

# Targeted Program for Provision of Mother's Own Milk to Very Low Birth Weight Infants

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## KEY WORDS

breastfeeding, human milk, breast milk, very low birth weight infant, smoking, morbidity

## ABBREVIATIONS

CI—confidence interval

GA—gestational age

MM—mother's milk

OR—odds ratio

VLBW—very low birth weight

Dr Husebye participated in the conceptualization and design of the study, participated in collection and tabulation of the data from medical records and analysis and interpretation of data, had the main responsibility for drafting the initial manuscript, and participated in revisions; Drs Kleven and Kroken participated in the conceptualization and design of the study, participated in the collection and tabulation of the data from the medical records, analysis and interpretation of the data, and participated in drafting and revising the initial manuscript; Dr Torsvik participated in the conceptualization and design, planned and performed the follow-up of most of the families after discharge from the NICU and in that respect collected most of the follow-up data, and participated in analysis and interpretation of the data and revising the manuscript; Dr Haaland is a biostatistician, and had a main responsibility of choosing methods and performing statistical analysis, participated in analysis and interpretation of data, and participated in drafting and revising the manuscript; Dr Markestad designed the protocol for the management of the infants while in the NICU and for recording the data consecutively, had a main responsibility for follow-up for a large part of the families, initiated the project, had the main responsibility for conceptualization and design of the study, participated in the analysis and interpretation of the data, and participated in drafting and revising the manuscript; and all authors approved the final manuscript as submitted.

[www.pediatrics.org/cgi/doi/10.1542/peds.2013-2463](http://www.pediatrics.org/cgi/doi/10.1542/peds.2013-2463)

doi:10.1542/peds.2013-2463

Accepted for publication May 7, 2014

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**WHAT'S KNOWN ON THIS SUBJECT:** Supplemented mother's own milk is the preferred nutrition for very low birth weight infants.



**WHAT THIS STUDY ADDS:** Through targeted encouragement and guidance, most mothers are able to provide milk to their very low birth weight infants, both for early and prolonged feeding, in an open-bay NICU.

## abstract

**OBJECTIVE:** Evaluate the effect of an evolving targeted program to encourage mothers to provide own milk (MM) to their very low birth weight (VLBW) infants in a traditional open-bay NICU.

**METHODS:** Retrospective review of medical records on all VLBW infants (birth weight <1500 g) born in a geographical region of Norway in 1986/1987, 1996, and 2007/2008 ( $n = 203$ ). Types of nutrition and data on maternal and infant health were prospectively and similarly recorded during all time periods. Between each period, targeted programs were initiated to encourage provision of MM.

**RESULTS:** The rates of providing MM (exclusively MM in parenthesis) for the 3 periods were 55% (33%), 85% (60%), and 89% (62%) when achieving full enteral feeds; 48% (11%), 76% (39%), and 92% (60%) at discharge; 15%, 42%, and 62% at 2 to 4 months' corrected age; and 10%, 40%, and 53% at 6 to 8 months' corrected age ( $P < .001$  at all end points). Neither maternal or pregnancy disorders nor neonatal morbidity had significant effects on provision of MM, but smoking was associated with a lower rate after discharge.

**CONCLUSIONS:** Both early and long-term provision of MM for their VLBW infants were strongly associated with targeted programs to encourage provision. We suggest that almost all mothers are able to provide their own milk if given targeted encouragement and guidance, even in crowded open-bay NICUs. *Pediatrics* 2014;134:e489–e495

Because of the multiple health benefits for the mother and infant, there is general agreement that appropriately supplemented human milk is the preferred nutrition for premature infants.<sup>1–4</sup> Furthermore, mother's own milk (MM) is considered superior to banked donor milk, because of its higher contents of protein and fat, and because pasteurization is usually not considered necessary.<sup>4</sup> Various programs for promoting breastfeeding in NICUs have been advocated, but an extensive systematic review concluded that the evidence base is limited, although kangaroo skin-to-skin contact, peer support, simultaneous breast milk pumping, multidisciplinary staff training, and Baby Friendly accreditation of the associated maternity hospital were associated with success.<sup>5</sup>

In Norway, human milk, provided as MM or banked donor milk, has always been the preferred early nutrition for prematurely born infants, but mothers have been increasingly encouraged and given more specific guidance in providing milk as the knowledge on benefits has increased. The aims of the current study were to assess the effect of initiatives on the part of a NICU to increase provision of MM, and to identify maternal and infant factors that may be of significance for success or failure.

