Journal of Neonatal Nursing 24 (2018) 196–202

Contents lists available at ScienceDirect

Journal of Neonatal Nursing

journal homepage: www.elsevier.com/jneo

The effect of maternal participation in preterm's care and improved short-term growth and neurodevelopment outcomes

Nethong Namprom*, Wilawan Picheansathian, Usanee Jintrawet, Jutamas Chotibang

Faculty of Nursing, Chiang Mai University, 50210 Chiang Mai, Thailand

ARTICLE INFO

Article history:
Received 1 December 2017
Received in revised form
2 March 2018
Accepted 19 March 2018
Available online 30 March 2018

Keywords:
Maternal Participation Program
Growth
Neurobehavioral development
Preterm infants

ABSTRACT

This study aimed to test the effectiveness of the Maternal Participation Program (MPP) on growth and neurobehavioral development of preterm infants. The hypothesis was that preterm infants whose mothers were in the experimental group demonstrated better growth and neurobehavioral development than the control group Double-blind randomized control trial evaluated 50 mothers whose preterm infants were hospitalized in the neonatal intensive care unit, a university hospital. Mothers were randomly assigned into two groups (experimental group = 25; control group = 25). The experimental group received the usual nursing care and the MPP, and the control group received only the usual nursing care. Preterm infants in the experimental group showed significantly higher weight gains, weight gain velocity, and growth velocity between 14 and 28 days after birth; as well as better neurobehavioral development at days 14 and 28. The effectiveness of the MPP to promote the growth and neurobehavioral development of preterm infants was proven.

Introduction

The incidence of preterm infant's birth in Thailand is currently high (The National Statistical Office Thailand, 2013). The survival rate of this group has also increased due to advances in medical technology and nursing care. Yet, the survival of preterm infants is accompanied by a high risk of health problems due to their immaturity (Browne, 2004). Thus, they require special care in a neonatal intensive care unit (NICU).

Being hospitalized in an NICU, preterm infants are in a different environment from the maternal womb. NICU environments expose vulnerable preterm infants to potentially harmful stimuli resulting in both short and long-term negative effects on their growth and development (Sullivan et al., 2012), especially neurobehavioral development problems (Braga and Sena, 2012; Schlapbach et al., 2012). For growth, the time from birth to 28 days of life is the important period for preterm infants to catch up (LaHood and Bryant, 2007), and the third to fourth week of their life is the critical period for a growth spurt. Slow growth rate and poor postnatal growth of preterm infants during hospitalization are associated with altered neurodevelopmental outcomes (Ong et al., 2015; Roze et al., 2012).

Maternal stimulation is one of the beneficial methods to enable preterm infants to achieve normal neurodevelopment (Holditch-Davis and Blackburn, 2014). This activity increases synaptogenesis and can improve preterm infant's neurobehavioral status (Lester et al., 2011; Volpe, 2008). However, hospitalized preterm infants in an NICU miss a chance to establish bonding to their mothers after birth (Aagaard and Hall, 2008; Stefana and Lavelli, 2017). Longitudinal studies demonstrated that neurobehavioral outcomes of preterm infants at later stages were significantly improved after empowering mothers to participate in caring for their infants (Welch et al., 2014, Welch et al., 2015). Thus, including mothers in the care of the preterm infants in an NICU is a crucial and beneficial element to support the most appropriate growth and development of preterm infants. Unfortunately, mothers are commonly restricted from providing appropriate care for preterm infants in an NICU (Hall et al., 2013; Lasiuk et al., 2013).

In Thai culture, mothers normally refrain from getting involved in caring for their infants in NICU. In previous studies among Thai mothers in northern Thailand, who participated in caring for their infants in an NICU, stated their need to perform more infant care activities (Pholanun et al., 2013; Taya et al., 2007). It was also found that Thai parents had their own ways in providing care for their hospitalized child, and they asked less for assistance and knowledge than Western parents who participated in caring for their

* Corresponding author.
E-mail address: nethong.namprom@cmu.ac.th (N. Namprom).

https://doi.org/10.1016/j.jnn.2018.03.003
1355-1841/

child (Pongjaturawit & Harrigan, 2003). In previous studies, the samples were not randomly assigned into control and experimental groups, the intervention duration was inconsistent (Damrongrak et al., 2012; Singkla, 2007), and none of the studies focused on the health outcomes of preterm infants. Currently, there is no specific comprehensive intervention for maternal participation in the care of preterm infants in Thailand. However, cultural awareness and sensitivity should be employed so as to delineate the cultural underpinnings of maternal participation in Thai culture.

