Journal of Clinical and Nursing Research

Research Article

BIO-BYWORD SCIENTIFIC PUBLISHING PTY LTD

A Clinical Analysis of Physical and Neurological Development in very Low Birth Weight Infants with MEIR (Massage, Exercises, Intelligence training, and Rehabilitation training)

Yonghong Deng, Shulian Wang*, Zhaohui Liu, Qi Liao, Yan Zeng

Department of Neonatology, Loudi Central Hospital, Loudi 417000, Hunan Province, China

Funding: Loudi Science and Technology Project (Loucaiqizhi [2014]).

Abstract: ***Objective:*** This study aimed to investigate the application of MEIR (Massage, Exercises, Intelligence training, and Rehabilitation training) in Chinese VLBW infants and to observe its effects on infants' growth and development. ***Methods:*** Clinical data of 92 VLBW infants who were treated at the neonatal intensive care unit (NICU) of Loudi Central Hospital were retrospectively analyzed. The patients were grouped as the MEIR group (n=47) and controls (n=45). Physical and neurodevelopment development were compared between the two groups. ***Results:*** There were differences in height and weight and head circumference between the two groups at all corrected ages (all P<0.05). Abnormal motions, reflexes, muscular tension, audio-visual reactions, and posture, and the total numbers of abnormalities of 3-, 6-, 9- and 12-corrected month-old infants in the MEIR group were lower than in the control group (all P<0.05). The mental development index and psychomotor development index of 6- and 12- corrected month infants in the MEIR group were higher than in the control group (all P<0.05). ***Conclusion:*** MEIR could improve the physical and neurological developments of VLBW infants, reduce the incidence of adverse events, and improve their growth and development.

Keywords: Very low birth weight infants; MEIR; Physical development; Neurological development.

Publication date: July, 2020
Publication online: 31 July, 2020

*_Corresponding author:_ Shulian Wang, wangshl2011@yeah.net

1 Introduction

Very low birth weight (VLBW) infants refer to premature babies with a birth weight of <1.5 kg[1, 2]. The worldwide prevalence of VLBW infants is 1.1%-7%, depending upon countries and types of hospitals[1, 3]. Because of various immature organs and of the loss of body substance and reserve in the early stages of life, physical and neurological development may be impaired, which would increase the incidence of adverse events of VLBW infants (e.g., pulmonary infection, septicemia, and cerebral palsy), and would decrease survival[4]. Respiratory distress syndrome occurs in 90% of VLBW infants[5], while chronic lung disease occurs in about 21%, retinopathy of prematurity in 8%, intraventricular hemorrhage in 3%, and necrotizing enterocolitis in 1%[1, 2, 5-8]. The survival of VLBW infants vary widely from 33% in Iran[9] to 90% in New Zealand and The Netherlands[10, 11]. In China, about 100,000 infants are born with VLBW each year[12].

In developing countries, only 40% of VLBW infants have a normal development, compared to up to 90% in developed countries[6]. Large studies reported that 25%-50% of VLBW infants will show cognitive and/or behavioral impairments, and 5% will have cerebral palsy and various neurological and motor deficits[13-15].

Normal outcomes with no or fewest complications

in VLBW infants depend mainly on the quality of prenatal and perinatal health care[9], which focus on both early rescue and improving long-term prognosis. A number of studies using a variety of interventions showed that early developmental and behavioral interventions can improve cognitive, behavioral, and social outcomes of VLBW infants[16-18].

Therefore, the aim of this study was to investigate the application of Massage, Exercises, Intelligence training, and Rehabilitation training (MEIR) in Chinese VLBW infants and to observe whether there was a positive impact of MEIR on their growth and development.

2 Materials and methods

2.1 General data

Clinical data of 92 VLBW infants who were treated at the neonatal intensive care unit (NICU) of Loudi Central Hospital, a third-level grade-A hospital of China, were selected for retrospective analysis. The inclusion criteria were: 1) premature infants with birth weight <1.5 kg and gestational age <37 weeks; 2) oral feeding was >100 ml/kg/d at discharge, body weight was >2.0 kg, and vital signs were stable; and 3) the legal guardians signed the informed consent. This study was approved by the Ethics Committee of Loudi Central Hospital.

