Original article

Influence of anthropometric parameters on breastmilk provision in preterm infants[☆],[☆☆]

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A B S T R A C T

Objective: To explore how growth trends may relate to maternal provision of breastmilk to preterm infants in the Neonatal Intensive Care Unit (NICU).
Design: Non-experimental, retrospective, descriptive.
Setting: Level III, 40-bed suburban neonatal intensive care unit (NICU).
Participants: 94 preterm infants (< 37 post-menstrual age) admitted to the NICU between September 2011 and May 2013.
Methods: This retrospective chart review explored the relationship between infant growth during hospitalization and maternal provision of breastmilk at discharge. Growth data were collected including standard weekly growth measurements from birth through hospital discharge. In addition, average growth over time or growth velocity was assessed for weight (g/kg/d), head circumference (cm/d) and length (cm/d). Growth parameters at birth and discharge were plotted using the **Olsen 2010 Growth** Calculator for **Preterm** Infants to obtain standardized assessments of growth percentiles. Key growth factors were examined against the primary investigational outcomes of continued breastmilk provision at discharge and length of hospital stay. Variables included infant characteristics, number of daily direct-to-breast feedings (identified as traditional oral breastfeeding), and maternal characteristics. Statistical tests included student *t*-test and chi square. Logistic regression models were used to evaluate data and multiple regression was used to examine growth variables.
Result: In this cohort, 44% of mothers continued to provide breastmilk at the time of infant discharge. Growth velocity was a significant predictor of continued provision of breastmilk at discharge (p = 0 0.002, OR 1.39). Ponderal index, combined with other variables were highly predictive of length of stay (p < 0.001, R^2 = 0.858). Those infants whose first oral feed was direct-to-breast (versus bottle) were more likely to still be receiving breastmilk at discharge (adj OR 5.3).
Conclusion: First oral feed being direct-to-breast and higher growth velocity are supportive of continued breastmilk provision throughout hospitalization. These results highlight a need for additional breastfeeding support for mother-infants dyads who provided a bottle as the first oral feed or with poorer growth progression.

1. Introduction

Exclusive provision of breastmilk feedings for all infants in the first six months of life is now widely accepted as ideal for achieving optimal growth, development and long-term health (World Health Organization, 2014). For preterm infants (defined as < 37 weeks' post-menstrual age), breastmilk is even more important, as its nutritional and immunological components aid premature infants to fight infection while assisting with promotion of early gut microbial colonization

(Cong et al., 2017). One of the greatest challenges to this population is extrauterine growth restriction, defined as weight below the 10th percentile for post-menstrual age (PMA) (Clark, Thomas, & Peabody, 2013). Early implementation of parenteral and enteral nutrition (within the first 24 h of life) has been linked to earlier achievement of full enteral feeds (Waktins, Duggan, & Walker, 1996). Nonetheless, infant's severity of illness, maternal illness and length of hospitalization inherent to this population can interfere with feeding progression and sustained provision of breast milk. Infant weight gain has long been the

standard outcome measurement for growth, however, head circumference growth has been positively correlated with improved neurodevelopmental outcomes and early neonatal growth (Franz et al., 2009). Additionally, better head circumference growth is associated with breastmilk feedings during hospitalization (Ghoda, Kreissl, Brandstetter, Fuiko, & Widhalm, 2011). This investigation was guided by three major investigational aims with an overarching focus on understanding factors that are associated with continued provision of breastmilk at discharge including: i.) Evaluate the association between early feeding experiences (i.e. first oral feed direct-to-breast) and continued provision of breastmilk at discharge; ii.) Explore the association between characteristics at birth and the continued provision of breastmilk at discharge; and iii.) Evaluate the potential predictive value of growth quality during hospitalization related to the continued provision of breastmilk at discharge and on hospital length of stay.

To meet these aims, we examined mothers' initiation and continuation of breastmilk provision throughout hospitalization until discharge. Weight, length, head circumference and ponderal index increases were examined as potential predictors of mothers' sustained breastmilk provision. Lastly, the influence of number of direct-to-breast feeds (traditional oral breastfeeding) in any 24-h period was examined in relation to sustained breastmilk provision at discharge.

