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Breastfeeding Evaluation Indicators System is a Promising Evaluation Tool for Preterm Infants in Neonatal Intensive Care Units (NICUs)

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Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
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Background: Breast feeding can enhance preterm infants' neurodevelopmental outcome, regulate immune function development. This study aims to develop breastfeeding evaluation indicators system in neonatal intensive care units (NICU) and to provide theoretical basis for all-round evaluation of breast feeding quality for hospitalized preterm infants.





Material/Methods: This study was performed based on Avedis Donabedian's theory of medical care quality. Preterm infant breast feeding evaluation indicators system frame was initially formed by using literature review, clinical on-spot observation and expert consultation methods. By using specialists meeting method and Delphi method, evaluation indicators system for preterm infants breastfeeding was verified and established. Breastfeeding evaluation indicators system were performed in NICU of hospitals in Binzhou and Shanghai. Feasibility and usability of indicators system were examined.

Results: Breastfeeding evaluation indicators system for preterm infants comprise 3 levels, including level 1 (3 indicators), level 2 (7 indicators), and level 3 (18 indicators). Recognition rates of importance for level 2 and 3 range from 94.4% to 100.0% and 80.6% to 100.0%, respectively. Mean of Likert rating for level 2 and 3 range from 3.31 to 3.89 and 3.03 to 3.97, which are all higher than the average value of 2.50. Kendall's coefficient and its significance test showed that consistency of experts' opinion for indicators' importance is high ($P < 0.001$). This strategy of combining qualitative and quantitative methods could be used in overall evaluation of the breastfeeding quality in NICUs.

Conclusions: Indicators system is feasible and is a promising evaluation tool for continuously improving breastfeeding quality for preterm infants in NICUs.

MeSH Keywords: **Breast Feeding • Neonatal • Premature Birth**

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Background

Breast milk is the best natural food for babies, especially for preterm infants [1,2]. Breast feeding can not only enhance preterm infants' neurodevelopmental outcome, but also regulate the development of immune function and reduce the incidence of nosocomial infections, septicemia, and meningitis [3,4]. The benefits of feeding the premature with their own mothers' breast milk [2]. It is widely reported and many of the protective influences of breast milk are more pronounced and critical for the premature [5]. According to Lucas, preterm infants whose mothers provided breast milk had a substantial advantage in subsequent IQ at age 7.5 to 8 years over those who did not receive mother's milk, even after adjustment for a wide range of factors that might have confounded this comparison [6]. Apart from nutritional and immunological benefits, human milk has positive effects on cognitive functioning in preterm infants [4,7], and it is an important part of Maternal and Child Health (MCH) work in the world to protect, promote, and support breast feeding for newborns [8]. However, in the course of implementation and management for preterm infants' breastfeeding, there are still many difficulties and disputes in China, due to inadequate management for breastfeeding in NICUs and the immature development of infants. The rate of breastfeeding for preterm infants is very low, in some reports even zero [9]. Currently, in China there is neither an objective standard nor a unified method to evaluate the implementation quality for preterm infant breastfeeding in NICUs, and research on the evaluation indicators system for preterm infant feeding is nonexistent. Therefore, development of a preterm infant breastfeeding evaluation indicators system emerged as a topic that needed further exploration. The aim of the study was to develop a breastfeeding indicators system that fits the special conditions and characteristics of premature infants and to explore the factors influencing the quality of breastfeeding provided to premature infants from the elements of hospital, infant, and mother in order to provide support to and a theoretical basis for increasing breastfeeding rates for preterm infants.

Material and Methods

Study design

This study used clinical on-spot observation, experts consulting, and Delphi method to develop and verify the indicators of a breastfeeding evaluation system for preterm infants in Binzhou Medical University Hospital, Binzhou, China.

Setting and sample

A convenience sample of 40 experts in 4 hospitals in Shandong Province, China was selected for 2 rounds of Delphi consultation.

The inclusion criteria for experts were: (a) bachelor's degree or above, (b) senior professional titles, (c) worked for more than 10 years in areas of maternity, NICU, or nursing management, and (d) rich professional knowledge. There is no exact rule for sample size in Delphi study [10,11]; Lock [12] suggested expert panel sizes ranging from 12 to 110. We selected 40 experts who were the nursing directors, NICU medical experts, and nursing specialists in maternity and NICU, respectively, in 4 hospitals in Shandong Province, China.

