topic. Since neonatal nurses are the primary caregivers in the NICU, they are in a key position to influence the environment of the developing neonate, as well as therapeutic interventions. For the implementation of neuroprotective developmental care to be successful, all NICU staff must have the knowledge and skills to effectively implement this care and there must be cooperation and collaboration between all health care providers as well as ancillary and support staff. Additional organizational support from the C-suite, the entire leadership team (nursing, medical, allied health, and support services) is warranted. Researchers continue to investigate specific neuroprotective interventions with recommended strategies to attenuate the potentially adverse effects of the neonatal intensive care unit environment on both the immediate and long-term outcomes of the preterm infant and family. Despite evidence of short- and long-term benefits of developmental care, several studies documented nurses' lack of knowledge of developmental care.[5] Because professional practices are such a key component of neuroprotective developmental care, it is crucial to design and offer attractive and effective training programs that can not only standardize neuroprotective developmental care approaches to neonatal care among all staff, but ultimately improve infant and family outcomes.[6] Because the implementation of a neuroprotective care approach demands that NICU staff acquire new knowledge and skills, it is surprising to note that very little has been published on developmental care training programs and their evaluation.[4–13]

Background

The Wee Care Neuroprotective NICU program (Wee Care; Philips Healthcare, Andover, MA) is an 18-month developmental care training program which was established in 1997 to provide comprehensive neuroprotective family-centered developmental care education and training for healthcare professionals who care for high-risk infants and their families on a daily basis. The Wee Care Neuroprotective NICU Program; which trains all NICU staff has been shown to improve noise and light levels in the NICU, improve infant medical outcomes, improve staff satisfaction/engagement, improve family satisfaction, decrease length of stay (LOS), and decrease hospital costs.[4–9]

The Wee Care educational component is a multiday structured program in neuroprotective family-centered developmental care that provides on-line eLearning, didactic education and hands-on interactive workshops to interprofessional healthcare staff who care for premature and sick infants, as well as their families in the NICU setting. This training and consultative program is an evidence-based quality improvement program designed to optimize the NICU environment and caregiving practices in order to facilitate the best outcomes for premature infants and their families. This unique program combines evidence-based practices with seven neuroprotective core measures for family-centered developmentally supportive care aimed at standardizing neuroprotective care practices in the NICU. This is achieved and sustained by incorporating transformational change methodology into the training program. Each of the seven core measures, (Healing Environment, Partnering with Families, Positioning and Handling, Safeguarding Sleep, Minimizing Stress and Pain, Protecting Skin, and Optimizing Nutrition), have neuroprotective interventions that promote normal development and prevent disabilities.[1,2] Details of each core measure including its definition, related standards, desired infant characteristics, goals, and identified neuroprotective interventions to achieve optimal developmental care practices are provided in Appendix A.[14–27]

Prior to training, the Wee Care lead educator/consultant assessed the hospital's current facility and care practices with data captured on an in-depth site assessment survey tool. The site assessment tool was originally developed by William G. Cvetnic, MD, in collaboration with other Wee Care consultants and has demonstrated inter-rater reliability.[4] This tool was the first of its kind to quantify neuroprotective family-centered developmental care practices in the NICU; which enhanced the validity and reliability of the study. Data compiled provide an ideal score for each neuroprotective core measure as well as an overall score, which serves as a comparative reference point to Wee Care sites for benchmarking against other Wee Care facilities as well as documenting individual unit progress.

After completion of the pre-site assessment, the lead educator/consultant evaluated the hospital needs related to the strengths and weaknesses of the Neonatal IDC model's seven core measure findings to design a program tailored to balance weaker areas with stronger areas. An interprofessional team of expert clinical educators provided an 8-hour didactic and interactive program with a balanced practical overview of neuroprotective developmentally supportive care theories and practices. Staff trained in the Wee Care Neuroprotective NICU Program consisted of any and all staff who touch, care for, or are in the environment of infants in the NICU, such as NICU registered nurses (RNs), neonatal nurse practitioners (NNPs), physicians (pediatricians, fellows, residents, and attending neonatologists), occupational, physical and speech therapists, respiratory therapists (RTs), nursing assistants/technicians, lactation consultants, pharmacists, social workers, case managers/discharge planners, as well as ancillary support staff, such as unit secretaries, housekeepers, x-ray technicians, and unit assistants. Staff confidentiality was upheld throughout all educational programs and this study.

A leadership workshop followed the on-site training component to educate unit champions on the development of goals, action plans, with measurable outcomes through the plan–do–study–act quality improvement process. The progress of goal attainment was monitored monthly through team meetings via phone or on-site. The Wee Care educators worked with staff for a minimum of 1 year after the didactic and hands-on workshops in order to ensure the integration of neuroprotective family-centered developmental care practices into daily practice. On-site clinical and leadership follow-up visits were scheduled at various intervals throughout the implementation year. The final follow-up visit for each site took place approximately 12 months after the training intervention was implemented and included the completion of the same pre-site assessment survey instrument.