2.2 Instruction of parents

All infants received parenteral nutrition support, and conventional healthcare and/or treatment including ventilator respiratory support, alveolar surfactant replacement therapy, and anti-infective treatment. Infants received a series of physical activity training, which include massage, exercises, intelligence training, and rehabilitation training (MEIR).

Massage: The family members were instructed to carry out a full body massage 1-2 weeks after discharge from the hospital, 5-15 min/time, as least twice per day. The massage was light at the start and the intensity was progressively increased by paying close attention to the baby's reaction and adjusting the way and strength of massage accordingly. At any stage of the massage, crying, increased muscle tone, skin color changes, or vomiting reaction, massage should be paused immediately. If those signs lasted for >1 min, the massage was stopped.

Exercises: Exercise training started 1-2 weeks after discharge. The intervention time was at corrected age of 1 year old. As for exercise signs of discomfort led to change the strength of exercise or to stop. The corrected age refers to the corrected physiological age from the gestational age of 40 weeks (pre-production period). For example, a preterm infant with a gestational age of 32 weeks, the actual age is 3 months, then the corrected age of the child is 1 month.

Intelligence training: Intervention was carried out in the cognition, emotion, and language of infants after discharge.

Rehabilitation training: Rehabilitation training was carried out for infants with neurodevelopmental abnormalities. If infants had abnormalities like motor retardation and abnormal posture, then massage and active and passive training were carried out. This aimed at infants with severe neurodevelopmental abnormalities or poor effect of family rehabilitation for 1 month.

The VLBW infants were divided into the MEIR and control groups, if infants in the MEIR group failed to attend follow-up more than three times, they were regrouped as control. The physical activity of infants was recorded monthly for 6 months post discharge, and then recorded every three months until to the corrected age of 1 year. The follow-up included neuromotor system, physical development (including Height, Weight and Head circumference), social adaptability, and living ability in infants.

2.3 Evaluation of severe neurodevelopmental abnormalities

Abnormal exercise: Normal babies of 4-5 months of age are able to turn over (from supine position to side position); at the age of 6 months, they are able to turn over (from supine position to prone position); at the age of 7-9 months, they are able to climb forward (about 20 cm moving forward); at the age of 10 months, they are able to climb forward. Abnormality was determined if the infant was not conforming to the above criteria.

Abnormal reflex: The asymmetric tonic neck reflex in infants was observed. Abnormality was determined if positive performance of upper or lower extremities was still present 4 months post exercise.

Abnormal muscular tension: Standards of adductors angle in infants: 1-3 month old: 40-80; 4-6 month old: 70-110; 7-9 month old: 100-140; and 10-

12 month old: 130-150. Abnormality was determined if not conforming to these criteria.

Abnormal audio-visual reaction: The movement of the head and eyeballs in infants following a red ball was observed by eye tracking of the red ball. Abnormality was determined if infants could not turn their head, or they were unable to stare or eye track. A hard plastic box with 20 corn beans was used to observe the auditory response of infants to its shaking. Abnormality was determined if infants had no response to the sound, or they turned their head.

Abnormal posture: Abnormality was determined if infants leaned forward while sitting, the body was in a low tensioning state, or infants leaned backward while sitting, extensor tension was high, flexor tension was not enough. Professional rehabilitation institutions were selected to carry out systematic evaluation, and physical rehabilitation training was conducted at the same time.

2.4 Neurodevelopment

The neurodevelopment in infants was evaluated according to the 20-item neuromotor assessment for 0-1 year-old infants and the Children's Developmental Center of China (CDCC) evaluation[19]. The 20-item neuromotor assessment for 0-1 year-old infants included five parts: exercise, reflex, muscular tension, audio-visual reaction, and posture. At the corrected age of 6 months and 12 months, CDCC (including the mental development index (MDI) and psychomotor development index (PDI) was evaluated by two independent physicians.