## METHODS

### Patients and Setting

All very low birth weight (VLBW) infants, that is, birth weight <1500 g, born in Hordaland County, Norway, and admitted to the NICU in 1986/1987, 1996, and 2007/2008 were included in the study. The NICU, located at Haukeland University Hospital, is the only unit caring for preterm infants in the county, which has ~6000 births per year, and it serves as a level III nursery for the neighboring counties.

The NICU was built in ~1980, is crowded, and has no separate rooms, but reclining

chairs can be placed between incubators and in the vicinity of cots. When the infants are in a cot and can be safely taken out of the unit, the parents may spend some time alone with the infant in a separate room. Accommodation for parents has to a limited extent been available on the premises, but away from the NICU. The regular maternity unit at the hospital was accredited as Baby Friendly according to the requirements of "The Baby Friendly Hospital Initiative"<sup>6</sup> in 1994. An international group, The International Lactation Consultant Association, has expanded the World Health Organization initiative to promote breastfeeding in NICUs,<sup>7</sup> and the NICU was accredited according to these requirements in 2007.

The only management routines other than feeding practices that were changed during the study period were the introduction of surfactant in 1992 and a gradual increase in use of nasal continuous positive airway pressure.

### Feeding Practices

Throughout the study, orogastric or nasogastric gavage feeding was usually started on the first day of life. When small feeds were tolerated on intermittent gavage, increasing volumes were given continuously by pump while decreasing parenteral nutrition. Total intake was increased gradually from ~60 to 170 mL/kg per day, and parenteral nutrition was at the latest discontinued when ~130 to 140 mL/kg of enteral feeds were tolerated. A commercial human milk fortifier was added to both MM and donor milk when 170 mL/kg of enteral feeds was tolerated. The same feeding protocol was adhered to for the entire period except that the commercial human milk fortifier was changed from Presemp (Semper, Sundbyberg, Sweden) to Nutriprem (Nutricia, Schipol, The Netherlands) in January 2008.

### Feeding Interventions

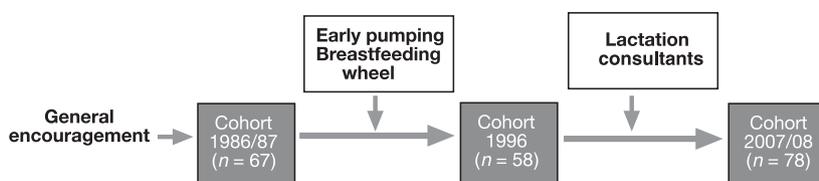
Throughout the study period, parents were encouraged to stay in the NICU as much as they wanted, practice skin-to-skin contact, and provide milk by manual expression or by using manual or electric pumps at home and electric pumps in a separate room while staying in the hospital. Electric pumps were provided at home without charge. These procedures were not altered during the study period.

Starting in the early 1990s, 2 specific programs were introduced to increase the mothers' ability to provide milk (Fig 1). Within the first hours after birth, the mothers were encouraged to start manual expression and rapidly change to electric pump approximately every 3 hours throughout the 24 hours. As soon as the infants could be taken out of their incubators, a specific 10-point stepwise procedure for promoting breastfeeding, the "Breastfeeding Wheel" was introduced (Fig 2). The Breastfeeding Wheel was developed by Berlieth Persson in Sweden and is widely used in Scandinavia. The program starts with skin-to-skin contact and subsequently continues through various stages of sucking on the nipple to full breastfeeding while decreasing gavage feeding. Dates when each specific step is accomplished are recorded in the figure. The feeding tube was kept in place until full feeds were taken by breast, cup, or bottle.

