




Availability of Breast Milk for Preterm Neonates by Gestational Age during NICU Stay

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Abstract

The objective of this study was to explore the availability of expressed breast milk (EBM) volume for the premature neonates born from mothers in different gestational age groups during neonatal intensive care unit (NICU) stay. All preterm infants (extreme-preterm infant [EPTI, <28 weeks], very-preterm infant [VPTI, 28–31^{6/7} weeks], and moderate-preterm infant [MPTI, 32–33^{6/7} weeks]) and their mothers were included in the study. Infants not receiving mother's own milk and neonates deceased or discharged against medical advice, and the mother with illness during postpartum period were excluded from the study. A predesigned tool was used to collect information on maternal characteristics, neonatal characteristics, and milk diary for preterm neonates from the NICU case records. The primary outcome variable EBM volume available on day 7 was compared across three gestational groups. Logistic regression was used to predict EBM availability. A total of 78 preterm neonates, including 10 EPTI, 37 VPTI, and 31 MPTI, had average birth weight of 962.5 ± 228.25 , $1,185.1 \pm 183.14$, and $1,293.2 \pm 182.92$ g, respectively. Receipt of exclusive breast milk among EPTI, VPTI, and MPTI was 80, 94, and 83.8%, respectively. Maternal characteristics were similar except for the mode of conception ($p = 0.001$), mode of delivery ($p = 0.04$), and antenatal steroid exposure ($p = 0.02$) among three gestational categories. The median (Q1–Q3) volume of EBM on day 7 were 160 (136.3–202.5), 150 (140–187.5), and 160 (150–220) mL for EPTI, VPTI, and MPTI neonates, respectively, without any statistical significance. Regression analysis suggests no effect of gestational age on EBM availability. The feasibility of mother's own milk use for extremely preterm neonates is similar to higher gestational preterm neonates.

Keywords

- ▶ neonate
- ▶ preterm birth
- ▶ nutrition
- ▶ human milk

Introduction

Prematurity is one of the leading causes of neonatal mortality worldwide.¹ Mother's own milk is the recommended enteral nutrition for preterm neonate and pasteurized donor

milk is recommended in its absence.² Preterm neonates receive lesser amount of breast milk in initial days compared with term neonates secondary to physiological immaturity and pathological morbidities. The necrotizing enterocolitis and feed intolerance in preterm neonates are inversely

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related to gestational age and birth weight, and could be protected by mother's own milk.³ Aggressive enteral nutrition practice has significantly cut down the need of central line, total parenteral nutrition, late-onset sepsis, and extra-uterine growth restriction.⁴ The average duration to reach full enteral nutrition among very low birth weight (VLBW) neonates is 7 to 10 days.⁵ Premature delivery impairs the phase of lactogenesis II, leading to insufficient milk for preterm neonates for aggressive enteral nutrition.⁶ Maternal characteristics such as mode of delivery, mode of conception, and antenatal steroid are known confounders for the availability of expressed breast milk (EBM) in preterm mothers.⁷⁻⁹ In this context, the present study explores the availability of breast milk volume for preterm neonates by gestational age of maternal delivery.

Methods

This is a hospital-based review of case records of inborn preterm neonates admitted to neonatal intensive care unit (NICU) from February 2019 to October 2019. All inborn preterm (extreme-preterm infant [EPTI] [<28 weeks], very-preterm infant [VPTI] [$28-31^{6/7}$ weeks], and moderate-preterm infant [MPTI] [$32-33^{6/7}$ weeks]) neonates delivered less than 34 weeks were included in the study. Infants not receiving mother's own milk and neonates deceased or discharged against medical advice or maternal illness where mother admitted to intensive care due to postpartum complication, and breast milk expression was not possible in initial 48 hours were excluded from the study. As per hospital policy, pregnant mothers admitted in expectant delivery before 34 weeks were given antenatal counseling and the perinatal team took the responsibility of preterm delivery care. Maternal age, parity, mode of conception, presence of antenatal Doppler, presence of oligohydramnios, antepartum hemorrhage, maternal illnesses, antenatal steroid administration, and mode of delivery were recorded from the antenatal history of neonatal case records. Mothers expressing breast milk were supported by dedicated neonatal sisters and junior residents under supervision of neonatologist. Mothers and family members were encouraged to initiate manual milk expression from first contact and importance of breast milk always prioritized. In case of inadequacy of mother's own milk, galactagogue (tablet domperidone 10 mg thrice daily for 2 weeks) and breast pump were advised by treating physician to augment milk production. Kangaroo mother care (KMC) was a standard protocol, universally practiced for all preterm neonates after critical illness was over. The available EBM (the milk volume produced by mother) per day was recorded in neonatal nursing charts and was used for encouragement of milk expression during daily family counseling. Neonatal gestational age was assigned based on maternal last menstrual period, expected time of delivery from first trimester ultrasound, and modified new Ballard scoring. Timing of initiation of trophic feeding and advancement of enteral nutrition were implemented by treating neonatologist based on NICU protocol. Full enteral feeding attainment was defined by the stoppage