This study selected a convenience sample of 32 mother/preterm-infant pairs in the NICU of Binzhou Hospital, Shandong, China. There were 32 NICU preterm infants whose gestational ages ranged from 26 to 36 weeks, including: (a) 5 cases of gestational age younger than 30 weeks, (b) 15 cases of gestational age between 30 and 34 weeks, and (c) 12 cases of gestational age older than 34 weeks. Exclusion criteria were: (a) case with unstable vital signs, (b) case unable to breathe regularly or swallow, and (c) case with oxygen masks. Inclusion criteria were: (a) lactated, (b) willing to feed the baby with breast milk, (c) voluntarily participating the study, (d) communicating effectively, and (e) without disorders affecting breast feeding.

Ethical consideration

This study was conducted after receiving approval from the institutional review board at our hospital. The recruitment of research participants was conducted through individual interviews. During meetings with each participant, researchers explained the purpose and the procedures of this study, including voluntary participation and withdrawal, as well as anonymous data collection solely for research purposes. Upon obtaining participants' written consent forms, the study proceeded.

Measurements

The indicators and the weights were as follow. For the first level indicators, the precedence chart [13] is used to calculate the weights. For the second and third level indicators, the Analytic Hierarchy Process (AHP) [13] is applied to calculate the weights; each indicator is expressed by the Recognition Rate of Importance (%), the mean of Likert rating with 95% confidence interval (95% CI) and the weight. Variable coefficient [13] was introduced to express the degree of variability of concordance by experts – the smaller the variable coefficient, the better of the experts' concordance. For examination of experts' concordance in judging indicators, Kendall's Coefficient of Concordance (W) and its significance test (P) [14] were used. Kendall's W ranges from 0 (no agreement) to 1 (complete agreement); it represents the ratio of variability of total ranks of indicators to the maximum possible variability of total ranks.

Data collection

Literature reviews were performed as follow. A systematic literature review was undertaken in the databases PubMed, MEDLINE, LILACS, CNKI, and Ovid using the following combination of keywords: “premature infants” OR “preterm infant” OR “premature birth” AND “breastfeeding” OR “breast feeding” AND “quality evaluation” OR “quality indicators” OR “indicators system” OR “quality indicators”, “health care” AND “neonatal intensive care unit”. The initial searches identified 45 articles in databases using the keywords above. After analysis of abstracts, 24 articles that did not meet the inclusion criteria were excluded. This review therefore covers 21 articles.

Clinical on-spot observation was performed as follows. Breastfeeding is an interactive process between mother and infant. The clinical on-spot was observed, including the preparation, the implementation, and the result of breastfeeding; the related information and data from the NICU and hospital management; the behavioral development of preterm infants; and the mothers’ preparation and skills for breastfeeding. The above were analyzed to initially formulate the important items for evaluation of preterm infant breastfeeding.

Expert consulting: We consulted 10 experts who are members of the expert panel with questionnaires involving the important elements and items collected above for preterm infant breastfeeding evaluation. The framework of evaluation indicators system for premature breastfeeding was composed of 3 levels, with 3 indicators in Level 1, 7 indicators in Level 2, and 20 indicators in Level 3.

Delphi Method: The Delphi method is a structured communication technique, originally developed as a systematic, interactive forecasting method which relies on a panel of experts [15]. The experts answer questionnaires in 2 or more rounds.

A panel of 40 experts of doctors, nurses, and administrators in NICUs, obstetrics, and nursing, respectively, in 4 different Grade III general hospitals in Binzhou, Huimin, and Jinan were consulted for the first round by postal service and by email. The panel was initially asked to select and rank the indicators of an evaluation system reflecting the quality of breastfeeding for preterm infants in NICUs according to the importance of the indicators, by using a 4-point Likert rating scale. The indicators involving the experts’ suggestions and opinions were collected and analyzed, and necessary changes were made before resending to the same experts for the second round. Each indicator was considered consensus if the expert opinion rating (the recognition rate of importance) was more than 70% for Likert rating of 3 or 4 in the 4-point scale.

