

Achievement of full enteral feeding using volume advancement in infants with birth weight 1,000 to <2,000 grams

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Abstract

Background Early enteral feeding is one of the efforts to improve gastrointestinal adaptability in preterm infants. Volume advancement (VA) enteral feeding has been associated with less time to reach full feeding, which can improve outcomes.

Objective To evaluate the duration of VA needed to achieve full enteral feeding (FEF) in low birth weight (LBW) and very low birth weight (VLBW) infants and related factors.

Methods This prospective study was done in infants with birth weight 1,000 to <2,000 grams in the Neonatal Ward and NICU of Dr. Moh. Hoesin General Hospital, Palembang, South Sumatera. All infants underwent VA feeding. The time needed to achieve FEF (150 mL/kg/day) was recorded. Several clinical factors were analyzed for possible associations with the success rate of achieving FEF within 10 days of feeding.

Results Thirty-five infants were included in this study with a mean gestational age of 31.83 (SD 2.67) weeks. Their median body weight at the start of protocol was 1,400 (range 1,000-1,950) grams and 80% had hyaline membrane disease. Median time to achieve FEF was 11 (range 8-21) days, with 48.6% subjects achieving FEF in ≤ 10 days. Gestational age <32 weeks (OR 5.404, 95%CI 0.963 to 30.341), birth weight <1,500 grams (OR 5.248, 95%CI 0.983 to 28.003), and male gender (OR 4.751, 95%CI 0.854 to 26.437) were associated with the failure of achieving FEF within 10 days of feeding, however, no factors remained statistically significant after multivariate analysis.

Conclusion Full enteral feedings in infants with birth weight 1,000 to <2,000 grams with VA feeding are achieved within a median of 11 days. Gestational age, birth weight, and gender are not associated with time needed to achieve FEF. [Paediatr Indones. 2020;60:173-7; DOI: 10.14238/pi60.4.2020.173-7].

Keywords: LBW; VLBW; preterm infants; volume advancement; full enteral feeding

Low birth weight (LBW) is defined as birth weight lower than 2,500 grams, and further classified into very LBW (VLBW), birth weight <1,500 grams and extremely (ELBW), birth weight <1,000 grams. Depending on gestational age, infants are grouped as moderate to late preterm, very preterm, and extremely preterm.^{1,2}

More than 20 million infants worldwide representing 15.5% of all births are born with low birth weight, 96.5% of them in developing countries.³ In 2013, the incidence was 10.2% in Indonesia and 9% in South Sumatera.⁴ According to medical records at Dr. Moh. Hoesin General Hospital (RSMH) in 2017, 377 infants hospitalized in the NICU and Neonate Ward had body weight of 1,000 grams to < 2,000 grams (data not published).

Preterm infants have a high risk of mortality due to their immature organs, including gastrointestinal

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problems, as well as immature oromotor function, such as the lack of sucking and swallowing reflex coordination. These problems may cause difficulty in achieving FEF in LBW and VLBW infants, predisposing them to malnutrition. Two previous studies showed that VLBW infants are at risk of developmental delay, emphasizing the need for long-term neurodevelopmental follow-up.^{1,5,6}

Enteral feeding for LBW infants typically starts at 10-15 mL/kg BW/day, with breast milk or formula for preterm infants. There are two enteral feeding strategies: frequency advancement (FA) and volume advancement (VA). In the VA method, feeding is characterized by rapidly increasing administered volume in increments of 20 mL/kg BW/day, while in the FA method, the frequency of administration is increased before volume. The goal of enteral feeding is to achieve full enteral feeding (FEF) of 150 mL/kg BW/day.⁷⁻¹⁰ Early achievement of FEF (within 10 days) is associated with fewer nutritional complications.¹¹ Several factors may influence the achievement of FEF in LBW and VLBW infants, including gestational age, birth weight, APGAR score at 5 minutes, weight at feeding initiation, type of milk, and infection.¹¹

This study was done in LBW and VLBW infants with weights of 1,000 grams to < 2,000 grams, as a pilot study, to identify the time required to achieve FEF (150 mL/kgBW/day) using VA enteral feeding. We also evaluated other factors potentially affecting FEF time.