In this study, the researcher developed the MPP based on the Neonatal Integrative Developmental Care (IDC) model (Altimier and Phillips, 2013), with consideration of Thai culture for enhancing growth and neurobehavioral development of NICU preterm infants through maternal participation. The purpose of this study was to test the effectiveness of the MPP on the short term growth and neurobehavioral development of preterm infants. Thus, the objectives of this study were to compare growth and neurobehavioral development of preterm infants between groups whose mothers receiving the usual nursing care plus the MPP and those receiving only the usual nursing care.

Theoretical framework for development of the maternal participation program

The MPP was developed by the researcher based on the conceptual framework of the Neonatal Integrative Developmental Care (IDC) model (Altimier and Phillips, 2013). The IDC model provides guidelines to promote neuroprotective intervention for preterm infants. The central core neuroprotective intervention is partnering with the family to perform the six care practices for preterm infants: 1) creating a healing environment by minimizing the impact of the artificial extrauterine environment in an NICU, 2) providing fetal positioning and supporting the preterm infant to have autonomic stability during handling, 3) minimizing stress and pain to improve physiological stability-enhanced regulation in preterm infants, 4) promoting and safeguarding sleep to prolong periods of uninterrupted sleep, 5) protecting skin, and 6) optimizing nutrition by promoting breast feeding.

The MPP has three key components of the intervention process including psychosocial support, parent education, and therapeutic developmental interventions aiming to improve the growth and neurobehavioral development of preterm infants (Benzies et al., 2013). Psychosocial support refers to assisting, facilitating, and encouraging mothers to participate in caring for their infants by nurse. Parent education refers to teaching the content of the six care practices for preterm infants indicated above. Lastly, therapeutic developmental interventions aim to improve growth and neurobehavioral development of preterm infants, and refer to the participation activities by mothers pertaining to performance of the six care practices.

Methods

Development and content of the of the Maternal Participation Program (MPP)

The intervention in the MPP was developed by integration of the three key components including psychosocial support, parent education, and therapeutic developmental interventions targeting infants in this study. The MPP had activities of 4 weeks duration. Application of the intervention was divided into two sets of infants: preterm infants of 28–30 wk gestations and preterm infants of 31–32 wk gestations. The activities were performed by the researcher who is an NICU nurse. The activities consisted of four, 1-hr teaching sessions, and four, 1-hr practice sessions, along with assisting, facilitating, and encouraging mothers to participate in the six care practices for preterm infants indicated above which were provided within those sessions. Table 1 illustrates the MPP activities.

The program consisted of two main components led by researcher: (a) education pertaining to the preterm infant's neuroprotective care, and (b) an improved care-giving strategies including facilitation, assistance, and encouragement. Teaching and practice sessions were conducted by means of media, including the education plan, multi-touch interactive multimedia, and a handbook with relevant information on practicing learned skills. Steps of implementing the MPP were offered for 4 wk. The feasibility and acceptability of the MPP was assessed via conducting a pilot study that was tested with mothers of three preterm infants using the same criteria of the participants in this study. The results of the pilot test indicated the feasibility and acceptability of the MPP.

Design

The RCT, two-group pretest-post-test design, with the double-blind technique, was used to test the effectiveness of the MPP on preterm infant growth and neurobehavioral development.

Participants

Mother-preterm infant dyads were recruited with the following inclusion criteria for the mother: 1) being 18 years of age or older, 2) being able to read and speak Thai, 3) giving birth of the preterm infant with the gestational age of between 28 wk and 32 wk based on the New Ballard score, and 4) having a first time hospitalized preterm infant in the NICU with anticipation of survival, no congenital anomaly, birth weight of less than 2500 g, singleton birth, and born at the study site. After the recruitment, 50 mothers were randomly assigned into experimental and control groups using permuted-block randomization, 25 in each group. The study groups were blinded to the research assessor and statistical analyst.

Measures

Demographic variables

Mothers were asked to complete the personal data profile including age, educational level, occupation, marital status, family income, type of delivery, and duration of admission. For infants', the researcher collected data from their medical records on the first admission to the NICU. Data included gender, gestational age, birth weight, infants' size for gestational age, order of preterm infants, APGAR score in the first minute and the fifth minute, diagnosis, CRIB score, nutrition type, enteral feeding intake, energy intake, day of full feeding retained umbilical catheter, duration of hospitalized admission, and duration of NICU stay.

Maternal participation activities

The researcher evaluated mothers' participation level in infant care using the Maternal Participation in Caring for Preterm Infant's Checklist (MPCPI) on 14 and 21 d after the infant's birth. The MPCPI is a dichotomous checklist of six care practice activities and 16 items developed by the researcher. The content validity of the MPCPI checklist was 0.94, and the Cronbach's alpha coefficient was 0.84 at the 14th day after infant birth. The total score was used to measure the level of maternal participation activities of participants with feedback. In cases where the mothers' overall participation level was less than 95%, the researcher and participants conducted discussions to eliminate any causes or barriers preventing participation in care practices with their preterm infant.