2.5 Statistical analysis

SPSS 17.0 (IBM, Armonk, NY, USA) was used for statistical analysis. Repeated measure analysis of variance (GLM) was used. Continuous data were expressed as mean ± standard deviation and analyzed using the Student t-test. Categorical data were expressed as proportions and analyzed using the chi-square or Fisher exact test, as appropriate. Two-sided P-values <0.05 were considered statistically significant.

3 Results

3.1 Demographic data

92 infants infants were divided into the control (n=45) and MEIR (n=47) groups. As shown in Table 1, there were no significant differences in gestational age, gender, birth weight, and delivery mode between the two groups (all P>0.05). The familial economic conditions of the two groups were similar (P>0.05).

Table 1. Comparison of the demographic and clinical data between the two groups

Group (N)	MEIR (n=47)	Control (n=45)	P
Gender, n (%)			
Male	27 (51.1)	26 (57.8)	0.914
Female	20 (48.9)	19 (42.2)	
Gestational age (weeks)	30.50±1.32	30.98±1.39	0.09
Birth weight (kg)	1.19±0.11	1.21±0.10	0.277
Hospital stay (day)	36.8±11.5	36.1±9.7	0.732
Body weight at discharge (kg)	2.19±0.20	2.21±0.10	0.550
Delivery mode, n (%)			
Natural	29 (61.7)	30 (66.7)	0.620
Cesarean section	18 (38.3)	15 (33.3)	
Economic condition (income/month, Yuan)	4029±389	4061±397	0.696

3.2 Comparison of the physical development

As seen in Table 2, there were significant differences in height, weight and head circumference of 3-, 6-, 9- and 12- month-old (corrected age) infants between the two groups (all P<0.05).

Table 2. Comparison of physical development of infants between two groups

	MEIR (*n*=47)	Control (*n*=45)	*P*
Height (cm)			
3 months	60.96±1.23	59.68±1.23	<0.001
6 months	67.55±1.08	65.76±0.99	<0.001
9 months	72.71±1.18	70.46±1.03	<0.001
12 months	75.84±1.24	73.47±1.0	<0.001
Weight (kg)			
3 months	6.67±0.36	6.0±0.33	<0.001
6 months	8.27±0.35	7.43±0.28	<0.001
9 months	9.47±0.35	8.4±0.32	<0.001
12 months	10.33±0.36	9.1±0.33	<0.001
Head circumference (cm)			
3 months	40.11±0.53	38.29±0.62	<0.001
6 months	43.18±0.6	41.02±0.57	<0.001
9 months	45.24±0.67	43.03±0.56	<0.001
12 months	46.26±0.62	43.87±0.57	<0.001

3.3 Neuromotor abilities of infants

As shown in Table 3, the number of abnormal motions, reflexes, muscular tension, audio-visual reactions, and posture, as well as the total number of abnormalities of 3- corrected month, 6- corrected month, 9- corrected month and 12- corrected month infants in the MEIR group were significantly lower than those in the control group (all $P<0.05$).

Table 3. Neuromotor assessment

	MEIR (*n*=47)		Control (*n*=45)		*P*
	Yes	No	Yes	No	
Abnormal exercise, n					
3 months	14	33	29	16	0.001
6 months	11	36	26	19	0.001
9 months	6	41	20	25	0.001
12 months	2	45	15	30	<0.001
Abnormal reflex, n					
3 months	15	32	28	17	0.004
6 months	12	35	24	21	0.006
9 months	8	39	21	24	0.002
12 months	3	44	16	29	0.001
Abnormal posture,n					
3 months	14	33	27	18	0.004
6 months	4	43	20	25	<0.001
9 months	3	44	15	30	0.001
12 months	0	47	10	35	0.001
Abnormal muscular tension, n					
3 months	13	34	25	20	0.007
6 months	7	40	20	25	0.002
9 months	4	43	18	27	<0.001
12 months	2	45	15	30	<0.001
Abnormal audio-visual reaction, n					
3 months	15	32	28	17	0.004
6 months	12	35	23	22	0.012
9 months	7	40	18	27	0.007
12 months	2	45	15	30	<0.001
Total # of abnormalities, n					
3 months	71	104	137	88	<0.001
6 months	46	189	113	112	<0.001
9 months	28	207	92	133	<0.001
12 months	9	226	71	154	<0.001