Methods

This prospective study was conducted from October 2018 to February 2019 in Neonatal Ward and NICU of Mohammad Hoesin Hospital (RSMH), Palembang, South Sumatera. Hospitalized infants with birth weight 1,000 to < 2,000 grams were screened for inclusion after parents provided written, informed consent. Infants with major congenital malformations, malformation of the gastrointestinal tract, intraventricular hemorrhage grades 3 and 4, hypoxic ischemic encephalopathy, or incomplete infant data (no APGAR score, no birth data, such as birth weight) were excluded from this study.

All stable infants were enrolled and given 10 mL/kg/day in three hourly enteral feedings within

24-48 hours after birth. Volume was increased gradually with 20 mL/kg/day increments based on clinical condition. Full enteral feeding (FEF) was defined as the ability to tolerate 150 mL/kg/day of enteral feeding. Feeding consisted of expressed breast milk or premature formula by nasogastric tube. Before achieving FEF, additional parenteral nutrition was given to meet nutritional requirements. Infants experiencing clinical deterioration that necessitated cessation of enteral feeding for >24 hours were considered to have dropped out. And for unstable infants, who had respiratory distress, hypoglycemia, hypotension and shock, had late enteral feeding.

We also analyzed factors that may affect the time needed to achieve FEF, including gestational age, weight at the start of enteral feeding, presence of infection (clinical sepsis, sepsis, or bronchopneumonia), and respiratory distress syndrome.^{9,11} Clinical sepsis was defined as general signs or symptoms of weakness, feeding problems, weight loss, lethargy, apnea attacks, dyspnea, cyanosis, diarrhea, vomiting, or circulatory or hematological disorders. Sepsis was defined as signs and symptoms of clinical sepsis with two or more laboratory findings: leukocyte < 5,000/mm³ or > 34,000/mm³, ratio of immature to total neutrophils of 0.2 or more, ESR > 15 mm/hours, and C-reactive protein > 9 mg/dL. Bronchopneumonia was defined as breathing difficulties characterized by dyspnea, tachypnea, chest retractions, respiratory grunting, cyanosis with normal or decreased respiratory sounds, crackles, rales, and infiltrates on chest x-ray.²

This study was reviewed and approved by the Ethics Committee of Sriwijaya University Medical Faculty. Bivariate analysis was done using Chi-square test and multivariate analysis using logistic regression test. Statistical analyses were carried out using SPSS for Windows version 24.0.

Results

Forty-two infants were screened for our study, but seven dropped out from study because of clinical deterioration [NEC (2 infants), respiratory failure due to pulmonary hemorrhage and subsequent death (2) duodenal stenosis (1), and gastrointestinal bleeding leading to cessation of enteral nutrition more than 24 hours (2)]. Hence, a total of 35 infants were analyzed (Table 1).

Table 1. Clinical characteristics of subjects

Characteristics	(N=35)
Gestational age, n	
Extremely preterm (< 28 weeks)	1
Very preterm (28 to < 32 weeks)	14
Moderate to late preterm (32 to < 37 weeks)	20
Birth weight, n	
1000 - < 1500 grams	21
1500 - < 2000 grams	14
Gender, n	
Male	19
Female	16
APGAR score at 5 min, n	
< 5	1
5 or more	34
Body weight at start of protocol, n	
1,000 to < 1,500 grams	21
1,500 to < 2,000 grams	14
Type of milk, n	
Breast milk	14
Formula milk	21
Infection, n	
Yes	7
No	28
Birth place, n	
RSMH	27
Others	8
Time to start enteral feeding, n	
< 24 hours	9
24-48 hours	26

Birth weight was identical to weight at initiation of enteral feeding in all infants, with median 1,400 (1,000-1,950) grams. Mean gestational age was 31.83 (SD 2.67) weeks. Hyaline membrane disease was found in 80% of infants. Mean FEF achievement was 11.7 days, with median 11 (range 8-21) days. There were 17 (48.6%) subjects who achieved FEF in ≤ 10 days. Mean weight gain was 5.8 grams each day, with median weight gain 5.69 (range -2.20-18.67) grams/kg/day.

Factors potentially affecting achievement of FEF are listed in **Table 2**. Subjects with gestational age less than 32 weeks, body weight less than 1,500 grams, and male gender had greater proportions of failure to achieve FEF within 10 days. Correlation analysis identified a moderately negative correlation between weight gain and starting weight (**Table 3**). After multivariate analysis, no factor was found to independently influence FEF achievement (**Table 4**).