of parenteral nutrition and achievement of 120 mL/kg/d of enteral nutrition. Both maternal and neonatal variables were described as descriptive statistics, that is, mean \pm standard deviation (SD), median (Q1-Q3), and frequency (%). Categorical variables were analyzed by chi-square/Fisher's exact test. The primary outcome variable, that is, EBM volume available on day 7 was compared across three gestational groups by Kruskal-Wallis' nonparametric test. The median value was used to categorize seventh day EBM volume into two groups, that is, <156 and ≥ 156 mL volume. Multivariable binomial logistic regression analysis was done to model the effect of gestational age on EBM on day 7 availability above median volume. SPSS (version 20 IBM) was used for data analysis.

Results

Out of 84 inborn preterm neonates, 5 neonates died and 1 neonate was on formula feeding due to maternal death. Total 78 preterm neonates were studied comprising 10 (12.82%) EPTI, 37 (47.44%) VPTI, and 31 (39.74%) MPTI with mean (\pm SD) birth weight (kg) were 0.96 ± 0.23 , 1.19 ± 0.18 , and 1.29 ± 0.18 , respectively. The demographic profile of maternal characteristics across three gestational groups is given in **Table 1**. The three groups of mothers were similar in their characteristics except for the mode of maternal conception, antenatal steroid coverage, and mode of delivery. Mothers in the EPTI group had a lower rate of cesarean section 2/10 (20%) in comparison to 23/37 (62.1%) in VPTI and 20/31 (64.5%) MPTI groups. The antenatal steroid exposure of EPTI, VPTI, and MPTI groups were 5/10 (50%), 17/37 (45.94%) and 24/31 (77.4%), respectively.

The receipt of breast milk stratified by gestational age groups among preterm neonates is shown in **Fig. 1**. In this study, 8 of 10 (80%) EPTI, 35 of 37 (94.59%) VPTI, and 26 of 31 (83.87%) MPTI had received only express breast milk during NICU stay and rest were on mixed feeding (breast milk plus formula feeding). Neonatal characteristics of each group of preterm neonates including enteral nutrition are shown in **Table 2**. The median (Q1-Q3) EBM volume on day 2 (EPTI: 14 [0-18.25] mL, VPTI: 15 [10-24.5] mL, and MPTI: 16 [11-25] mL), day 7 (EPTI: 160 [136.3-202.5] mL, VPTI: 150 [140-187.5] mL, and MPTI: 160 [150-220] mL), and at NICU discharge (EPTI: 257.5 [175-280] mL, VPTI: 300 [260-320] mL, and MPTI: 270 [190-290] mL) were not significantly different across different gestational age groups (**Fig. 2**).

The EBM availability on day 7 was not significantly different across gestational age groups after matching for the confounders (**Table 3**).

Discussion

In perinatal care practice, supportive of breast milk availability for preterm neonates from the very beginning should be on evidence-based policies and family centered.^{10,11} In a developing country, there is a lack of availability in pasteurized donor breast milk and human milk banking facility and formula feeding being used as the alternative enteral nutrition in absence of mother's own milk.¹² To our knowledge,