This study builds on and extends existing research to determine whether the Wee Care Neuroprotective NICU Program based on the Neonatal IDC model had an effect on seven neuroprotective core measures (CM) for family-centered developmental care.[2]

Design and Methods

Setting/Sample

The sample included eighty-one ($N = 81$) level II (12%) or level III (84%) NICU sites from 27 US states as well as Belgium and the Netherlands. All level II designated NICUs were affiliated with a level III “sister” hospital NICU or network. Sixty percent of the NICU sites were academic teaching units compared to 40% that were non-teaching community settings. Seventy-nine percent of the NICUs were associated with a labor and delivery (L & D) service and 21% were stand-alone children's hospitals. To assess for any secular trends, the NICU sites were separated into 5-year categories by implementation program years in which 30% of the Wee Care Neuroprotective NICU Programs took place from 1995 to 1999; 32% from 2000 to 2004; 30% between 2005 and 2009; and 8% thus far in the years of 2010–2013. Characteristics of participating NICU sites are shown in Table 1. The NICUs' bed sizes ranged from 6 to 100 beds with anywhere from 15 to 500+ staff being trained in each NICU or NICU network. All of these

Table 1
Characteristics of participating NICU sites.

Characteristics	%
NICU level	
Level II	16
Level III	84
Hospital type	
Academic teaching	60
Community non-teaching	40
Labor and delivery service	
Yes	79
No	21
Program year	
1995–1999	30
2000–2004	32
2005–2009	30
2010–2013	8
	$N = 81$

NICUs had implemented the Wee Care Neuroprotective NICU Program and had completed pre- and post-site surveys.

The Northeastern University's Institutional Review Board (IRB) approved this study. Hospital confidentiality was upheld throughout the study. The expectation was to identify if any of the 7 core measures scores improved, were unchanged, or negatively impacted so that the training program could be modified and improved.

Instrument

The Wee Care assessment survey consists of questions/observations related to 7 neuroprotective core measures which are scored utilizing a Likert scale ranging from 0 to 5 (higher scores demonstrate better practices). Each core measure is assigned a score of increasing value reflecting the unit's developmental care practices across all seven core measure domains which correlate to idealized quantifiable developmental care practices: Healing Environment ($n = 44$); Partnering with Families ($n = 40$), Positioning and Handling ($n = 36$), Safeguarding Sleep ($n = 20$), Minimizing Stress and Pain ($n = 14$), Protecting Skin ($n = 10$), and Optimizing Nutrition ($n = 16$), with an overall ideal composite score equaling 180. Ideal maximum scores for each core measure and composite core measures 1-7 are highlighted in Table 2. This tool was revised in 2011 with the same questions; however, the questions were mapped to the 7 specific core measure categories with quantified scores in each category for comparison of results.

Data Collection

The pre-site survey was completed 4–8 weeks prior to the Wee Care Neuroprotective NICU Program training implementation, and the post-site survey 12–14 months after the on-site educational intervention by one of four lead educators/consultants trained in the use of the Wee Care survey tool (inter-rater reliability = 0.98). All data were then entered into a final excel secure database for secondary analysis in order to examine changes in the overall core measure composite pre-site vs. post-site scores, as well as each individual pre and post-site core measure score.

Data Analysis

Descriptive univariate, bivariate and correlational analyses were done on the aggregated pre-site and post-site scores for each of the seven core measures and for the composite core measures scores. Statistical significance for the differences in pre/post scores was tested with the Student's t-test. Additional ANOVA analyses were done to determine if there was an association with the level designation of the NICU, the type of hospital, the presence of a labor and delivery service, or the year of the training (by 5 year-intervals). Number Crunching Statistical Software (NCSS) version 7 software was used to conduct the statistical analyses. Statistical significance was set at $p < .05$.

Results

Results showed that each individual core measure represented in the Neonatal Integrative Developmental Care Model resulted in significant improvements, as well as the overall composite core measures score (CM 1–7) ($p < .001$). Percent changes in each pre- and post-site

Table 2
Ideal Maximum Scores for 7 Neuroprotective Core Measures of Wee Care.

Survey categories	Descriptions of Wee Care categories	Ideal score
CM 1 Healing Environment	• Review of established & implementation of policies/procedures/protocols/guidelines • Measurement of noise levels (decibels/dB) • Measurement of light levels (foot candles/FTC) • Facilitate early, frequent, and prolonged skin-to-skin care	44
CM 2 Partnering with Families	• Assessment of: - Dignity and respect for families through open family access and participation in care - Collaboration, communication and information - Thoroughness of parental education	40
CM 3 Positioning and Handling	• Evaluation of infants' positioning (midline, flexion, containment) in supine, sidelying, and prone positions • Observation of staffs' handling and caregiving of neonates • Provide swaddling when bathing & weighing	36
CM 4 Safeguarding Sleep	• Assessment of care provided around: - Infant sleep–wake states - Cycled lighting - Controlled lighting at the level of the infants' eyes - Facilitate early, frequent, and prolonged skin-to-skin care	20
CM 5 Minimizing Stress & Pain	• Provide tummy-time/prone-to-play time routinely for infants that are Back-to-Sleep • Provide non-pharmacologic support (positioning, containment, swaddling, pacifier, and sucrose) with all minor invasive interventions • Utilization the use of a validated and reliable pain assessment tool	14
CM 6 Protecting Skin	• Assessment and management of skin integrity, thermoregulatory practices, and positioning and handling appropriate to protect the infant's vulnerable skin • Utilize a validated and reliable skin assessment tool	10
CM 7 Optimizing Nutrition	• Assessment of interventions that optimize nutrition • Incorporation of infant readiness cues, quality of nippling, and caregiving scale with feeding encounters • Support breastfeeding mothers in feeding at the breast, as well as pumping	16
Total CM 1–7 Composite Score	Total composite core measures 1–7 score	180

Table 3
Pre- and post-site score results for core measures 1–7 variables.