Discussion

In this prospective study on infants with birth weight of 1,000 to <2,000 grams, we aimed to assess the rate of full enteral feeding achievement. We found that only 48.6% of infants successfully achieved FEF in < 10 days. The median time needed to achieve FEF in all subjects was 11 days. No complications related to enteral feeding were apparent in this study. Not achieving FEF in < the first 10 days of life has been associated with malnutrition (odds ratio 1.97).¹² Another study found that with either volume advancement or frequency advancement, infants regained their birth weight within 7-10 days. The longer duration needed for FEF achievement in our study may have been related to younger gestational age, which is associated with gastrointestinal tract immaturity and inadequate digestive enzymes.⁹

We noted a mean weight increase of 5.8 grams/kg/day. This result was lower than a previous study on low birth weight infants. They reported that 60% could achieve weight gain of >5 grams/kg/day, and risk factors for not gaining more weight included gestational age, birth weight, intrauterine growth, and complicating illnesses.¹³ In our study, the overall lower weight gain may have been related to the finding that the majority of subjects had complicating illnesses.

Factors affecting the success in achieving FEF in this study were gestational age, and starting weight. Younger gestational age (< 32 weeks), lower starting weight (1,000 to < 1,500 grams), and male sex were associated with failure to achieve FEF within 10 days of enteral feeding. A study found that infants with weight < 1,000 grams needed 2 weeks to achieve FEF, while those with weight between 1,000 and 1,500 grams only needed one week.⁷ Another study estimated that an additional one week of gestational age would reduce the time needed to achieve FEF by 15.9%. The same study also found that small for gestational age can increase the time needed to achieve FEF by 16.6%.¹¹ Previous studies found that male sex was associated with worse short and long term outcomes, usually associated with infections.^{7,9} No factors in this study remained significant upon multivariate analysis, indicating that interplay between factors may be needed to affect the outcome.

Factors associated with success in achieving FEF in another study, but not ours, were higher CRIB II

Table 2. Bivariate analysis of factors potentially affecting achievement of FEF within 10 days enteral feeding (N=35)

Variables	Not achieved	Achieved	Total	RR	95%CI	P value
Gestational age						
< 32 weeks	11	4	15	2.095	0.167 to 1.008	0.025
32 or more weeks	7	13	20			
Body weight at start of protocol						
1,000 to < 1,500 grams	14	7	21	2.33	0.234 to 0.930	0.027
1,500 to < 2,000 grams	4	10	14			
Gender						
Male	12	7	19	1.684	0.293 to 1.188	0.130
Female	6	10	16			
Type of milk						
Formula milk	10	11	21	0.952	0.478 to 1.898	0.890
Breast milk	7	7	14			
Infection						
Yes	4	3	7	1.143	0.545 to 2.397	0.735
No	14	14	28			
Clinical sepsis						
Yes	2	1	3	0.627	0.123 to 3.212	0.478*
No	15	17	32			
Sepsis						
Yes	0	3	3	2.133	1.475 to 3.085	0.125*
No	15	17	32			
Bronchopneumonia						
Yes	2	1	3	0.427	0.047 to 4.744	0.478*
No	17	15	32			
HMD						
Yes	17	14	31	2.194	0.390 to 12.338	0.261*
No	1	3	4			

*Fisher's exact test

Table 3. Correlation with weight gain per day

Variables	r	P value
Body weight at start of protocol	-0.531	0.001
Gestational age	-0.317	0.063

scores, maternal hypertension, Caesarean delivery, formula milk, presence of patent ductus arteriosus, and complicating illnesses such as respiratory distress syndrome, sepsis, and pneumonia.¹¹ The lack of association in our study may have been due to the small sample size. Moreover, the majority of subjects in our study had respiratory distress syndrome, which may mask its effects and the effects of other illnesses. In conclusion, infants with weight 1,000 to < 2,000 grams who receive volume advancement enteral feeding, have a median duration of 11 days to achieve FEF, which is slightly longer than the recommended duration of 10 days. We also noted VA enteral feeding to be safe. Infants with younger gestational age, lower starting weight, and male sex tend to achieve FEF in

Table 4. Regression logistic analysis for factors potentially affecting achievement of FEF within initial 10 days of enteral feeding

Variables	OR	95%CI	P value
Gestational age < 32 weeks	5.404	0.963 to 30.341	0.055
BW < 1,500 grams	5.248	0.983 to 28.003	0.052
Gender	4.751	0.854 to 26.437	0.075

more than 10 days. We recommend a larger study to better characterize factors affecting the success of achieving FEF using VA enteral feeding.

Conflict of interest

None declared.

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