After 1996, the program was expanded by educating a number of nurses to become lactation consultants through a college program. They work with the mothers on an individual basis and in groups, and as teachers for the other nurses to create a uniform understanding on how to encourage and guide mothers.

### Collection of Data

Medical records of all eligible infants were reviewed in retrospect, but the



**FIGURE 1**  
Cohorts and interventions.

data were similarly and prospectively recorded throughout the study. Volumes and types of nutrition were recorded daily. The types of enteral nutrition (ie, MM, donor human milk, or formula) were recorded when full enteral feeds were first recorded, at 1 month of age, and at discharge. If only MM was noted that day, the nutrition the next 2 days also was reviewed and intake was recorded as partial MM if any other nutrition was noted. After discharge, the infants were followed at 2 to 4, 6 to 8, and 12 to 13 month's corrected age (ie, age from expected term date), and it was not differentiated between exclusive or partial MM. Information also was recorded on social background,

pregnancy, birth, and characteristics of the infants (Table 1).

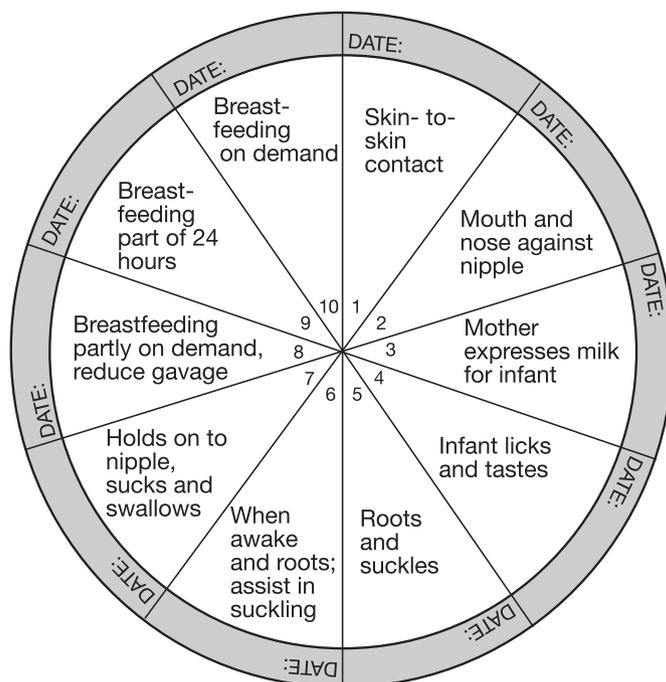
### Definitions

Full enteral feeds were defined as no longer in need of parenteral nutrition or fluid. Maternal education was recorded as high if she had completed high school. Gestational age (GA) was determined on the basis of ultrasound assessments at 17 to 18 weeks' gestation except for a few who did not have a scan. For these infants, GA was based on date of the last menstrual period combined with clinical assessment using the Dubowitz score<sup>8</sup> or Ballard score.<sup>9</sup> Small for gestational age was defined as birth weight less than the

10th percentile for GA using recently revised gender-specific growth charts for Norwegian infants.<sup>10</sup> All infants had regular cerebral ultrasound assessments during the first weeks of life. Cerebral hemorrhage was classified according to Papile et al,<sup>11</sup> periventricular cysts were recorded as periventricular leukomalacia, and necrotizing enterocolitis was diagnosed if treated as such on suspicion or if confirmed by intramural air or perforation. Retinopathy of prematurity was classified according to the Committee for Classification of Retinopathy of Prematurity.<sup>12</sup>