Variable	Pre-test		Post-test		T-test	*p*-Value
	Mean	*SD*	Mean	*SD*		
Core measure 1 Healing Environment	18.44	10.48	29.67	11.58	−6.46	<.001*
Core measure 2 Partnering with Families	23.15	5.71	29.14	5.82	−6.60	<.001*
Core measure 3 Positioning and Handling	10.32	4.99	20.94	4.15	−14.73	<.001*
Core measure 4 Safeguarding Sleep	6.95	3.33	12.00	3.59	−9.28	<.001*
Core measure 5 Minimizing Stress and Pain	6.53	2.72	10.19	2.31	−9.22	<.001*
Core measure 6 Protecting Skin	3.58	1.90	6.60	1.86	−10.24	<.001*
Core measure 7 Optimizing Nutrition	4.48	2.10	9.26	2.52	−13.10	<.001*
Composite CM 1–CM 7	73.46	22.85	117.79	23.35	−12.21	<.001*

* Statistically significant.

core measure score also increased substantially for each core measure. The comparative mean scores, SDs and results of ANOVAs between pre- and post-test scores for each core measure as well as the overall composite (CM 1–7) are presented in Table 3. There was a 28% increase for Partnering with Families (CM 2), an 89% increase for Healing Environment (CM 1) and Minimizing Stress and Pain (CM 5), a 118% increase for Protecting Skin (CM 6) and Safeguarding Sleep (CM 4), a 153% increase for Optimizing Nutrition (CM 7), and a 180% increase for Positioning and Handling (CM 3) (Fig. 2).

The ANOVA results of selected program characteristics (level of NICU, hospital type, presence of labor and delivery service, and 5-year intervals of program implementation) are provided in Tables 4–7, respectively. There were no statistical differences in any core measure related to level of NICU designation (Table 4), academic teaching vs. community non-teaching status of the NICU (Table 5), or the presence of a labor and delivery service (Table 6). The variability of the means and standard deviations of each core measure across the four time intervals of the program year interval, as well as the total program years, are reflected in Table 7. Three core measures [Healing Environment, ($F = 2.98$; $p < .04$); Partnering with Families ($F = 3.25$; $p < .04$) and Protecting Skin ($F = 3.19$; $p < .03$)] were statistically significant due to an increase in the fourth program year interval.

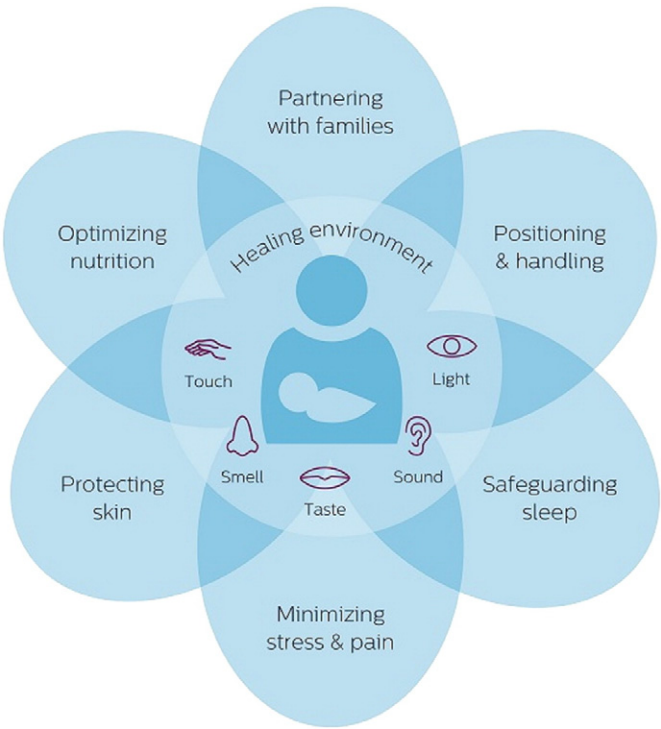

Fig. 1. Neonatal Integrative Developmental Care Model © Koninklijke Philips N.V., 2014. All rights reserved.

Discussion

The findings demonstrate that the Wee Care Neuroprotective NICU Program was effective in improving practices within each of the seven neuroprotective core measures resulting in significantly improved scores for each core measure as well as significant improvement in the overall composite score (CM 1–7) for neuroprotective family-centered developmental care of premature and sick neonates. Infant, family, staff, and hospital outcomes also improved post-training for hospitals that had established dashboards with metrics that were tracked. The Wee Care Neuroprotective NICU Program is unique in that it seeks to educate and train the entire interprofessional NICU team in a very consolidated period of time. This is important since professional care practices are key components of developmental care and providing consistent, uniform care is not possible without uniformity in attitudes, behaviors and practices. Unit-wide implementation of the Wee Care Neuroprotective NICU Program among all disciplines at once is a way to avoid the experience of many isolated developmental care specialists who have found it frustrating and ineffective to attempt a major change in unit culture and practices on a case by case basis over time in order to implement neuroprotective family-centered developmental care. Transformational change management augments the Wee Care Program by hardwiring practice changes over time.

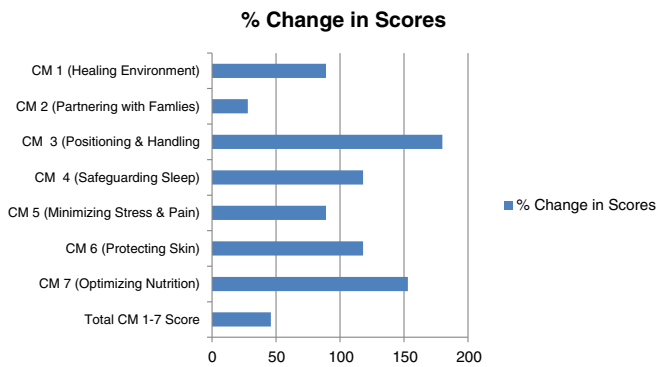

Fig. 2. Percent change in CORE measure scores.