Data analysis

Data analyses were conducted by using SPSS, version 15.0 (SPSS Inc., Chicago, IL, USA). We also calculated the recognition rate of importance for indicators that were the expert’s opinion rating of 3 or 4 in the 4-point Likert scale, the mean of the Likert rating with 95% confidence interval, the variable coefficient, and the weight of the indicators. Chi-square tests were used for Kendall’s Coefficient of Concordance (*W*) and its significance test, and $p < .05$ was considered statistically significant.

Results

Literature review

On the basis of our literature review, a protocol was developed with elements associated with the breastfeeding of preterm infants. According to Avedis Donabedian’s theory of three dimensions of medical care quality [16], which include structure, process, and outcome, combined with the process workflow of breastfeeding which involves the infant and mother, 20 important items were selected and a framework was formed as the basis for establishing an indicators system. The 20 items are: The staff professional knowledge and skills for breastfeeding; The staff perception and attitudes towards premature breastfeeding; The management regulations for premature breastfeeding; Rooming-in facilities; Rooting reflex; Areolar grasp; Latched on (minutes); Strength of sucking; Time of sucking; Longest sucking burst (number of sucks); Swallowing signs; Infant state when first put to the breast; Infants state after feeding; Milk volume intake; Mother’s satisfaction about infant feeding behavior; Type of nipple; Lactation performance; Mother’s confidence for breast feeding; Mother’s knowledge about breast feeding; and Mother’s skills for breast feeding.

The characteristics of expert panel

For the first round of Delphi method, questionnaires are sent out to 40 experts and 36 of them are collected back, with a response rate of 90%. For the 36 experts, the ages ranged from 32 to 58 years old, with the average of 41.45 ± 7.24 years old, the average years of professional experience was 21 ± 5.21 years. Thirteen had a Master of Science in Nursing (MSN) degree, 12 had a Bachelor of Science in Nursing (BSN) degree, 9 had an Associate Degree in Nursing (ADN), and 2 received a vocational nursing diploma. There are 8 NICU medical experts, 18 NICU nursing experts, and 10 obstetrical nursing experts, which accounts for 22%, 50%, and 28%, respectively. There were 35 experts joined in the second round survey who were also in the experts group in the first round.

Table 1. Consultation Results of Indicators in level 1 and level 2.

Indicator code	Indicator name	Recognition rate of Importance* (%)	The mean of Likert rating (95% CI**)	Variable coefficient	Weight
I-1	NICU management elements for preterm infants breastfeeding				0.17
II-1	The knowledge and skills of Staff for preterm infant breastfeeding	94.4	3.50 (3.22–3.69)	0.17	0.51
II-2	Management configuration	100.0	3.31 (3.10–3.53)	0.14	0.49
I-2	Preterm infant breastfeeding behavior				0.42
II-3	Preparation for breast feeding	100.0	3.89 (3.52–3.99)	0.08	0.33
II-4	Process of breast feeding	97.2	3.61 (3.34–3.92)	0.15	0.34
II-5	Results of breast feeding	100.0	3.64 (3.35–3.97)	0.13	0.33
I-3	Mother’s preparation and skills for breastfeeding				0.41
II-6	Mother’s preparation for breastfeeding	100.0	3.86 (3.52–3.98)	0.09	0.52
II-7	Mother’s Skills for breast feeding	100.0	3.64 (3.31–3.82)	0.14	0.48

* Recognition Rate of Importance is the percentage of the experts’ opinion rating 3 or 4 in the 4-point Likert rating for indicators;
** CI – confident interval.

Indicators in level 1 and level 2

Table 1 shows the indicators in level 1 expressed in weight (W) and the indicators in level 2 expressed in the recognition rate of importance (%), the mean of Likert rating with 95% confidence interval (95% CI), the variable coefficient, and the weight. The recognition rates of importance range from 94.4% to 100.0% for Level 2 indicators of 7, the mean of Likert rating ranges from 3.31 (95% CI 3.10–3.53) to 3.89 (95% CI 3.52–3.99), which are higher than the average value of 2.50. It means that, according to expert opinion, all of the 7 indicators are important. The variation coefficients for indicators of level 2 ranges from 0.08 to 0.17, which are lower than 0.20 and indicates that experts tend to be in agreement about the indicators.