### Statistical Analyses

Statistical analyses were performed by using the SPSS statistical software version 20 (IBM SPSS Statistics, IBM Corporation, Chicago, IL) and R version 2.15.2 (R Foundation for Statistical Computing, Vienna, Austria). Because some of the continuous data were not normally distributed, all were presented as medians and interquartile range. The 3 cohorts were compared by using the Kruskal-Wallis test for continuous variables and the  $\chi^2$  test for categorical variables. Logistic regression analyses were used to determine which maternal and infant factors were associated with provision of MM. In the regression analyses, time was considered a continuous covariate, although the samples were obtained from only 3 cohorts. To decide which independent variables to include in the multivariate analyses, univariate analyses were conducted for time (in years), age of mother (years), marital or partnership status versus single motherhood, previous children (yes/no), education of mother (high/low), smoking (yes/no), GA (weeks), small for gestational age (yes/no), gender of infant, duration of ventilator treatment (days) and respiratory support (ie, the sum of ventilation, continuous positive airway pressure, and oxygen supplementation in days), and



**FIGURE 2**  
The Breastfeeding Wheel (translated and reproduced with permission from Berlith Persson, Helsingborg Hospital, Sweden).

**TABLE 1** Characteristics of the Mothers and Infants of VLBW Infants (Birth Weight <1500 g) Born in 1986/1987, 1996, and 2007/2008

	1986/1987, <i>n</i> = 67		1996, <i>n</i> = 58		2007/2008, <i>n</i> = 78		<i>P</i> <sup>a</sup>
	<i>n</i> <sup>b</sup>		<i>n</i> <sup>b</sup>		<i>n</i> <sup>b</sup>		
<b>Mothers</b>							
Age, y, median (IQR)	66	28 (8)	57	28 (7)	77	31 (9)	.008
Age <20 y, <i>n</i> (%)	66	6 (9.1)	57	1 (1.8)	77	2 (2.6)	.25
High education, <sup>c</sup> <i>n</i> (%)	42	13 (31)	49	25 (51)	45	32 (71)	.001
Single mothers, <i>n</i> (%)	60	7 (12)	55	5 (9)	73	7 (10)	.89
Smokers, <i>n</i> (%)	37	21 (57)	56	16 (29)	74	12 (16)	<.001
Previous children, <i>n</i> (%)	67	42 (63)	56	34 (61)	76	40 (53)	.43
Pregnancy complications, <i>n</i> (%)	59	38 (64)	54	26 (48)	76	37 (49)	.13
Cesarean delivery, <i>n</i> (%)	65	48 (74)	58	50 (86)	77	53 (69)	.063
<b>Infants</b>							
Boys, <i>n</i> (%)	67	37 (55)	58	26 (45)	78	46 (59)	.25
Gestational age, wk, median (IQR)	67	30 (3)	58	29 (4)	78	28.5 (3)	.03
Gestational age <28 wk, <i>n</i> (%)	67	11 (17)	58	21 (37)	78	21 (28)	.05
Birth weight, g, median (IQR)	67	1190 (292)	58	1165 (252)	78	1140 (463)	.23
Birth weight <1000 g, <i>n</i> (%)	67	12 (18)	58	17 (29)	78	27 (35)	.08
Ventilator treatment, d, median (IQR)	66	1 (4)	58	1 (5)	77	1 (2)	.53
Respiratory support, d, <sup>d</sup> median (IQR)	67	6 (37)	58	17 (53)	77	35 (60)	.01
Severe brain pathology, <sup>e</sup> <i>n</i> (%)	62	2 (3)	56	5 (9)	73	8 (11)	.24
Necrotizing enterocolitis, <i>n</i> (%)	67	0	58	0	78	3 (4)	.09
Retinopathy of prematurity, <sup>f</sup> <i>n</i> (%)	60	0	56	8 (14)	74	14 (18)	.002
Age full enteral feeds, d, median (IQR)	67	7 (5.5)	58	8 (5)	75	7 (6.5)	.65
Postmenstrual age at discharge, wk, median (IQR)	63	38.7 (2.8)	58	37.8 (2.8)	76	37.6 (3.5)	.02
Weight at discharge, g, median (IQR)	66	2455 (415)	58	2245 (575)	76	2316 (733)	.001

IQR, interquartile range.