Table 1 Maternal characteristics stratified by preterm gestational age groups

Maternal characteristics		Extreme preterm (N = 10)	Very preterm (N = 37)	Moderate preterm (N = 31)	p-Value
Age of mother (y), mean [95% CI] ± SD		31.4 (29.5–33.3) ± 2.7	28.9 (27.3–30.4) ± 4.6	28 (25.8–30.2) ± 5.9	0.187
Parity	Primi	7 (70.00%)	19 (51.35%)	22 (71.00%)	0.227
	Multi	3 (30.00%)	18 (48.65%)	9 (29.00%)	
Assisted reproductive technique for conception	No	6 (60.00%)	34 (91.90%)	31 (100.00%)	0.001
	Yes	4 (40.00%)	3 (8.10%)	0 (0.00%)	
Singleton or multiple pregnancy	Singleton	6 (60.00%)	22 (59.45%)	21 (67.70%)	0.762
	Multiple	4 (40.00%)	15 (40.55%)	10 (32.30%)	
Maternal gestational diabetes mellitus	No	10 (100.00%)	33 (89.20%)	28 (90.30%)	0.752
	Yes	0 (0.00%)	4 (10.80%)	3 (9.70%)	
Maternal hypertension	No	7 (70.00%)	34 (91.90%)	26 (83.90%)	0.133
	Yes	3 (30.00%)	3 (8.10%)	5 (16.10%)	
Hypothyroidism	No	10 (100.00%)	31 (83.80%)	27 (87.10%)	0.516
	Yes	0 (0.00%)	6 (16.20%)	4 (12.90%)	
Cardiorespiratory illness	No	10 (100.00%)	36 (97.30%)	30 (96.80%)	0.999
	Yes	0 (0.00%)	1 (2.70%)	1 (3.20%)	
Premature rupture of membrane	No	10 (100.00%)	25 (67.60%)	24 (77.40%)	0.091
	Yes	0 (0.00%)	12 (32.40%)	7 (22.60%)	
Oligohydramnios	No	10 (100.00%)	36 (97.30%)	28 (90.30%)	0.349
	Yes	0 (0.00%)	1 (2.70%)	3 (9.70%)	
Antenatal abnormal Doppler	No	9 (90.00%)	36 (97.30%)	29 (93.50%)	0.469
	Yes	1 (10.00%)	1 (2.70%)	2 (6.50%)	
Antepartum hemorrhage	No	10 (100.00%)	36 (97.30%)	28 (90.30%)	0.349
	Yes	0 (0.00%)	1 (2.70%)	3 (9.70%)	
Antenatal steroid	No	5 (50.00%)	20 (54.05%)	7 (22.60%)	0.022
	Yes	5 (50.00%)	17 (45.95%)	24 (77.40%)	
Mode of delivery	Vaginal	8 (80.00%)	14 (37.90%)	11 (35.50%)	0.04
	Cesarean section	2 (20.00%)	23 (62.10%)	20 (64.50%)	
Galactagogue use	No	6 (60.00%)	21 (56.75%)	22 (71.00%)	0.467
	Yes	4 (40.00%)	16 (43.25%)	9 (29.00%)	

Abbreviations: CI, confidence interval; SD, standard deviation.

there was no literature reported regarding the availability of mother's own breast milk based on gestational age stratification for preterm neonates reported from South East Asia. Considering the problematic onset of lactogenesis for preterm mothers during initial postnatal days and average duration to achieve full feeding by 7 to 10 days among VLBW neonates, the seventh day expressed milk volume was chosen as the primary outcome to emphasize the availability of mother's own milk during the need of aggressive enteral nutrition. In a multicentric study, adequacy of milk at 6 weeks was predicted from day 4 milk volume.¹³

Preterm mothers need more multisupportive care for the availability of breast milk compared with term mothers.⁹ Prenatal breastfeeding education is not established except a

few baby-friendly hospitals in developing countries for preparedness of milk expression manually or through breast pump within the first hour of infant birth. In Parker et al's study, initiation of milk expression within 1 hour of delivery significantly increased milk volume compared with later (>1 hour) expression.¹⁴ The frequency and duration of pumping matter along with the timing of initiation for the availability of milk in postdelivery, which is practically difficult in initial stressful days. The availability of breast milk for VLBW neonates depends on the site or unit of care in NICU, representing the role of health care providers in improving breastfeeding.¹⁵ Duration of NICU stay inversely related to the gestational age of preterm birth and for sustained availability of breast milk, the family should be