Table 1
MP program activities.

Time frame	Content for mothers of preterm infants aged of 28–30 weeks	Content for mothers of preterm infants aged of 31–32 weeks	Supporting activity
Week 1			
Day 1 –2 *Session 1*	*An initial session*: recognizing participants, *Optimizing nutrition:* breast feeding supply *Creating healing environment*: colostrum mouth care, breast milk order, soft touch, providing the mother's scent via breast milk smell	*An initial session*: same *Optimizing nutrition*: same *Creating a healing environment*: same	
Day 3 *Session 2*	*Optimizing nutrition*: Breast feeding *Promoting, safeguarding sleep*: uninterrupted infants' sleep	*Optimizing nutrition*: Same content *Creating a healing environment*: intermittent kangaroo mother care	
Day 4	Promote maternal participation in three care practices in session 1 and 2	Promote maternal participation in three care practices in session 1 and 2	Assistance, facilitation, and encouragement
Day 5 *Session 3*	*Minimizing stress and pain*: infant's behavioral cues, comfort and minimizing stress *Positioning and handling:* fetal position, facilitated tucking, and handling	*Promoting, safeguarding sleep:* Same content *Positioning and handling:* Same content	
Day 6	Promoting maternal participation in two care practices in session 3	Promoting maternal participation in two care practices in session 3	Assistance, facilitation, and encouragement
Day 7 Session 4	*Creating a healing environment:* intermittent kangaroo mother care *Protecting skin:* developmentally appropriate infant massages	*Minimizing stress and pain:* same content *Protecting skin:* Same content	
Week 2			
Day 8	Promoting maternal participation in two care practices	Promoting maternal participation in two care practices	Assistance, facilitation, and encouragement
Day 9 –13	Promoting maternal participation in six care practices	Promoting maternal participation in six care practices	Assistance, facilitation, and encouragement
Day 14	**1st Monitoring**: the Maternal Participation in Caring for Preterm Infants' Checklist	**1st Monitoring**: the Maternal Participation in Caring for Preterm Infants' Checklist	Repeated teaching and practice, assistance, facilitation, and encouragement
	1st Assessment: Infant's weight and neurobehavioral development	**1st Assessment**: Infant's weight and neurobehavioral development	
Week 3			
Day 15 –20	Promoting maternal participation in six care practices	Promoting maternal participation in six care practices	Assistance, facilitation, and encouragement
Day 21	2nd Monitoring: the Maternal Participation in Caring for Preterm Infants' Checklist	2nd Monitoring: the Maternal Participation in Caring for Preterm Infants' Checklist	Repeated teaching and practice, assistance, facilitation, and encouragement
Week 4			
Day 22 –27	Promoting maternal participation in six care practices	Promoting maternal participation in six care practices	Assistance, facilitation, and encouragement
Day 28	**2nd Assessment**: Infant's weight and neurobehavioral development	**2nd Assessment**: Infant's weight and neurobehavioral development	

Growth

Infant growth was measured on days 14 and 28 after birth. Growth of a preterm infant refers to the change of an infant's weight. It was measured by a digital weight scale, model SK-1000 in grams, with an accuracy of 0.01 g, at two different time points, including from days 0–28, with sub analyses for days 0–14, and days 14–28. The infant's weight was calculated in terms of weight gain, weight gain velocity, and growth velocity. **Weight gain** is the weight increase over a specified time between initial weight and weight at the second time. **Weight gain velocity** is the change of an infant's weight in g/d at two different time points. **Growth velocity** is the change of an infant's weight in g/kg/d at two different time points. It was used to measure the body weight of naked preterm infants by the research assessor. . Weight gain was calculated using the formula: weight gain (g) = Wn - W1. Weight gain velocity was calculated in g/d using the formula: weight gain velocity = (Wn-W1)/D21; whereas, growth velocity was calculated in g/kg/d using the formula: growth velocity = $[1000 \times \ln(Wn/W1)]/(Dn - D1)$.

Neurobehavioral development

Infant neurobehavioral development was measured on 14 and 28 d after infant birth. Neurobehavioral development is the distinct change in neurobehavioral function of preterm infants at a given conceptional age. This is assessed using the Neonatal Neurobehavioral Examination (NNE) developed by Morgan et al. (1988). This scale was used with the permission of the developer. The scale reflected clearly any changes in the neurobehavioral function of preterm infants with increasing age. It has a three-section scale of a total of 27 items, equally divided into 9 items in each section. The sections included tone and motor patterns, primitive reflexes, and behavioral responses with a three-point rating scale (1–3) for each item. The total scores ranged from 27 to 81. Higher total scores indicated better gestational maturation and neurobehavioral status. The inter-rater method was used by the research assessor and physical therapist who is an expert in preterm infant neurodevelopment examination. Both individuals independently used the scale to examine the same preterm infants at the same times. The calculation index of agreement of inter-rater observer reliability was 0.96.