Table 4
Mean core measures related to level of NICU designation.

Variables	Level II NICU $n = 13$		Level III NICU $n = 68$		All NICUs $N = 81$		F ratio	*p* value
	Mean	*SD*	Mean	*SD*	Mean	*SD*		
CM 1 Healing Environment	7.54	3.1	11.9	8.3	11.2	7.8	3.55	.06
CM 2 Partnering with Families	5.7	2.7	6.0	2.8	6.0	2.8	0.18	.68
CM 3 Positioning and Handling	10.2	4.1	10.7	4.0	10.6	4.0	0.14	.71
CM 4 Safeguarding Sleep	4.4	2.1	5.2	2.4	5.0	2.4	1.22	.27
CM 5 Minimizing Stress and Pain	3.8	1.5	3.6	1.4	3.7	1.4	0.10	.75
CM 6 Protecting Skin	3.1	1.4	3.9	1.2	3.0	1.2	0.03	.87
CM 7 Optimizing Nutrition	4.7	1.7	4.8	2.5	4.8	2.4	0.02	.89
Total CM 1–CM 7	39.4	12.9	45.3	15,8	44.3	15.4	1.61	.21

An integral part of the Wee Care Neuroprotective NICU Program is the identification of neuroprotective developmental care champions in the NICU who are taught change management principles and mentored in utilizing these principles as they work on unit-wide goals, in order to sustain change.

Improving clinical practice requires multifactorial elements. Focusing on education related to neuroprotective care, identifying and mentoring champions, revising practice guidelines, tracking compliance, implementing small tests of change, and reporting patient, family, staff, and hospital outcomes are essential in helping NICU care providers see the impact of practice changes.

Neuroprotective Core Measures

While statistically significant improvements in each core measure were demonstrated (Table 3), the magnitude of increase in the scores differed over each core measure. The core measure demonstrating the greatest percent change pre- and post-Wee Care Neuroprotective NICU Program was Positioning and Handling (CM 2), followed by Optimizing Nutrition (CM 4). Both mean post-site scores more than doubled from the pre-site scores. Focus on positioning the neonate in a midline, flexed, and contained position, with developmentally appropriate therapeutic positioning aids, as well as gentle, slow handling techniques has always been a strong part of the Wee Care program. Training related to this core measure is extremely interactive as participants are given the opportunity to position themselves in adult-sized positioning aides to experience what it feels like to be positioned both poorly without boundaries and appropriately with boundaries for supportive containment. Although there has also been education related to feeding from the beginning of the Wee Care Neuroprotective NICU Program, the emphasis on this topic was increased dramatically with literature from 2008 introducing measurable scales related to infant-driven feeding practices, including feeding readiness cues, quality of nippling, and caregiver techniques.[26,27]

The less dramatically improved scores found in the Healing Environment and Minimizing Stress/Pain core measure results may be due to long-standing emphasis in the literature regarding the importance of these developmental care topics. White, Smith and Shepley, (2013), on behalf of the Committee to Establish Recommended Standards for Newborn ICU Design have become the "gold" standard for NICU design further enforcing the Healing Environment core measure.[28] The need for assessment and management of pain standards have long been supported by research and are recognized by the Joint Commission (TJC), Agency for Healthcare Research and Quality (AHRQ), and the American Academy of Pediatrics (AAP) and the Canadian Paediatric

Table 5
Mean core measures related to academic teaching vs. community non-teaching NICUs.

Variables	Academic teaching setting $n = 48$		Community non-teaching setting $n = 33$		All settings $N = 81$		*F* ratio	*p* value
	Mean	*SD*	Mean	*SD*	Mean	*SD*		
CM 1 Healing Environment	11.0	7.5	11.6	8.4	11.2	7.8	0.11	.74
CM 2 Partnering with Families	6.1	2.5	5.9	3.2	6.0	2.8	0.09	.77
CM 3 Positioning and Handling	10.9	4.0	10.3	4.1	10.6	4.0	0.41	.52
CM 4 Safeguarding Sleep	5.0	2.2	5.2	2.6	5.0	2.4	0.17	.68
CM 5 Minimizing Stress and Pain	3.7	1.4	3.6	1.5	3.7	1.4	0.06	.80
CM 6 Protecting Skin	3.0	1.2	3.0	1.3	3.0	1.2	0.02	.88
CM 7 Optimizing Nutrition	5.1	2.6	4.3	1.9	4.8	2.4	2.56	.11
Total CM 1–CM 7	44.7	15.0	43.8	16.2	44.3	15.4	0.07	.79

Table 6
Mean core measures related to presence of L & D service.