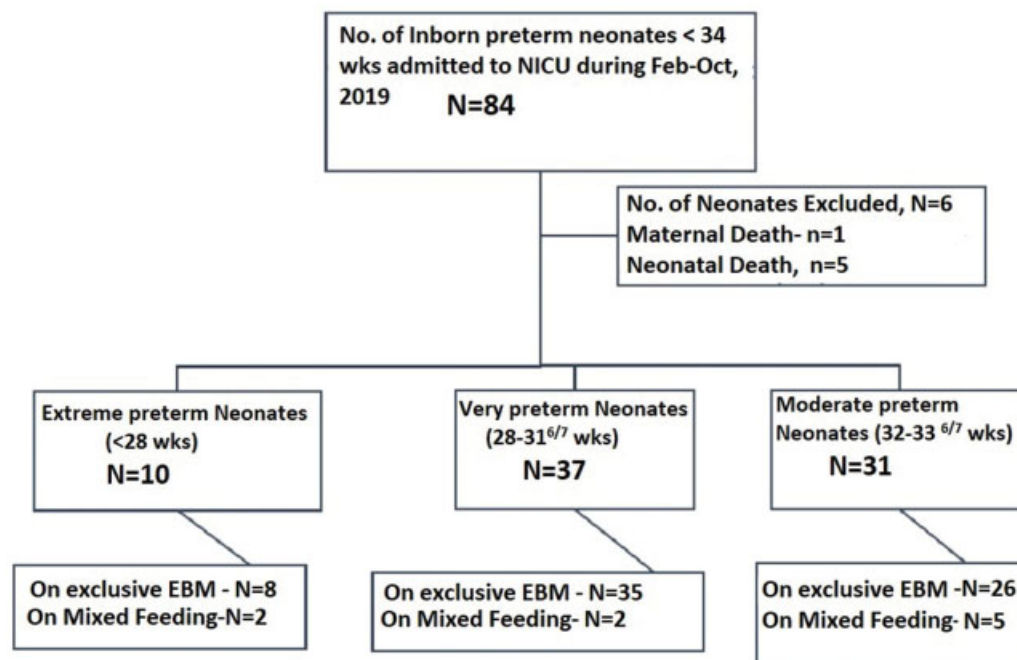


Fig. 1 Receipt of breast milk by the preterm neonates. EBM, expressed breast milk; NICU, neonatal intensive care unit; Mixed Feeding, EBM + formula feeding.

Table 2 Neonatal characteristics stratified by preterm gestational age groups

Neonatal characteristics		Extreme preterm N = 10	Very preterm N = 37	Moderate preterm N = 31	p-Value
Birth weight (kg), mean (95% CI) \pm SD		0.96 (0.80–1.13) \pm 0.23	1.19 (1.12–1.25) \pm 0.18	1.29 (1.23–1.36) \pm 0.18	<0.001
Gender	Male	6 (60.00%)	14 (37.80%)	15 (48.40%)	0.402
	Female	4 (40.00%)	23 (62.20%)	16 (51.60%)	
Use of exclusive breast milk	No	2 (20.00%)	2 (5.40%)	5 (16.10%)	0.238
	Yes	8 (80.00%)	35 (94.60%)	26 (83.90%)	
Weight at discharge (kg), mean (95% CI) \pm SD		1.90 (1.83–1.96) \pm 0.09	1.93 (1.84–2.01) \pm 0.26	1.86 (1.67–2.05) \pm 0.52	0.8
Initiation of feeding (d), median (IQ1–Q3)		2.5 (2–3)	2 (2–3.5)	2 (1–2)	0.021
Full feed reached (d) median (Q1–Q3)		14.5 (10.5–20)	12 (9–19)	8 (6–10)	<0.001
Duration of hospital stay (d), median (Q1–Q3)		68.5 (54–92)	44 (33.5–57.5)	27 (19–34)	<0.001
Duration of KMC (d), median (Q1–Q3)		34.5 (31–49)	22 (16.5–28)	11 (8–17)	<0.001

Abbreviations: CI, confidence interval; KMC, kangaroo mother care; SD, standard deviation.

supported such as shelter to mother and few family members, KMC practice, nonnutritive sucking, regular family counseling, psychological support, maternal nutrition, and health care. Kangaroo care units were superior in breast milk feeding for preterm neonates in various studies.^{16–18} In this study, all neonates are supported with KMC following the initial sickness period and on average, half of the total hospital days of all preterm neonates are with KMC. Intermittent feed holding secondary to late-onset neonatal sepsis,

necrotizing enterocolitis, and prematurity-related feed intolerance are commonly encountered during extreme preterm care, which affects maternal psychology and a major barrier for milk production. The study site was enriched with two dedicated staff nurses for sustained antenatal and postnatal maternal support, daily basis recording of mother's attempt for milk expression, and daily basis milk volume recording which was used as a continuous maternal motivation.