Analytic strategy

During the intervention process, four participants (7.4%) prematurely left before the end of the intervention: two participants from both the control group, and the experimental group. In the control group, a preterm infant developed severe necrotizing enterocolitis (NEC stage 3) and had hospital acquired infections. In the experimental group, a preterm infant was diagnosed with gut mal-rotation, and another was discharged before completion of the outcomes assessment. The data from 50 participants were analyzed using the intention-to-treat principle (ITT) to ensure the validity of the results. Data were analyzed using mean, standard deviation, frequency, percentage, Chi-square test, Fisher's exact test, Mann-Whitney U *t*-test, and two-way Repeated Measure ANOVA.

Procedures

Data were collected after receiving approval from the Research Ethics Committee of the Faculty of Nursing, the Faculty of Medicine, Chiang Mai University, and the director of Maharaj Nakorn Chiang Mai Hospital. After receiving permission from the supervisor of the two NICUs, the researcher contacted staff of two NICUs to explain the purpose and procedures of this study. The researcher recruited the mothers of preterm infants who met the inclusion criteria from the registration books of the NICUs, Maharaj Nakorn Chiang Mai Hospital. The researcher randomly divided participants into the experimental group and the control group using the permuted block of four method. The participants who agreed to participate in this study were asked to sign an informed consent form. After providing information about the study, the participants who were willing to participate signed the informed consent form. Participants were asked to complete the Personal Data Profile. The researcher conducted data collection of the infants using the infant's personal data profile and the CRIB. The experimental group received the usual nursing care from the NICUs' staff. In addition, they received the MPP during preterm infants' treatment in the NICU. The researchers intervened each participant according to the protocol of the MPP indicated above.

Results

Demographic variables

The sample included 50 dyads of mothers and hospitalized preterm infants in the NICU–25 in the control group with a mean age of 28.02 y (standard deviation [*SD*] = 5.93 y), and 25 in the experimental group with a mean age of 29.84 y (SD = 5.06 y). The majority of the preterm infants were male. A median gestational age of preterm infants was 31 wk with a mean birth weight of 1353.60 g in the control group and with a mean birth weight of 1439 g in the experimental group. There were no significant differences in terms of demographic data between control and the experimental groups. Table 2 presents the complete demographic data.

Maternal participation activities

All mothers in the experimental group performed 100% of four care practices: optimizing nutrition, healing environment, safeguarding sleep, and positioning and handling at days 14 and 21. Only some mothers did the other two care practices, minimizing stress and pain and protecting skin, at days 14 and 21.

Growth

The findings of this study revealed that preterm infants in the experimental group did not show significantly higher weight gain from birth than those in the control group on days 14 or 28 after birth. The comparison of mean weight gain of preterm infants between two groups is displayed in Table 3. Preterm infants in the experimental group demonstrated significantly higher weight gain at the 14th and 28th day compared with the control group. In addition, there was a significantly higher weight gain velocity and growth velocity in the experimental group than the control group at the 28th day from the 14th day ($p < .05$). The averages of weight gain, weight gain velocity, and growth velocity are presented in Table 4.

Table 2
Demographic data represented as percentages ($N = 50$).

Demographic variable	Control group ($N = 25$)		Experimental group ($N = 25$)	
	n	%	*n*	%
Mothers				
Educational level				
Elementary education	4	16.0	2	8.0
Secondary school	4	16.0	0	0
High school	3	12.0	3	12.0
Diploma or vocational certificate	4	16.0	3	12.0
Bachelor degree	11	44.0	13	52.0
Master or higher	2	8.0	4	16.0
Occupation				
Housekeeper	9	6.0	4	16.0
Employee/worker	9	36.0	9	36.0
Agriculture	1	4.0	0	0
Own business	1	4.0	5	20.0
Government officer	5	20.0	7	28.0
Type of delivery				
Normal labor	11	44.0	14	56.0
Cesarean section	14	56.0	11	44.0
Preterm infants				
Gender				
Male	15	60.0	14	56.0
Female	10	40.0	11	44.0
Apgar score in 1 min				
0 - 6	8	72.0	11	44.0
7–10	17	68.0	14	56.0
Apgar Score in 5 min				
0 - 6	3	12.0	3	12.0
7–10	22	88.0	22	88.0
CRIB score				
0 - 5	20	80.0	23	92.0
6 - 10	5	20.0	2	8.0
Diagnosis*				
Respiratory distress syndrome	25	100.0	25	100.0
Hyperbilirubenemia	23	92.0	24	96.0
Apnea of prematurity	13	52.0	14	56.0
Feeding intolerance	13	52.0	5	20.0
PDA	12	48.0	10	40.0
Anemia	7	28.0	7	28.0
Atrial septal defect (ASD)	4	16.0	1	4.0
Intraventricular hemorrhage	4	16.0	3	12.0
Congenital pneumonia	3	12.0	1	4.0

* = One infant was diagnosed with more than one symptom.