3.4 MDI and PDI

As shown in Table 4, the MDI and PDI of 6- and 12-month-old (corrected age) infants in the MEIR group were significantly higher than those in the control group (all $P<0.05$).

4 Discussion

Previous study showed that VLBW infants can achieve good outcomes with early detection and early intervention, especially within one year of age[19]. This study showed that the height, weight and head circumference of 3-, 6-, 9- and 12-month-old VLBW infants were significantly higher than in the control group who received standard management for VLBW or premature infants. In addition, the head circumference of 3- and 6-month-old VLBW infants in the MEIR group were significantly larger than those in the control group, which is supported by Barton et al[20]. This study also showed that the MDI and PDI at corrected age of 6 and 12 months were significantly higher than in the control group, supporting that MEIR had a significant effect on improving infant's intelligence and motor development. It has proved that mild skin massage could stimulate the secretion of gastric hormone, promote digestion, absorption, and use of nutrients, and at the same time enable them to establish regular sleep and promote physical growth indirectly[21].

According to previous studies, the smaller the age of VLBW infants, the stronger the plasticity of the brain, especially during the first 1-2 years after birth[22, 23]. After brain injury, infants could have obvious manifestations of compensatory and recovery ability. Therefore, if effective exercise and sensory function training were performed in early intervention to VLBW infants, the intervention could correct abnormal posture, motions, reflexes, and muscular tension, reconstruct the damaged brain function and brain tissue, as well as improve central nervous system in infants.

Nevertheless, the four aspects of massage, baby exercise, intelligence training, and rehabilitation of this study are inseparable and cannot be analyzed individually since the development is a reciprocal and consecutive process. Furthermore, the intervention must be tailored to each infant. Additional studies are necessary to determine the exact contribution of each individual intervention.

The present study is not without limitations. Because of the small sample size, the results might be biased and long-term and large-scale clinical studies are needed for validation. Especially, determining the developmental outcomes after 12 months could be useful to determine the real value of MEIR. Furthermore, the control group was formed by infants who failed to follow-up more than three times, which could introduce a bias although the two groups did not differ for several clinical and demographic characteristics. Finally, the massage intensity was not standardized and was performed according to the reactions of the infants. A randomized controlled trial would have generated more reliable results.

Table 4. Comparison of results of CDCC between two groups

Groups	MEIR (n=47)	Control (n=45)	P
6-month			
MDI	109.0±4.8	96.4±4.9	<0.001
PDI	101.6±4.8	91.5±4.7	<0.001
12-month			
MDI	112.4±3.6	93.81±5.4	<0.001
PDI	105.9±4.7	88.9±5.3	<0.001

MDI, mental development index, PDI, psychomotor development index

References

[1] Fanaroff AA, S.B., Wright LL, et al. Trends in neonatal morbidity and mortality for very low birthweight infants[J]. American journal of obstetrics and gynecology, 2007, 196(147): e1-8.

[2] Eichenwald EC, S.A. Management and outcomes of very low birth weight[J]. The New England journal of medicine, 2008, 358: 1700-1711.

[3] Behram R, S.B.A. Preterm birth: Causes, consequence, and prevention[M]. Washington, D.C.: National Academies Press, 2007.

[4] L, B. Influence of early comprehensive intervention on very low birth weight infants'growth and development[J]. China Continuing Medical Education, 2017, 9: 198-199.

[5] Stoll BJ, H.N., Bell EF, et al. Neonatal outcomes of extremely

preterm infants from the NICHD Neonatal Research Network[J]. Pediatrics, 2010, 126: 443-456.