Variables	L & D service $n = 64$		No L & D service $n = 17$		All sites $N = 81$		*F* ratio	*p* value
	Mean	*SD*	Mean	*SD*	Mean	*SD*		
CM 1 Healing Environment	11.1	8.4	11.5	5.3	11.2	7.8	0.03	.86
CM 2 Partnering with Families	6.0	2.9	5.9	2.2	6.0	2.8	0.03	.86
CM 3 Positioning and Handling	10.5	4.0	11.1	3.9	10.6	4.0	0.33	.56
CM 4 Safeguarding Sleep	5.1	2.5	4.8	2.1	5.0	2.4	0.19	.66
CM 5 Minimizing Stress and Pain	3.7	1.5	3.4	1.2	3.7	1.4	0.63	.43
CM 6 Protecting Skin	3.0	1.2	3.1	1.2	3.0	1.4	0.02	.90
CM 7 Optimizing Nutrition	4.6	2.2	5.6	2.9	4.8	2.4	2.55	.11
Total CM 1–CM 7	44.0	15.9	45.4	13.9	44.3	15.4	0.10	.74

Society (CPS), providing solid support for the Minimizing Stress and Pain core measure.[29–32]

Because of increased survival rates of extremely low birth weight infants, (<1000 g), scientific research in the areas of Protecting Skin and Safeguarding Sleep core measures has increased over the last decade. This knowledge has been used to enhance the training related to these two topics.

The statistically significant increase in the pre- and post-site CM 2 (Partnering with Families) score may be reflecting a trend during the 4th program year interval in which more focus is being placed on Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) scores. Another impetus to incorporate family-centered care into patient care environments in recent years has been the anticipated implementation of the Patient Protection and Affordable Care Act (PPACA), where HCAHPS scores will significantly impact hospital reimbursements. HCAHPS is the first standard publicly reported survey of patients'/families' opinions of their hospital care.[33] Knowing that patient/family satisfaction scores will be tied to reimbursement has placed the creation of family and healthcare provider partnerships at the forefront of priorities for healthcare providers and administrators. The education provided by the Wee Care Neuroprotective NICU Program on Partnering with Families gives staff and administration the tools to help improve their HCAHPS scores and enhances the efforts made by hospitals in this direction.

Level of NICU Designation

It was anticipated that level II designated NICUs would have higher scores for the Partnering with Families core measure because parents may find fewer barriers to being at their babies' bedsides in less acute academic settings, but this was not the case. It was thought that because level III NICUs (84% of study NICUs) focus care on the very-low-birth-weight (<1500 g) and extremely-low-birth-weight (<1000 g) infants, as well as critically ill infants, more attention is focused on medical technological needs, rather than the extra-uterine NICU environment where the premature infant now lives, resulting in lower scores in the Healing Environment core measure; however, this was not the case. There was no statistical significance in any core measure in relation to the Level of NICU designation. Because 100% of the level II units were affiliated with sister level III NICUs, these level II units frequently benefit from their level III sister hospital through nursing, medical, and educational resources which could make it difficult to establish any relationships. Uniform improvement in the Healing Environment core

Table 7
Mean core measure scores related to program year implementation.

Variables	Program year 1995 $n = 25$		Program year 2000 $n = 26$		Program year 2005 $n = 24$		Program year 2010 $n = 6$		All program years $N = 81$		*F* ratio	*p* value
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
CM 1 Healing Environment	11.4	6.3	9.5	6.7	10.7	7.5	19.7	13.9	11.2	7.8	2.98	.04*
CM 2 Partnering with Families	5.4	2.1	5.9	2.1	6.0	3.2	9.0	4.0	6.0	2.8	3.25	.04*
CM 3 Positioning and Handling	10.6	3.7	9.9	4.1	11.5	4.4	10.3	3.2	10.6	4.0	0.68	.57
CM 4 Safeguarding Sleep	5.1	2.0	4.9	2.5	5.0	2.0	6.2	2.7	5.1	2.4	0.51	.68
CM 5 Minimizing Stress and Pain	3.6	1.4	3.6	1.4	4.0	1.6	3.0	0.6	3.7	1.4	0.97	.41
CM 6 Protecting Skin	3.2	1.1	2.8	1.1	2.8	1.2	4.3	1.8	3.0	1.2	3.19	.03*
CM 7 Optimizing Nutrition	4.8	2.5	4.8	2.5	4.5	2.0	5.5	2.7	4.8	2.4	0.29	.83
Total CM 1–CM 7	44.1	11.8	41.3	13.4	44.4	17.8	58.0	21.8	44.3	15.4	1.98	.13

* Statistically significant.

measure scores after Wee Care education, regardless of NICU designation, emphasizes the importance of not assuming that knowledge of environmental needs of extremely preterm infants are intuitively understood by the NICU staff who care for them.

Academic Teaching vs. Community Non-Teaching NICUs

It was believed that community non-teaching NICUs would have higher core measure scores than academic teaching facilities simply because of the higher volume of direct caregivers a neonate is exposed to in academic settings (less continuity), but this was not found to be true. Academic teaching facilities typically have a higher number of healthcare providers per patient because of the medical education infrastructure and subspecialties (attending physicians, fellows, residents, interns, medical students, nursing students, as well as ancillary support specialties). Because of this, one could assume that infants are touched and interrupted more than an infant would be in a community non-teaching NICU, leading to less neuroprotective care for infants. Although 60% of the NICUs were academic teaching units, there was no statistical difference in any core measure score relative to academic teaching or community non-teaching settings.

Presence of a Labor and Delivery Service

The lack of a labor and delivery service frequently occurs in Children's Hospitals and it was thought that Children's NICUs, with their varied and acute patient population, would have overall lower core measure scores because the focus of staff is frequently on technology rather than neuroprotective principles. A higher Partnering with Families score was anticipated because of the "philosophy" of family-centered care that is often fostered throughout Children's Hospitals. However, neither of these beliefs was supported by the results since there were no statistical differences in any core measures related to the presence of a Labor and Delivery service at the hospital site.