<sup>a</sup> Kruskal-Wallis or  $\chi^2$  tests.

<sup>b</sup> Number with data.

<sup>c</sup> Completed high school.

<sup>d</sup> Sum of ventilator, continuous positive airway pressure, and supplemented oxygen.

<sup>e</sup> Cerebral hemorrhage grade 3–4 or periventricular cysts.

<sup>f</sup> Any degree.

postmenstrual age at discharge (weeks). The dependent variables were full or partial nutrition with MM versus no MM at each of the 4 end points. Independent variables were included in the multiple regression analyses if  $P < .2$  in at least 1 of the univariate regressions, which was true for all variables. Results were expressed as odds ratios (ORs) and 95% confidence intervals (CIs). A  $P < .05$  was considered statistically significant. Collinearity between independent variables was assessed as the Pearson's correlation coefficient. Ninety-four of the 203 patients had missing values among the independent variables, but by applying an imputation approach they were not excluded in any analyses.<sup>13</sup> Patients with missing values on a dependent variable were excluded in that analysis. Imputation was conducted by using the package

Amelia II in R,<sup>13</sup> and consisted of 3 steps. First, 100 datasets without missing values were simulated based on the original data. Next, a regression model was fit to each data set. Finally, the 100 models were combined as recommended.<sup>13</sup>

Being a retrospective review of hospital records, the study was exempt from review by the Regional Committee for Medical and Health Research Ethics, but it was approved by the regional Data Protection Official for Research.

## RESULTS

Of 216 VLBW infants admitted to the NICU, 71 were born in 1986/1987, 59 in 1996, and 86 in 2007/2008. Ten infants were excluded because of early death. The median age at death was 3 days, and only 2 of them lived longer than 6 days

(43 and 53 days; they received partial enteral feeds with MM). Two infants from the first and 1 from the second group were excluded because medical records could not be found. Thus, 203 infants were included (Table 1). Some background information was missing for some of the infants (Table 1) and some did not meet for follow-ups (Table 2). Characteristics of infants who attended follow-up did not differ from those who did not; however, their mothers tended to have a higher educational level (56% vs 41%,  $P = .12$ ), were more likely to have given MM at discharge (76% vs 68%,  $P = .26$ ), fewer were single (8% vs 14%,  $P = .24$ ), and fewer were smokers (27% vs 35%,  $P = .28$ ). Median corrected age at follow-up differed somewhat for the 3 periods because of changes in routines (Table 2).

The proportion of mothers with high education steadily increased and the proportion of smokers decreased from 1986/1987 to 2007/2008 (Table 1). Mean GA, birth weight, and weight at discharge decreased, whereas duration of respiratory support and proportion with retinopathy of prematurity increased during this period (Table 1). There were no significant differences in median duration of ventilator treatment or median age when tolerating full enteral feeds, or in proportion of infants experiencing severe cerebral or gastrointestinal complications (Table 1).

From 1986/1987 to 2007/2008, there was a steady increase in proportion of infants receiving MM when tolerating full enteral feeds, at 1 month of age, at discharge, and at follow-up during the first 6 to 8 months of age (Table 2). In 2007/2008, 92% received exclusive or partial feeding with MM at discharge, generally by taking the breast, and 62% and 53% received MM at follow-up at median corrected ages of 9 and 26 weeks (Table 2).