Indicators in level 3

Table 2 shows the indicators in level 3 expressed in the recognition rate of importance (%), the mean of Likert rating with 95% confidence interval (95% CI), the variable coefficient, and the weight. Among the indicators in level 3, indicators III-1, III-2, III-3, III-4 are in level I-1, indicators III-5, III-6, III-7, III-8, III-9, III-10, III-11, III-12, III-13 are in level I-2, indicators III-14, III-15, III-16, III-17, III-18 are in level I-3, respectively. And among the indicator in level 3, indicators III-1, III-2 are in level II-1, indicators III-3, III-4 are in level II-2, indicators III-5, III-6 are in level II-3, indicators III-7, III-8, III-9, III-10 are in level II-4, indicators III-11, III-12, III-13 are in level II-5, indicators III-14, III-15 are in level II-6, indicators III-16, III-17, III-18 are in level II-7, respectively. The expert recognition rates for Level 3

indicators ranged from 80.6% to 100.0%, and the mean values were between 3.03(95% CI 2.67–3.35) and 3.97 (95% CI 3.82–4.00), which were all higher than the average value of 2.50. This indicates that all 18 indicators were considered to be important. The variation coefficients of these 18 indicators range from 0.04 to 0.24. All of the coefficient values were lower than 0.20 except for the item “the staff perception and attitudes towards premature breastfeeding” (variation coefficients=0.24 >0.20). It manifests the coordination that experts tend to be in agreement about the indicators.

The consistency test for experts’ evaluation results

The Kendall’s coefficient and its significance test [14] are used to examine the consistency of experts’ evaluation results for all of the 3 level indicators. Details are shown in Table 3. Experts tend to be in agreement for Level 1 indicators and in extreme agreement for Level 2 and Level 3 indicators. It is generally thought that the consistency of experts’ opinion for indicators’ importance is high.

Clinical application of the evaluation indicators system

By applying the established premature breastfeeding evaluation indicators system to 2 NICU wards in hospitals in Binzhou and Shanghai (the targeted preterm infants were more than 34 weeks corrected gestational age at the time), commencing in October 2010 and finishing in December 2010. We comprehensively assessed the quality of breast feeding by taking the method of weighted sum, using the formula of weighted

Table 2. Consultation results of the indicators in level 3.

Indicator code	Indicator name	Recognition rate of Importance* (%)	The mean of Likert rating (95% CI**)	Variable coefficient	Weight
III-1	The staff professional knowledge and skills for breastfeeding	83.3	3.06 (2.78–3.38)	0.19	0.50
III-2	The staff perception and attitudes towards premature breastfeeding	80.6	3.03 (2.67–3.35)	0.24	0.50
III-3	The management regulations for premature breastfeeding	94.4	3.33 (3.08–3.58)	0.18	0.50
III-4	Rooming-in facilities	94.4	3.36 (3.10–3.59)	0.17	0.50
III-5	Rooting reflex	91.7	3.42 (3.12–3.69)	0.19	0.49
III-6	Latched on (minutes)	100.0	3.97 (3.82–4.00)	0.04	0.51
III-7	Strength of sucking	97.2	3.47 (3.21–3.67)	0.16	0.27
III-8	Time of sucking	94.4	3.61 (3.32–3.89)	0.15	0.24
III-9	longest sucking burst (number of sucks)	97.2	3.25 (3.02–3.48)	0.15	0.24
III-10	Swallowing signs	97.2	3.36 (3.08–3.59)	0.18	0.25
III-11	Infants state after feeding	91.7	3.42 (3.11–3.72)	0.19	0.32
III-12	Milk volume intake	98.6	3.53 (3.23–3.81)	0.17	0.34
III-13	Mother's satisfaction about infant feeding behavior	100.0	3.81 (3.59–3.99)	0.11	0.34
III-14	Type of nipple	97.2	3.25 (2.95–3.53)	0.11	0.32
III-15	Lactation performance	100.0	3.78 (3.56–3.99)	0.15	0.34
III-16	Mother's confidence for breast feeding	92.1	3.11 (2.93–3.38)	0.18	0.34
III-17	Mother's knowledge about breast feeding	94.4	3.25 (3.12–3.55)	0.17	0.43
III-18	Mother's skills for breast feeding	97.2	3.50 (3.32–3.86)	0.16	0.57

* Recognition rate of importance is the percentage of the experts' opinion rating 3 or 4 in the 4-point Likert rating for indicators;

** CI – confident interval.

Table 3. The Kendall's coefficient values and its significance test.