Neurobehavioral development

Preterm infants in the experimental group showed significantly better neurobehavioral development than those in the control group on days 14 and 28 after birth ($p < .01$). There were significant differences in terms of tone and motor pattern and behavioral response between the experimental and control groups on days 14 and 28, but there was no significantly difference in primitive reflexes. Table 4 summarizes the average score of neurobehavioral development in each group.

Discussion

The MPP increased the preterm infants' growth compared with the control group. However, there were no significant differences between the experimental group and the control group at 14 and 28 d after birth. In addition, there were no significant differences in weight gain velocity and growth velocity between the experimental and control groups on days 14 and 28 after birth. This result is congruent with the study by Beheshtipoor et al. (2013), which found that there was no effect on infants' weights during the first 2–3 wk after the intervention. The study by Maguire et al. (2008)

Table 3
Comparison of mean weight gain of preterm infants between groups and time of measurement (n = 50).

Weight gain of preterm infants	Analysis of Variance				
	SS	df	MS	F^r	p-value
Within subject					
Time	3168400.00	1	3168400.00[a]	343.78	.000
Time x Group	64009.00	1	64009.00[a]	6.95	.011
Error	442391.00	48	9216.48[a]		
Between subject					
Group	54756.00	1	54756.00	1.15	.289
Error	2288569.00	48	47678.52		

Note. r = 2-way repeated measures ANOVA.
a = Greenhouse-Geisser was used to adjust the degree of freedom.

Table 4
Values of study variable: Growth and neurobehavioral development (n = 50).

Variables	Control group		Experimental group		Statistical value	P -value
	Mean ± SD	Range	Mean ± SD	Range		
Growth						
From birth						
Weight gain (g)						
Day14	94.40 ± 124.17	−70–340	90.60 ± 102.54	−70–260	−0.12	.907[a]
Day28	399.88 ± 230.49	45–900	497.20 ± 186.36	180–875	1.64	.107[a]
Weight gain velocity (g/d)						
Day14	6.74 ± 8.87	-5–24.29	6.47 ± 7.32	-5–18.57	−0.12	.907[a]
Day28	14.28 ± 8.23	1.61–32.14	17.76 ± 6.66	6.43–31.25	1.64	.107[a]
Growth velocity (g/kg/d)						
Day14	5.58 ± 7.20	−4.72–25.57	10.63 ± 3.53	−3.58–15.78	−0.58	.565[a]
Day28	9.28 ± 5.56	0.78–21.69	16.68 ± 3.68	4.33–18.28	0.62	.541[a]
From Day14						
Weight gain (g)						
Day28	305.40 ± 145.67	70–615	406.60 ± 125.08	140–805	2.63	.011[a]
Weight gain velocity (g/d)						
Day28	21.81 ± 10.41	5–43.93	29.04 ± 8.93	10 ± 57.50	2.63	.011[a]
Growth velocity (g/kg/d)						
Day28	13.65 ± 5.86	4.15–23.67	16.68 ± 3.68	10.79–27.69	2.19	.034[a]
Neurobehavioral development						
Day14						
Tone and motor pattern	13.69 ± 2.98	10–23	15.62 ± 2.84	10–21	160.50	.013[b]
Primitive reflexes	14.00 ± 2.09	10–18	15.42 ± 3.02	9–21	189.00	.062[b]
Behavioral responses	13.52 ± 2.31	10–19	16.54 ± 2.98	11–22	3.87	.000[a]
Total score	41.22 ± 6.61	31–60	47.58 ± 7.75	31–63	132.50	.002[b]
Day28						
Tone and motor pattern	17.38 ± 2.98	12–26	20.24 ± 3.50	13–27	2.64	.011[a]
Primitive reflexes	17.04 ± 4.29	11–26	19.28 ± 3.45	10–24	2.02	.050[a]
Behavioral responses	16.00 ± 3.36	10–22	21.24 ± 2.98	16–27	5.78	.000[a]
Total score	50.42 ± 11.05	35–69	60.76 ± 9.02	41–74	3.59	.001[a]

Note. [a] = *independent t-test.*
[b] = Mann-Whitney *U* test.

revealed that basic developmental care provided in the NICU had no effect on short-term growth in very preterm infants. This can be explained by the usual physiological preterm infant weight loss; preterm infants normally lose 12–15% of their weight after birth, and slowly catch up in weight. Moreover, it was found in the present study that maternal participation activities in the experimental group during the first 2 wk were less performed than after 2 wk.