In the multivariate regression analyses, the proportion of infants receiving MM

**TABLE 2** Number of Children Receiving Exclusive, Partial, or No MM at Different Ages

	1986/1987, <i>n</i> = 67	1996, <i>n</i> = 58	2007/2008, <i>n</i> = 78	<i>P</i> <sup>a</sup>
	<i>n</i> <sup>b</sup>	<i>n</i> <sup>b</sup>	<i>n</i> <sup>b</sup>	
When full enteral feeds	64	57	73	
Age, d (IQR)	7 (5.5)	8 (5.0)	7 (6.5)	.65
• Exclusive MM	21 (33)	34 (60)	48 (62)	<.001
• Partial MM	14 (22)	14 (25)	21 (27)	
• No MM	29 (45)	9 (15)	4 (6)	
At age 1 mo	61	52	75	
• Exclusive MM	24 (39)	34 (65)	60 (80)	<.001
• Partial MM	20 (33)	14 (27)	12 (16)	
• No MM	17 (28)	4 (8)	3 (4)	
At discharge home	64	57	74	
Postmenstrual age, wk (IQR)	38.7 (2.8)	37.8 (2.8)	37.6 (3.5)	.02
• Exclusive MM	7 (11)	22 (39)	44 (60)	<.001
• Partial MM	24 (37)	21 (37)	24 (32)	
• No MM	33 (52)	14 (24)	6 (8)	
At first follow-up	53	53	52	
Corrected age, wk (IQR) <sup>c</sup>	13 (3)	17 (2.5)	9 (3)	<.001
• Exclusive/partial MM	8 (15)	22 (42)	32 (62)	<.001
• No MM	45 (85)	31 (58)	20 (38)	
At second follow-up	48	53	49	
Corrected age, wk (IQR) <sup>c</sup>	29 (5)	31.5 (4.8)	26 (2)	<.001
• Exclusive/partial MM	5 (10)	21 (40)	26 (53)	<.001
• No MM	43 (90)	32 (60)	23 (47)	
At third follow-up	43	46	53	
Corrected age, wk (IQR) <sup>c</sup>	56 (2)	55.5 (3)	52 (2)	<.001
• Exclusive/partial MM	1 (2)	6 (13)	9 (17)	<.001
• No MM	42 (98)	40 (87)	44 (83)	

Estimates are median (interquartile range [IQR]) or *n* (%).

<sup>a</sup> Kruskal-Wallis or  $\chi^2$  test, tested exclusive or partial versus no MM.

<sup>b</sup> Number with data.

<sup>c</sup> Age from expected term date.

increased significantly with time across all 4 follow-up periods (*P* values < .001, and ORs in the range 1.10–1.16 per year). Women who were married or living in partnership had greater success at providing MM than single women at the time when full enteral feeds were first tolerated (OR 5.13, 95% CI 1.45–18.12) and at follow-up at 6 to 8 months' corrected age (OR 5.47, 95% CI 0.98–30.43), but not at discharge or at the 2- to 4-month follow-up. Smoking was associated with failure to provide milk at follow-up at 2 to 4 months (OR 0.14, 95% CI 0.04–0.44) and 6 to 8 months (OR 0.18, 95% CI 0.06–0.59), and there was a similar trend when reaching full enteral feeds (OR 0.46, 95% CI 0.16–1.30) and at discharge (OR 0.38, 95% CI 0.13–1.08). There were no other significant associations. All pairs of independent variables were tested

for collinearity, and only 3 correlations were >0.5 (days of ventilator treatment versus GA, 0.71; days of ventilator treatment versus days on respiratory support, 0.61; and days on respiratory support versus GA, 0.54). Hence, the individual effects of days of ventilator treatment, days on respiratory support, and GA may be difficult to measure and results involving these variables should be interpreted with caution, as their SEs are likely to be too high. However, multicollinearity generally does not introduce bias to the effect estimates.

## DISCUSSION

This study shows that most mothers of VLBW infants can provide MM within the first days after birth and maintain provision until discharge when encouraged and given specific guidance,

even in a crowded and in many ways outdated open-bay NICU, and that accomplishment of providing MM while in the NICU is associated with later successful breastfeeding. Being a single mother or a smoker had a negative effect on early and prolonged provision of MM at some end points, whereas none of the other factors were of significance.