	Level 3 indicators				
	Level 1 indicators	Level 2 indicators	Indicators of management for premature breastfeeding	Indicators of premature breastfeeding behavior	Indicators of mother's preparation and skills for premature breastfeeding
W^*	0.46	0.79	0.42	0.49	0.44
χ^{2***}	32.85	170.32	45.27	124.55	143.00
Df***	2	6	3	8	4
P	$P=.004$	$P<.001$	$P<.001$	$P<.001$	$P<.001$

* W is the values for Kendall's Coefficient of Concordance; ** χ^2 is the Chi-square values of Kendall's Coefficient of Concordance;

*** Df_c – degree of freedom, its' value= $n-1$

Table 4. Comprehensive evaluation values for the quality of premature breastfeeding in two hospitals.

Hospital	Y ₁	Y ₂	Y ₃	Y ₄	Y ₅	Y ₆	Y ₇	Y ₈	Y ₉	Y ₁₀
1	0.60	0.45	0.62	0.23	2.02	3.04	3.12	3.45	4.36	4.72
2	0.78	0.56	0.76	0.13	3.35	3.42	3.34	4.12	4.11	2.14
Hospital	Y ₁₁	Y ₁₂	Y ₁₃	Y ₁₄	Y ₁₅	Y ₁₆	Y ₁₇	Y ₁₈	Y(ΣYi)*	
1	2.23	3.56	3.04	2.56	7.78	3.51	3.04	4.98	53.31	
2	3.21	3.76	2.56	2.21	3.32	2.13	3.13	3.13	46.16	

* Y(ΣYi) is the sum of Yi (i ranges from 1 to 18), Yi stands for the weighted standardized value for each indicators.

sum of evaluation: make $Y_i = 100 * W_i S_i$, $Y = \sum Y_i$, among these, W_i means the weight coefficient of each indicator, $\sum W_i$ (i ranges from 1 to m)=1. S_i means the standardized value of each indicator, $0 \leq S_i \leq 1$; Y_i stands for the weighted standardized value for each indicator, and Y shows the weighted composite scores of the hospital. Results are shown in Table 4.

Discussion

Premature breastfeeding is an important issue that hospital nurses and mothers of premature infant have to deal with. How to fully understand the key aspects of impeding breastfeeding in preterm infants, and to modify and improve the breastfeeding rate based on the existing problems is the significance of establishing evaluation indicators system. In this study, we refined all the aspects which influence the breastfeeding in preterm infants through literature review, clinical observation, data analysis and comparison, induction and synthesis, and established the premature breastfeeding evaluation indicators system. The purpose of the study was to continuously improve the quality of premature breastfeeding with every aspect of influencing elements. Through the application of the system, which involves the assessment of NICU management, NICU facilities, preterm infant breastfeeding behavior development, and the preparation and skills of lactating mothers, hospital administrators and medical staff should discover the deficiencies and weaknesses in the preterm infant breastfeeding process, and then take corrective measures to promote premature breastfeeding rates and improve the quality. According to the progressive maturation of breastfeeding behaviors of preterm infants, NICU nurses and mothers should constantly revise the decision-making and operational procedures to promote continuous quality improvement and assure the success of breastfeeding of preterm infants.

This research shows that our experts reached consensus on the 3-level indicators classification (breastfeeding management of the hospital, behavior development of the premature, preparation and skills of the mother) (the significance test of Kendall's coefficient $P = 0.004 < 0.005$). Among the indicators,