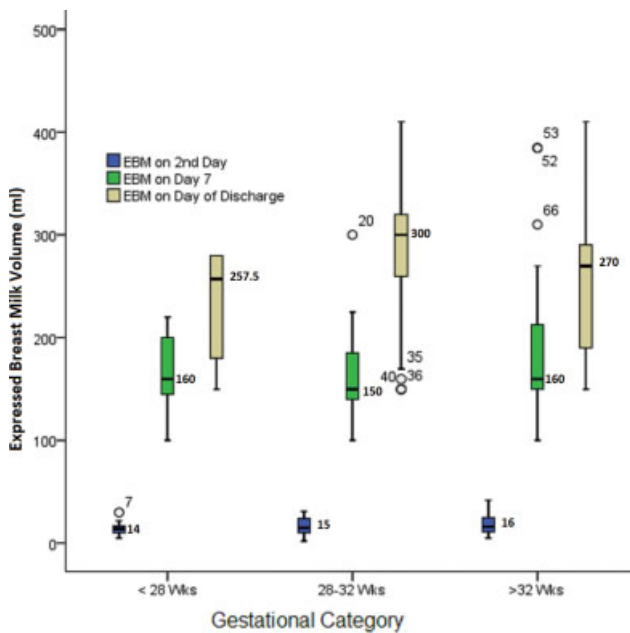


Fig. 2 Box plot showing expressed breast milk (EBM) volume on different postnatal days stratified by gestational age groups.

Table 3 Regression model

Variables	Exp (B)	95% CI Exp (B)	p-Value
Antenatal steroid			
No	1		
Yes	1.39	0.504–3.838	0.525
Mode of delivery			
Cesarean section	1		
Vaginal delivery	1.544	0.58–4.112	0.384
Assisted reproductive technique for conception			
Yes	1		
No	1.393	0.228–8.498	0.719
Gestational category			
Extreme preterm	1		0.896
Very preterm	0.863	0.177–4.214	0.855
Moderate preterm	1.097	0.212–5.671	0.912

Abbreviation: CI, confidence interval.

The enteral nutrition practice for VLBW neonates in this study was congruous to various studies toward the achievement of full enteral feeding by gestational age.^{4,5} From the National Vital Statistics System of United States 2017, the receipt of breast milk varies across gestational age was reported by Chiang et al. The extreme preterm (<28 weeks), early reterm (28–33 weeks), and late preterm received breast milk in 71.3, 76.0, and 77.3%, respectively.¹⁹ In this study, all inborn preterm neonates during the study period had ingested any breast milk except one neonate with maternal death. Among EPTI, VPTI, and MPTI, the exclusive breast milk ingestion during NICU was 80, 94, and 83%, respectively. In a

quality improvement program, through multiple Plan-Do-Check-Act cycles, the availability of EBM by 48 hours had improved from 4.7 to 15.8 mL and around 82.3% VLBW neonates were on EBM at the time of attaining 100 mL/kg/d enteral feeding.²⁰ The provision of breast milk for preterm neonates in California NICUs was predicted on gestational age and 1-week advancement in gestational age was associated with modest to increase in breast milk feeding at discharge.²¹

Maternal lactogenesis is affected by mode of delivery, maternal medication, and gestational age of delivery.⁷ Cesarean section is found to be a barrier to initiating breastfeeding even in term delivery.⁸ Antenatal corticosteroids have been found to have an effect on reduced breast milk volumes, in particular, in those women who have delivered at the very preterm gestational age and they need more supportive care.⁹ In Enhancing breast milk production with Domperidone in mothers of preterm neonates (EMPOWER) trial, the milk volume produced by mothers between 23^{0/7} to 26^{6/7} and 27^{0/7} to 29^{6/7} weeks were not significantly different, and there was no independent influence of mode of delivery and maternal antenatal steroid on EBM volume.²² We could not find any research to confirm or refute the link between the mode of conception and EBM volume. In this study, mode of conception, antenatal steroid exposure, and mode of delivery across gestational age groups have nonsignificant effect on the availability of EBM. Data were analyzed from a single tertiary center with a relatively small sample size from neonatal case records and milk diary. The nonavailability of the maternal sociodemographic profile including maternal education is a limitation in this study. Maternal education is a potential contributing factor to the mother's willingness to exclusively breastfeed.

Conclusion

Mothers of extreme and very preterm neonates expressed milk volume similar to that of moderate preterm neonates at different postnatal days despite physiological barrier and in contrast to usual perception. Therefore, the perinatal team must put coordinated effort for the availability of mother's own milk for all preterm neonates. Further prospective multicentric study on quality improvement on availability of breast milk for preterm neonates <34 weeks in a developing country is timely needed.

Conflict of Interest

None declared.

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