[6] Ruegger C, H.M. Adams M, et al. Population based trends in mortality, morbidity and treatment for very preterm- and very low birth weight infants over 12 years[J]. BMC pediatrics, 2012, 12: 17.

[7] Sritipsukho S, S.T., Sritipsukho P. Survival and outcome of very low birth weight infants born in a university hospital with level II NICU[J]. Journal of the Medical Association of Thailand, 2007, 90: 1323-1329.

[8] Chedid F, S.S., Haddad H, et al. Short-term outcome of very low birth weight infants in a developing country: comparison with the Vermont Oxford Network[J]. Journal of tropical pediatrics, 2009. 55: 15-19.

[9] Heidelise A, C.Y., Stéphane S, et al. Nursing mode of neonatal intensive care unit of newborn and neurodevelopmental outcome in preterm infants[J]. Chinese Journal of Evidence Based Pediatrics, 2015, 10(5): 321-327.

[10] Darlow BA, C.A., Donoghue DA. Improved outcomes for very low birthweight infants: evidence from New Zealand national population based data[J]. Archives of disease in childhood Fetal and neonatal edition, 2003, 88: F23-28.

[11] Anthony S, O.L., Brand R, et al. Changes in perinatal care and survival in very preterm and extremely preterm infants in The Netherlands between 1983 and 1995[J]. European journal of obstetrics, gynecology, and reproductive biology, 2004, 112:170-177.

[12] Organization, W.H., UNICEF Low birth weight[M]. Country, regional and global estimates, 2016.

[13] Zhu JJ, B.Y., Zhang GL, et al. No relationship between mode of delivery and neonatal mortality and neurodevelopment in very low birth weight infants aged two years[J]. World journal of pediatrics, 2014, 10: 227-231.

[14] Larroque B, A.P., Marret S, et al. Neurodevelopmental disabilities and special care of 5-year-old children born before 33 weeks of gestation (the EPIPAGE study): a longitudinal cohort study[J]. Lancet, 2008, 371: 813-820.

[15] Marlow N, W.D., Bracewell MA, et al. Neurologic and developmental disability at six years of age after extremely preterm birth[J]. The New England journal of medicine, 2005, 352: 9-19.

[16] He C, F.S., Luo H. Effect of early comprehensive intervention on physical development and intellectual development of preterm low birth weight infants[J]. Maternal Child Health Care China, 2016, 31: 976-978.

[17] McCormick MC, B.-G.J., Buka SL, et al. Early intervention in low birth weight premature infants: results at 18 years of age for the Infant Health and Development Program[J]. Pediatrics, 2006, 117:771-780.

[18] Melnyk BM, F.N., Alpert-Gillis L, et al. Reducing premature infants' length of stay and improving parents' mental health outcomes with the Creating Opportunities for Parent Empowerment (COPE) neonatal intensive care unit program: a randomized, controlled trial[J]. Pediatrics, 2006, 118: e1414-1427.

[19] X, B. Application of 20 examinations of 0~1 year old nervimotion in screening high-risk infants. National academic conference on the rehabilitation of children's cerebral palsy and international academic exchange conference[C], 2010.

[20] Barton M, S.A., O'Brien K, et al, Early-Onset Invasive Candidiasis in Extremely Low Birth Weight Infants: Perinatal Acquisition Predicts Poor Outcome[J]. Clinical infectious diseases, 2017, 64: 921-927.

[21] Diego MA, F.T. Hernandez-Reif M, Vagal Activity, Gastric Motility, and Weight Gain in Massaged Preterm Neonates[J]. The Journal of Pediatrics, 2005, 147(1): 50-55.

[22] Kang S, X.J., Liu Z. Application of parental participation in very low birth weight infants[J]. The Journal of Medical Theory and Practice, 2016, 29: 3118-3119.

[23] Van Hus J, J.-V.M., Koldewijn K, et al. Early intervention leads to long-term developmental improvements in very preterm infants, especially infants with bronchopulmonary dysplasia[J]. Acta paediatrica, 2016, 105: 773-781.