Significant differences were found in weight gain, weight gain velocity, and growth velocity on day 28 from day 14 between the experimental and control groups. The MPP might be effective for significant weight gain in the experimental group after 2 wk of the preterm infant's life. The findings are congruent with the study by O'Brien et al. (2013) that showed similar results after the educational and psychosocial supportive program Family Integrated Care (FIC) was implemented. This result is also consistent with a study among mothers who attended the FIC program (Bracht et al., 2013). In addition, the researcher stayed close to the mothers to facilitate, assist, and encourage them to perform activities throughout the program. This might help the mothers gain more confidence and skills in caring for their infants (Goulet et al., 1998; Vazquez and Cong, 2014).

According to the IDC model, the six care practices can help promote an infant's growth by means of reducing energy expenditure, promoting growth hormones, and optimizing nutrition through breast feeding. Reducing energy expenditure is promoted by using gentle touch, I-KMC, fresh mother milk's odor, colostrum mouth care, eye-to-eye contact, soft voice, facilitated tucking, hand-to-mouth positioning, promoting quiet sleep, and minimizing stress and pain. Promoting growth hormones is achieved by using I-KMC, flex position, promoting quiet sleep, and infant massage. Lastly, optimizing nutrition through breast feeding is performed while using I-KMC. These practices provide multisensory stimulation, including emotional, tactile, proprioceptive, vestibular, olfactory, auditory, visual, and thermal stimulation (Cong et al., 2009), an increased quiet sleep state and more stable physiological status (Chiu and Anderson, 2009). In addition, supporting positioning, minimizing handling and containment, help to conserve energy for growth. Moderate pressure massage with synthetic oil and passive movement of the limbs can help to increase the bone density of preterm infants as well as increase vagal activity which may contribute to weight gain (Field et al., 2010; Vickers et al., 2004). Promoting breast feeding helps to maintain nutritional intake and support the growth of preterm infants. Therefore, a preterm infant's weight might be increased.

Our findings indicate that the neurobehavioral development score of preterm infants on days 14 and 28 after birth whose mothers were receiving the MPP was higher than the score of those receiving the usual nursing care. These findings support the beneficial nature of the MPP design using the IDC model as a framework (Altimier and Phillips, 2013). The increase of neurobehavioral development scores in the experimental group might result from the multisensory input of the six care practices, including the healing environment, positioning and handling, safeguarding sleep, minimizing stress and pain, protecting skin, and optimizing nutrition. These findings are consistent with the study by Montirosso et al. (2012) which found that the infants from the NICUs that were delivering more developmental care, demonstrated better neurobehavioral stability than those from NICUs with low developmental care. This also included higher attention and regulation, less excitability and hypotonicity, and lower stress/abstinence. Our results were also congruent with the study by Welch et al. (2014), which indicated the importance of early mother–infant nurture and of facilitating family nurture in the NICU. The findings of this study demonstrated that family nurture intervention (FNI) led to increased frontal brain activity during sleep greater than that in the standard group. The communication and sensory interaction between mothers and infants may affect brain function in learning. It seems likely that some form of learning may underlie the effects on brain development of preterm infants.

Neuroprotective care, including the six care practices, promotes the development of preterm infants (Altimier & Phillips, 2013) by influencing the expression of genes and also affects their brain plasticity. Five of the care practices in the neuroprotective interventions (creating a healing environment, positioning and handling, promoting and safeguarding sleep, minimizing stress and pain, protecting skin, and optimizing nutrition) encourage the stability of the infant's autonomic, sensory, motoric, and state regulation. Four of the care practices in the neuroprotective interventions (creating a healing environment, positioning and handling, promoting and safeguarding sleep, minimizing stress and pain, and protecting skin) encourage prolonged periods of uninterrupted sleep. Two of the care practices in the neuroprotective interventions (healing environment and optimizing nutrition) increased breast feeding. All of these benefits of the six care practices directly improve the neurobehavioral development of preterm infants.

Limitations

The study was conducted only in a single unit of the NICU with a particular gestational age and certain age of mothers. Some mothers had no chance to perform activities such as tucking, and kangaroo care while infants were receiving painful procedures. This is because of the hospital visiting policy which does not allow mothers to be with their infants at bedside all day. The generalization of the results may be limited.

Conclusions

The findings of this study support the implementation of the MPP based on the IDC model (Altimier and Phillips, 2013, 2016), and found that it was appropriate to implement with mothers in an NICU and Thai context. The program was implemented within the first 2 d after delivery, which is the critical period of bonding establishment for a preterm infant. The program helped the mother to quickly become familiar with the NICU environment, along with the six care practices as the best practices of neuroprotective interventions (Altimier and Phillips, 2013). The MPP enhanced maternal participation in caring for preterm infants. It is also improved infants' growth and neurodevelopmental development in the experimental group, and this was clearly detected after 14 d of the preterm infant's life.