Program Year Intervals

Healing Environment, Partnering with Families, and Protecting Skin core measure improvements increased with each program year interval. The statistically significant correlation between the program year and Healing Environment may have been influenced by the small sample size for program year interval 2010 ($n = 6$), (Table 7). Although this number was small, all 6 NICUs had recently been renovated or had built new single room NICUs during the training implementation. New NICU design standards which focus attention on acoustic and lighting standards, and physical space requirements were utilized which not only promoted a healing environment, but also facilitated the inclusion and participation of families into the infants' care.[28] With new renovations, experience design and workflow were addressed, potentially impacting the results in this category. During program year interval 2010–2014, the Wee Care survey was updated and Protecting Skin was re-categorized as a separate core measure, which may have influenced the significant correlation of improved core measure scores with program year intervals.

Limitations and Research Implications

A potential limitation of this educational model is that it included multiple interventions that could either complement or compete with each other, yet are each important in caring for the vulnerable population in the NICU.[4–6,23] Another potential limitation is that external events could have impacted the improvement in scores since the timeframe of each Wee Care Neuroprotective NICU Program spanned from 1 to 3 years. Although at each site, on average 97% of the staff participated in the Wee Care training, staff turnover could influence the magnitude of the differences observed between the pre and post training results.

Despite these limitations, the significant improvement in all 7 Neuroprotective Core Measures supports the concept that in-depth training, such as that provided by the Wee Care Program, is an attractive vehicle to help neonatal staff better implement neuroprotective family-centered developmentally supportive neonatal care. Ongoing evaluation of all sites that participate in the Wee Care Neuroprotective NICU Program, or other training programs, is recommended to track the impact of educational programs and to ensure that program content remains evidence-based. Future programs should integrate a utilization-focused evaluation to assess staff and family satisfaction as well as recommendations so that training materials can be continuously improved. More research is needed to determine optimal time frame intervals in which retraining of staff is required to sustain progress.

Implications for Practice

Neuroprotective Family-Centered Developmental Care is an essential element of newborn intensive care, as every touch and interaction the preterm infant encounters, affects brain development, and ultimately their long term outcome. Neuroprotective care will continue to move forward only if there is support from all levels of professional education and practice. Gaps between practice and evidence demonstrate that improvements in the Wee Care Neuroprotective NICU Program should focus on interprofessional training, guideline refinements specific to the NICU and individualized core measure training that need improvement based on pre-site assessment scores. As multidisciplinary staff are trained collaboratively in neuroprotective, family-centered developmental care concepts, mutual respect, communication, and teamwork among all disciplines is encouraged, further enhancing care of neonates and their families. The inclusion of as many healthcare providers as possible in the training in contrast to a model of training where just a few "experts" on the unit are trained, brings the level of neuroprotective care to a much higher and consistent level which supports buy-in and sustainability. Based on data from this study along with educating a new generation of nurses, and because of hospitals decreasing budgets, the 8 hour-didactic program has been adapted to include an e-learning component with a half-day interactive workshop. Scientific research on the sustainability of the Wee Care training is recommended as the population of our most vulnerable patients grows.

Conclusion and Recommendations

The Wee Care Neuroprotective NICU Program, based upon the Neonatal Integrative Developmental Care Model, incorporates evidence-based best practices into education and training that results in improved neuroprotective practices for high-risk premature and sick infants and their families along with improving infant, family, staff, and hospital outcomes. This study demonstrates that given the appropriate knowledge, training, educational and quality improvement opportunities, supported with leadership skills, the usual complement of RNs in a NICU can improve their knowledge acquisition and successfully implement neuroprotective family-centered developmentally supportive care. In order to provide optimal care to babies and their families, hospitals with both level II and III NICUs should invest in a comprehensive training methodology that incorporates the Neonatal Integrative Developmental Care Model and associated seven neuroprotective core measures into the neonatal and family-centered care they provide.

Conflict of Interest

The primary author has worked with Philips Healthcare for 4 years and has taught the Wee Care Neuroprotective NICU Program for 15 years as a lead educator/consultant. This study has been completed on personal time without financial support from Philips Healthcare.

Appendix A. Neuroprotective Interventions related to the Seven Core Measures of Neuroprotective Care

Core measure # 1: Healing Environment

Definition: The healing environment encompasses the physical environment of space, privacy & safety, as well as the sensory environment, which includes the tactile vestibular, olfactory, gustatory, auditory, and visual systems. The physical environment involves not only space, but also characteristics of space, which affect position, movement, and motor development. The sensory environment includes the exposures and experiencing of temperature and touch, position and movement, smell and taste, hearing and noise, vision and light. Environmental sensory insults can result in lifelong alterations in brain development and function.[1]

Standard: A policy/procedure/guideline on the Healing Environment including physical space, privacy and safety, as well as the protection of the infant's sensory system exists and is followed throughout the infant's stay