breastfeeding management elements, which refer to the breastfeeding facilities, management regulations as well as the staff qualifications, are important components of the system and the guarantee and prerequisite for premature breastfeeding. This is shown by the fact that our hospital has implemented a series of important management measures in recent years to promote preterm infant breastfeeding by setting up specific breastfeeding rooms for mothers, enhancing rooming-in, providing convenient facilities for breastfeeding, and establishing professional breastfeeding team. As a result, the premature breastfeeding rates increased by 42% by the time of discharge. Similarly, a hospital in Brazil encouraged and provided convenient facilities, set up a special fund for mothers of hospitalized premature infants, and fully promoted premature breastfeeding, thereby achieving a premature breastfeeding rate of 94.6% [17]. By implementing rooming-in and "mother kangaroo" care policy, Ethiopia and Indonesia hospitals' exclusive breastfeeding rate for low birthweight infants reached 98% and 83%, respectively [18]. Similarly, in the neonatal unit of the hospital of Sweden, 94.4% of the 71 cases of premature infants with gestational age <35 weeks, birth weight ≤ 2000 g, gained exclusive breastfeeding at discharge [19]. This successful premature breastfeeding experience has demonstrated that the hospital breastfeeding policy and effective management are vital in promoting breastfeeding for preterm infants.

The indicators for behavior development of the premature are important in evaluate the efficiency of breastfeeding. In comparison with term infants, the presence of immature sucking and swallowing behaviors of premature infants makes breastfeeding difficult [20]. However, it is still unknown at which corrected gestational age (GA) preterm infants are able to start breastfeeding, and at which corrected GA premature infants are able to develop the capacity for functioning breastfeeding. Therefore, the establishment of a breastfeeding evaluation system with the indicators of breastfeeding behaviors, such as rooting reflex, latched on (minutes), strength of sucking, time of sucking, longest sucking burst (number of sucks), and swallowing signs, can quickly assess the behavioral development and ability for effective breastfeeding of preterm infants.

Breastfeeding is an interactive process between mother and infant, and it needs not only the efficient feeding behavior development of preterm infants, but also the adequate preparation and feeding skills of mothers. For lactating mothers, the timely and sustained lactation of breast milk is the basis for successful breastfeeding. Many factors, such as maternal separation anxiety, diet, sleep, and combined morbidity can affect the milk production. All mothers with difficulties in establishing and maintaining milk production should be offered individualized support and guidance during the preterm infants' hospital stay. Lactation counseling should be provided and breastfeeding skill should be trained by the staff with adequate education and training in the specific needs of mothers and infants in NICUs and should include demonstration of milk expression by hand or pump.

This breastfeeding evaluation indicators system for preterm infants is an all-round comprehensive evaluation system for premature breastfeeding. The type and character of the indicators within the system are different in usage and data collection, so the application of the system should focus on strategy. Firstly, combination of qualitative and quantitative method in overall evaluation of preterm infant breastfeeding should be considered. For the qualitative indicators, the connotative and denotative meaning of the indicator should be defined, and thereby make hierarchy of the qualitative indicator and assign a certain number of points for each hierarchy matched, such as classes of the superior, the secondary, and the inferior can be assigned for 10 points, 6 points, and 2 points (assuming the standard value of 10), respectively. For the quantitative indicators, the actual value and standard value of the indicator should be determined according to the practical evaluation and indicator properties. Secondly, the guiding role of the indicators system should be given full play. The content and standard of evaluation indicators system guide the direction of efforts made by medical staff and mothers in NICUs. In the process of evaluation, by comparing the current situation with the standard of the system, they can find the weak areas which need improving, and take corrective actions to enhance breastfeeding of premature infants. Thirdly, a long-term work mechanism should be established to promote breastfeeding for preterm infants. By strengthening the

responsibility and cooperation between administrators, medical staff, and mothers, a joint working mechanism should be optimized to enhance the smooth progress of breastfeeding premature infants.

There are several limitations to our research: (a) the expert panel was only from 4 hospitals in Shandong Province, (b) a small size sample was self-selected in the clinical observation for preterm breastfeeding, (c) the indicators system was applied in only 2 NICU wards in hospitals. Studies with larger sample sizes are needed.

Conclusions

Understanding and detecting problems in preterm infant breastfeeding is the key to improving the preterm breastfeeding rate. The findings of this study can be used to evaluate the implementation quality for preterm infant breastfeeding in NICUs, which fits the special conditions and the characteristics of premature. The breastfeeding evaluation Indicators System for Preterm Infants in NICUs could be applied as a measure for evaluating the breastfeeding quality and for investigating the barriers to increasing the breastfeeding rate for preterm infants. Conducting further studies to increase the applicability of this system and thereby contributing to the enhancement of the breastfeeding quality for preterm infants is warranted.

Conflicts of interest

We declare that we have no conflicts of interest.

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