Ethical statement

Prior to data collection, this study and its instruments were approved by the Research Ethics Committee of the Faculty of Nursing, Chiang Mai University, Chiang Mai, Thailand, the approval number is 136/2515. The researcher also requested for permission for conducting the study from the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University, Chiang Mai, the approval number is 383/58 COA-NUR 136/2515.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jnn.2018.03.003.

References

Aagaard, H., Hall, E., 2008. Mothers' experiences of having a preterm in the neonatal care unit: a meta-synthesis. J. Pediatr. Nurs. 23 (3), e26–e36.
Altimier, L., Phillips, R.M., 2013. The Neonatal integrative developmental care model: seven neuroprotective core measures for family-centered developmental care. N.born Infant Nurs. Rev. 13 (1), 9–22.
Altimier, L., Phillips, R.M., 2016. The Neonatal Integrative Development Care Model: advanced clinical applications of the seven core measures for neuroprotective family-centered developmental care. N.born Infant Nurs. Rev. 16, 230–244.
Beheshtipoor, N., Shaker, Z., Edraki, M., Razavi, R., Zare, Z., 2013. The effect of family-based empowerment program on the weight and length of hospital stay of preterm infants in the neonatal intensive care unit. Galen Med. J. 2 (3), 114–119.
Benzies, K.M., Magill-Evans, J.E., Hayden, K.A., Ballantyne, M., 2013. Key components of early intervention programs for preterm infants and their parents: a systematic review and meta-analysis. BioMed. Cent. Pregnancy Childbirth 13 (Suppl. 1), 1–15.
Bracht, M., O'Leary, L., Lee, S.K., O'Brien, K., 2013. Implementing family-integrated care in the NICU: a parent education and support program. Adv. Neonatal Care 13 (2), 115–126.
Braga, P.P., Sena, R.R., 2012. Strategies for implementing continuity of care after discharge of premature infants: an integrative review. Acta Paul. Enferm. 25 (6), 975–980.
Browne, J.V., 2004. New perspectives on premature infants and their parents. Zero Three 24 (2), 4–12.
Chiu, S.-H., Anderson, G.C., 2009. Effect of early skin-to-skin contact on mother-preterm infant interaction through 18 months: randomized controlled trial. Int. J. Nurs. Stud. 46 (9), 1168–1180.
Cong, X., Ludington-Hoe, S.M., McCain, G.M., Fu, P., 2009. Kangaroo care modifies preterm infant heart rate variability in response to heel stick pain: pilot study. Early Hum. Dev. 85 (9), 561–567. https://doi.org/10.1016/j.earlhumdev.2009.05.012.
Damrongrak, P., Prasopkittikun, T., Tilokskulchai, F., Ngerncham, S., 2012. Effects of family-centered care on self-efficacy in participatory involvement in newborn caresatisfaction towards nursing service of mothers in NICU. J. Nurs. Sci. 30 (2), 70–79.
Field, T., Diegoa, M., Hernandez-Reifc, M., 2010. Preterm infant massage therapy research: a review. Infant Behav. Dev. 33 (2), 115–124. https://doi.org/10.1016/j.infbeh.
Goulet, C., Bell, L., St-Cyr, D., Paul, D., Lang, A., 1998. A concept analysis of parent-infant attachment. J. Adv. Nurs. 28, 1071–1081.
Hall, E.O.C., Kronborg, H., Aagaard, H., Brinchmann, B.S., 2013. The journey towards motherhood after a very preterm birth: mothers' experiences in hospital and after home-coming. J. Neonatal Nurs. 19, 109–113.
Holditch-Davis, D., Blackburn, S.T., 2014. Neurobehavioral development. In: Kenner, C., Lott, J.W. (Eds.), Comprehensive Neonatal Nursing Care, fifth ed. Springer, New York, pp. 689–721.
LaHood, A., Bryant, C.A., 2007. Outpatient care of the premature infant. Am. Fam. Physician 76 (8), 1159–1164.
Lasiuk, G.C., Comeau, T., Newburn-Cook, C., 2013. Unexpected: an interpretive