Infant Characteristics	Goals	Neuroprotective Interventions
Stability of infant's autonomic, sensory, motoric, and state regulation systems	An environment will be maintained that promotes healing by minimizing the impact of the artificial extra-uterine NICU environment on the developing infant's brain	**Space** • Maintain a private and safe environment for the infant and family that consists of a minimum of 120 sq. ft per patient **Tactile**: • Provide soft, gentle touch in all caregiving interactions • Facilitate skin-to-skin care as soon as possible after birth and then daily by either parent (or caregiver designated by parent) • Provide a neutral thermal environment (NTE) for the infant incorporating the following factors: - If ELBW, provide incubator humidity during the first two weeks after birth - Provide care in incubator until infant can maintain own temperature **Vestibular:** • Change infant's position slowly with no sudden movements **Olfactory:** • Maintain a scent-free & fragrance-free unit • Facilitate early, frequent, and prolonged skin-to-skin care • Provide the mother's scent when possible via breast pad, soft cloth, or Snoedel **Gustatory:** • Position infant with hands near face • Provide colostrum or EBM oral care per protocol • Provide positive oral feeding experiences as outlined in "Optimizing Nutrition" section **Auditory:** • Monitor sounds levels to maintain sound levels of < 50 dB • Turn off alarms as quickly as possible **Visual:** • Provide adjustable light levels up to a maximum of 60 ftc • Cover infant's eyes during every exam

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Core measure # 2: Partnering with Families

Definition: The concept of partnering with families in the NICU includes a philosophy of care, which acknowledges that over time the family has the greatest influence over an infant's health and well-being.[2]

Standard 1: A policy/procedure/guideline on Family Centered Care exists and is followed throughout the infant's stay.

Standard 2: There is a specific mission statement addressing Family-Centered Developmental Care

Infant Characteristics	Goals	Neuroprotective Interventions
Infant's response to parental interactions	- Parents will be viewed not as "visitors" but as vital members of the caregiving team with 24-hr/day access to their baby. - Parents will be supported in their role as the **most important caregivers** for their infant. - Infant will develop secure attachment with parents	• Acknowledge where the family is in regards to stages of grief and loss and provide individualized and appropriate resources as needed • *Actively* listen to families' feelings and concerns (both verbal and non-verbal) • Communicate the infant's medical and developmental needs in a culturally appropriate and understandable way. • Facilitate early, frequent, and prolonged Skin-to-Skin care • Educate parents on how they can participate in the care of their infant at the level they desire whenever desire • Assist parents in becoming competent in caring for their baby • Encourage parents as they develop confidence in their own abilities to continue providing care for their baby after going home

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Core measure # 3: Positioning and Handling:

Definition: Therapeutic positioning in the NICU is a fundamental mainstay and can influence not only neuromotor and musculoskeletal development, but also physiologic function and stability, skin integrity, thermal regulation, bone density, sleep facilitation and brain development.[3,4] Secure therapeutic positioning promotes improved rest, supports optimal growth and helps to normalize neurobehavioral organization.

Standard: A policy/procedure/guideline on Positioning and Handling exists and is followed throughout the infant's stay

Infant Characteristics	Goals	Neuroprotective Interventions
- Autonomic stability during handling - Ability to maintain tone and flexed postures with and without supports	- Autonomic stability will be maintained throughout positioning changes and handling activities as well as during periods of rest and sleep. - Preventable positional deformities will be eliminated or minimized by maintaining infants in a midline, flexed, contained, and comfortable position throughout their NICU stay - The caregiver sees her or himself in partnership with the baby so that caregiving procedures are performed "with" the infant rather than "to" the infant. - Infants will be provided developmentally appropriate stimulation/play as they mature (i.e. mobiles, swings)	• Anticipate, prioritize, and support the infant's individualized needs during every care-giving interaction to minimize stressors known to interfere with normal development • Facilitate early, frequent, and prolonged skin-to-skin care • Utilize a validated & reliable positioning assessment tool (i.e. IPAT) routinely according to hospital protocol • Maintain a midline, flexed, contained, and comfortable position at all times utilizing appropriate positioning aids and boundaries • Provide appropriate prone support to ensure flexed shoulders and hips • Assess infant sleep-wake cycle to evaluate appropriate timing of positioning and caring • Reposition infant with cares and minimally every 4 hours • Provide 4-handed support during positioning and caring activities • Provide swaddling when bathing and weighing • Promote hand to mouth contact Educate parents about the principles and techniques of positioning, containment, and handling

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Core measure # 4: Safeguarding Sleep

Definition: REM and NREM sleep cycling are essential for early neurosensory development, learning and memory, and preservation of brain plasticity for the life of the individual.[5] Sleep deprivation (both REM and NREM) results in a loss of brain plasticity, which is manifested by smaller brains, altered subsequent learning, and long-term effect on behavior and brain function. Facilitation and protection of sleep and sleep cycles are essential to long-term learning and continuing brain development through the preservation of brain plasticity.[6]

Standard: A policy/procedure/guideline on Safeguarding Sleep and Back-to-Sleep Practices exists and is followed throughout the infant's stay

Infant Characteristics	Goals	Neuroprotective Interventions
- Infant sleep-wake states, cycles, and transitions - Infant's maturity and readiness for Back-to-Sleep Protocol	- Infant sleep-wake states will be assessed before initiating all caregiving activities - Prolonged periods of uninterrupted sleep will be protected - Infants will be transitioned to Back-to-Sleep Protocol when developmentally appropriate	• Individualize all caregiving activities by clustering cares based on infant sleep-wake states • Facilitate early, frequent, and prolonged skin-to-skin care to promote normal sleep patterns • Pay close attention to infant cues and signs of stress during clustered cares • If necessary to arouse a sleeping infant, approach using a soft voice followed by gentle touch • Educate parents about the importance of sleep and reading infant cues • Use incubator covers to protect the infant from direct light • Promote a quiet environment to ensure uninterrupted sleep • Assure infant is able to maintain normal sleep pattern during Back-to-Sleep well before discharge and role model this behavior • Provide tummy-time/prone-to-play time routinely for infants that are Back-to-Sleep • Educate parents about the importance and rationale for Back-to-Sleep and tummy-time

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Core measure # 5: Minimizing Stress & Pain:

Definition: Consequences of neonatal stress include increased energy expenditure, decreased healing and growth, impaired physiologic stability and altered brain development. NICU stressors and painful interventions may raise cortisol levels, limiting neuroplastic reorganization and therefore, learning and memory of motor skills.[78]

Standard: A policy/procedure/guideline on the assessment and management of pain exists and is followed throughout the infant's stay.