The weaknesses of the study were the relatively low number of infants, limiting the possibility of reliably testing the effect of infrequently occurring events on provision of MM, and the retrospective design, resulting in missing information on some of the predictor variables. However, all eligible infants were accounted for and the data were recorded prospectively by using the same methods during all 3 periods, suggesting that the results would have been the same with a true prospective design. For the infants born during 2007/2008, the follow-up after discharge occurred somewhat earlier than for the 2 earlier cohorts, which may have contributed to a somewhat higher breastfeeding rate after discharge. Breastfeeding after discharge was probably somewhat overestimated, as women lost to follow-up tended to have characteristics that were associated with failure of providing MM.

The 3 cohorts differed with respect to median age of mothers, level of education, and smoking, but these changes over time probably reflected the general trend among pregnant women in Norway<sup>14</sup> and not a true difference in population, as migration is low.<sup>14</sup> The lack of other socioeconomic differences (eg, proportions of young and single mothers) supports this notion. However, during the study period, the overall partial or exclusive breastfeeding rate of 3-month-old infants in Norway increased from 80% in 1988 to 92% in 1998,<sup>15</sup> suggesting that the general attitude to breastfeeding also may have contributed to the increased rate among mothers of VLBW infants.

The rate of exclusive or partial feeding with MM at discharge from the NICU for the cohort born in 2007/2008 (92%) was similar to the current overall rate of exclusive or partial breastfeeding of 6-week-old infants in the catchment area of the hospital (92%, T.M., unpublished, 2014), but somewhat lower at 2 to 4 months' corrected age (ie, median chronological age of 5.5 months) and 6 to 8 months' corrected age compared with the overall rate at 6 months in the area (73%, T.M., unpublished, 2014), suggesting that it is more difficult to maintain long-term breastfeeding in VLBW infants. This observation agrees with previous studies.<sup>16,17</sup>

We are not aware of other studies addressing rates of providing MM during the first couple of weeks of life in VLBW infants, and most previous studies have found lower rates during the NICU stay than in our cohort born in 2007/2008,<sup>18–23</sup> even after intervention programs that resulted in increased provision of MM for VLBW infants<sup>24–26</sup> or for infants in general admitted to

a NICU.<sup>27</sup> One randomized trial of structured counseling did not, however, have any effect on provision of MM.<sup>19</sup> In Scandinavia, rates of exclusive or partial MM feeding for infants with GA <32 weeks have been reported to be 65% to 81% at discharge,<sup>17,22</sup> and similar to that of our study at 2 to 6 months' corrected age.<sup>17,28</sup>

Similar to our findings for VLBW infants, others have found a negative association between maternal smoking and rate and duration of breastfeeding in general.<sup>29</sup> To what extent the effect of smoking reflected social differences and motivation to provide milk or an inhibitory effect of smoking on lactation is speculative.<sup>29</sup> In several studies, successful provision of MM was associated with proxy measures of social advantage.<sup>20–22,25,28</sup> In our study, being a single mother was associated with a slightly lower success rate of early and late provision of milk, but no other social factors, such as education or earlier experience with children, were of significance. A lack of significant associations to social factors

and to the clinical condition of the infant may be partly a result of lack of power because of limited cohort size and a high rate of providing MM, but it suggests that social and medical disadvantages can be partly overcome through targeted guidance. The lack of association between the infants' clinical condition and provision of MM is in agreement with 1 earlier study on VLBW infants.<sup>19</sup>

## CONCLUSIONS

The implication of this study is that it is possible for most mothers to provide milk for their VLBW infants, both for early feeding and maintenance through the NICU stay and after discharge, even when infants are cared for in a traditional open-bay and crowded NICU, when encouragement and targeted guidance are provided by a competent staff. This knowledge is also important when testing the effect of more modern NICU designs on parent competence, including provision of MM (eg, family-centered single-room care).<sup>30</sup>

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PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

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**FINANCIAL DISCLOSURE:** The authors have indicated they have no financial relationships relevant to this article to disclose.

**FUNDING:** No external funding.

**POTENTIAL CONFLICT OF INTEREST:** The authors have indicated they have no potential conflicts of interest to disclose.

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*Pediatrics* 2014;134:e489

DOI: 10.1542/peds.2013-2463 originally published online July 21, 2014;

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