description of parental traumas' associated with preterm birth. BioMed. Cent. Pregnancy Childbirth 13 (Suppl. 1), S13.
Lester, B.M., Miller, R.J., Hawes, K., Salisbury, A., Bigsby, R., Sullivan, M.C., Padbury, J.F., 2011. Infant neurobehavioral development. Semin. Perinatol. https://doi.org/10.1053/j.semperi. 2010.10.003.
Maguire, C.M., Veen, S., Sprij, A.J., Cessie, S.L., Wit, J.M., Walther, F.J., 2008. Effects of basic developmental care on neonatal morbidity, neuromotor development, and growth at term age of infants who were born at <32 Weeks. Pediatrics 121 (2), e239–e245.
Montirosso, R., Del Prete, A., Bellu, R., Tronick, E., Borgatti, R., 2012. The neonatal adequate care for quality of life (NEO-ACQUA) study group: level of NICU quality of developmental care and neurobehavioral performance in very preterm infants. Pediatrics 129, e1129–e1137.
Morgan, A.M., Koch, V., Lee, V., Aldag, J., 1988. Neonatal Neurobehavioral examination: a new instrument for quantitative analysis of neonatal neurological status. J. Am. Phys. Ther. Assoc. Phys. Ther. 68, 1352–1358.
O'Brien, K., Bracht, M., Macdonell, K., McBride, T., Robson, K., O'Leary, L., Lee, S.K., 2013. A pilot study of family integrated care in a Canadian neonatal intensive care unit. BioMed. Cent. Pregnancy Childbirth 13 (Suppl. 1), S12.
Ong, K.K., Kennedy, K., Casta~neda-Gutierrez, E., Forsyth, S., Godfrey, K.M., Koletzko, B., Fewtrell, M., 2015. Postnatal growth in preterm infants and later health outcomes: a systematic review. Acta Paediatr. 104 (10), 974–986. https://doi.org/10.1111/apa.13128.
Pholanun, P., Kantawang, S., Klunklin, P., 2013. Maternal participation in caring for preterm infants in neonatal intensive care unit and related factors. Nurs. J. 40 (1), 89–101.
Pongjaturawit, Y., Harrigan, R.C., 2003. Parent participation in the care of hospitalized child in Thai and western cultures. Issues Compr. Pediatr. Nurs. 26, 183–199.
Roze, J.C., Darmaun, D., Boquien, C.Y., Flamant, C., Picaud, J.C., Savagner, C., Ancel, P.Y., 2012. The apparent breastfeeding paradox in very preterm infants: relationship between breast feeding, early weight gain and neurodevelopment based on results from two cohorts, EPIPAGE and LIFT. Br. Med. J. Open 2 (2). https://doi.org/10.1136/bmjopen012-000834 e000834.
Schlapbach, L.J., Adams, M., Proietti, E., Aebischer, M., Grunt, S., Borradori-Tolsa, C., Natalucci, G., 2012. Outcome at two years of age in a Swiss national cohort of extremely preterm infants born between 2000 and 2008. BioMed. Cent. Pediatri. 12 (198), 1–12.
Singkla, P., 2007. Effects of Nursing Mutual Participation of Mothers on Maternal Stress and Roles in Caring for Critical Premature Babies (Master of Nursing Science Thesis in Pediatric Nursing). Graduate School, Khon Kaen University.
Stefana, A., Lavelli, M., 2017. Parental engagement and early interactions with preterm infants during the stay in the neonatal intensive care unit: protocol of a mixed-method and longitudinal study. Br. Med. J. Open 7. https://doi.org/10.1136/bmjopen-2016-013824 e013824.
Sullivan, M.C., Miller, R.J., Msall, M.E., 2012. 17-year outcome of preterm infants with diverse neonatal morbidities: Part 2, impact on activities and participation. J. Spec. Pediatr. Nurs. 17, 275–287.
Taya, N., Picheansatian, W., Yunaka, R., 2007. Needs and received response among mothers of newborns in Neonatal Intensive Care Units. J. Health Sci. 16, 268–274.
The National Statistical Office Thailand, 2013. Public Health Statistics 2007-2010. Retrieved from. http://bps.ops.moph.go.th/2.1.3-53.pdf.
Vazquez, V., Cong, X., 2014. Parenting the NICU infant: a meta-ethnographic synthesis. Int. J. Nurs. Sci. 1, 281–290.
Vickers, A.1, Ohlsson, A., Lacy, J.B., Horsley, A., 2004. Massage for promoting growth and development of preterm and/or low birth-weight infants. Cochrane Database Syst. Rev. 2, CD000390.
Volpe, J.J., 2008. Neurology of the Newborn, fifth ed. Saunders, Philadelphia.
Welch, M.G., Firestein, M.R., Austin, J., Hane, A.A., Stark, R.I., Hofer, M.A., Myers, M.M., 2015. Family Nurture Intervention in the neonatal intensive care unit improves social-relatedness, attention, and neurodevelopment of preterm infants at 18 months in a randomized controlled trial. J. Child Psychol. Psychiatry 56 (11), 1202–1211.
Welch, M.G., Myers, M.M.M., Grieve, P.G., Isler, J.R., Fifer, W.P., Sahni, R., Ludwig, R.J., 2014. Electroencephalographic activity of preterm infants is increased by family nurture intervention: a randomized controlled trial in the NICU. Clin. Neurophysiol. 125 (4), 675–684.