Infant Characteristics	Goals	Neuroprotective Interventions
Behavioral cues indicating stress or self-regulation	- Promote self-regulation and neurodevelopmental organization	• Provide individualized care in a manner that anticipates, prioritizes, and supports the needs of infants to minimize stress and pain • Facilitate early, frequent, and prolonged skin-to-skin care • Utilize a validated & reliable pain assessment tool will be performed routinely according to hospital protocol • Provide non-pharmacologic support (positioning, containment, swaddling, pacifier, and sucrose) with all minor invasive interventions • Use pain assessment tool to evaluate the need for pharmacologic support • Involve parents in supporting their infant during painful procedures if they choose by assisting with containment, by providing sucrose, or by providing skin-to-skin holding • Educate parents on how to read their infant's behavioral cues related to stress and pain and how to provide comforting interventions

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Core measure # 6: Protecting Skin

Definition: Functions of the skin include thermoregulation, fat storage and insulation, fluid and electrolyte balance, barrier protection against penetration and absorption of bacteria and toxins, sensation of touch, pressure, and pain, and conduit of sensory information to the brain. Skin care practices outlining bathing practices, emollient usage, humidity practices, and use of adhesives for babies in each stage of development should be incorporated into unit practices and policies.[9]

Standard: A policy/procedure/guideline on Skin Care exists and is followed throughout the infant's stay

Infant Characteristics	Goals	Neuroprotective Interventions
Maturity and integrity of infant skin	- Reduce Transepidermal Water Loss (TEWL) of ELBW infants - Maintain skin integrity of the infant from birth to discharge - Provide developmentally appropriate infant massage	• Provide individualized care in a manner that anticipates, prioritizes, and supports the needs of infants to optimize neuromotor development • Facilitate early, frequent, and prolonged skin-to-skin care • Utilize a validated & reliable skin assessment tool (i.e. Braden Q) on admission and routinely according to hospital protocol • Provide humidity for ELBW infants during the first two weeks after birth • Provide appropriate positioning utilizing gel products to prevent skin breakdown • Minimize use of adhesives and use caution when removing adhesives to prevent epidermal stripping • Avoid soaps and routine use of emollients • Provide full body swaddled bathing no more than every 72 – 96 hours • Use water only for bathing < 1000 gram infants • Use pH neutral cleansers for bathing > 1000 gram infants • Educate parents on skin care, swaddled bathing, and delivery of developmentally appropriate infant massage

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Core measure # 7: Optimizing Nutrition

Definition: Breastfeeding is the single most powerful and well-documented preventive modality available to health care providers to reduce the risk of common causes of infant morbidity. Even when adequate breast milk is available, most premature neonates learn to eat via nipple feeding. Nipple feeding is a complex task for premature infants and requires a skilled caregiver in assisting the infant in achieving a safe, functional, and nurturing feeding experience.[10,11] Infant-Driven Feeding Scales that address feeding readiness, quality of nippling, as well as developmentally supportive caregiver interventions are beneficial when initiating oral feedings in the premature neonate.

Standard 1: A policy/procedure/guideline on Optimizing Nutrition (Cue-based/Infant-driven Breast or Bottle feeding) which includes infant readiness, quality of nippling and caregiver techniques) is followed throughout the infant's stay

Standard 2: A policy/procedure/guideline on Skin-to-Skin Care (Kangaroo Care) exists and is followed throughout the infant's stay

Infant Characteristics	Goals	Neuroprotective Interventions
- Physiologic stability with handling & feeding - Feeding readiness cues - Coordinated Suck/Swallow/Breathing (SSB) throughout breast or bottle feeding - Endurance to maintain nutritional intake and support growth	- Feeding will be safe, functional, nurturing, and developmentally appropriate. - Optimized nutrition will be enhanced by individualizing all feeding care practices - Oral aversions will be prevented by assuring is a positive experience for infant - Infants of breast feeding mothers will be competent at breast feeding prior to discharge	• Individualized care by incorporating cue-based/Infant-driven feeding practices • Facilitate early, frequent, and prolonged skin-to-skin care • Support mother's Expressed Breast Milk (EBM) supply • Minimize negative perioral stimulation (adhesives, suctioning, etc.) • Utilize indwelling gavage tubes rather than intermittent tubes. • Promote Non-Nutritive Sucking (NNS) at mother's pumped breast during gavage feeds • Hold infant and use NNS with appropriate sized pacifier during gavage feeds when mother is not available • Provide the taste and smell of breast milk with gavage feedings • Once orally feeding, focus on quality of feeding experience versus quantity of feeds • Utilize caregiver techniques when nippling infant to avoid twisting, jiggling, excessive chin and neck support, etc. • Promote side-lying position close to parent/caregiver when bottle feeding • Educate parents about infant feeding cues • Support breast feeding mothers in feeding infant at the breast

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Disclaimer

The owner of the Wee Care Neuroprotective NICU program (Philips Healthcare; Andover, MA) had no role in the study design, collection, analysis and interpretation of data; writing of the report; or decision to submit the manuscript for publication.

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