2. Methods

2.1. Study design

This was a retrospective chart review conducted in a Level III 40-bed suburban NICU in New England to investigate associations between continued provision of breastmilk at discharge with key factors including early feeding experiences, birth characteristics and growth quality in a cohort of preterm infants (< 37 weeks post-menstrual age, n = 94).

2.2. Sample

Preterm infants were included if they were admitted during the 24-month period (May 1, 2011 – May 1, 2013) with a birth weight equal to or < 1500 g. Infants were excluded if: birthweight > 1500 g; they had a known congenital anomaly, endotracheal tube, gastrointestinal tube, or documented feeding aversion; were admitted to the NICU after 7th day of life; mothers chose not to provide breastmilk; were transferred to another hospital or expired before discharge.

2.3. Procedures

2.3.1. IRB

This retrospective chart review was approved by Institutional Review Boards (IRB) at the both the university and participating hospital. Informed consent was waived given this was a retrospective review and no identifying information was being collected.

2.3.2. Medical record extraction

At the study site, birth characteristics, early feeding experiences and growth were documented within each infant's chart by nursing staff using documentation from the formal medical record, daily flow sheet and growth charts. A single trained research team member extracted the data through manual chart review and transcription of data into the research database onto an encrypted laptop computer. Variables of investigational interest are outlined as follows in the Measures section.

2.3.3. Measures

1.) **Infant Feeding**: Hospital unit policies support breastmilk provision unless medically contraindicated. At the time this study was conducted, the unit employed one full-time lactation consultant to support mothers. Infants were fed, advanced and supplemented according to well-established feeding progression protocols that increase feeding volumes based on an algorithm incorporating infant variables such as birth weight, gestational age and severity of illness to ensure consistency in feeding progression (Kish, 2014; Drenckpohl et al., 2009). See Fig. 2. Nurses documented whether the infant was fed formula or breastmilk orally via bottle, including the number of milliliters consumed for each feeding from birth until discharge. Infants who fed direct-to-breast were weighed prior to feeding and immediately after feeding to determine and document the volume consumed. Main investigational variables of interest highlighting the Early Feeding Experience included:

  a. *Initial Oral Feeding Method*: Given the potential impact on long-term feeding outcomes, the method of first oral feed was recorded (bottle or direct-to-breast) and included in the analyses categorically for further evaluation of associations with the main outcome variable of continued provision of breastmilk at discharge.

  b. *Average number of traditional breastfeedings per day*; and

  c. *Infant feeding method at the time of hospital discharge*-this variable was coded categorically and used as a main outcome variable.

  2.) **Hospital Length of Stay**: Infant length of hospital stay was totaled based upon the date of birth through the day of hospital discharge.

Hospital length of stay in days was used as a dependant variable related to independent variables of investigational interest.

3.) **Infant Growth**

  a. *Weight, length and head circumference* (*birth to discharge*): Growth data was collected at birth to record baseline weight, length and head circumference. Following birth, length and head circumference measures were collected weekly and weight was collected daily. Head circumference was measured using a standard disposable measuring tape in the occipital-frontal region and these measurements were collected in accordance with a standard hospital protocol. Similarly, length was measured weekly using disposable tape measures. Growth measurements were recorded from birth through hospital discharge. Total growth and average growth over time (velocity) was calculated as follows: weight gain (g/kg/d), head circumference growth (cm/d) and length growth (cm/d).

  b. *Growth Percentiles*: Growth parameters at birth and discharge were plotted using the **Olsen 2010 Growth** Calculator for **Preterm** Infants to obtain standardized assessments of growth percentiles. The Olsen tool was validated based on a contemporary, large, racially diverse US sample in order to provide clinicians with an updated tool for growth assessment in US NICUs (Olsen, Groveman, Lawson, Clark, & Zemel, 2010).

  c. *Ponderal index*: The Ponderal Index, similar to body mass index (BMI) was determined using growth parameters at birth and discharge. The ponderal index provides early evaluation of lean mass composition while accounting for early infant growth variability (O, 2006). A lower ponderal value is associated with leaner body composition and a higher index is associated with higher adiposity.

4.) **Birth Characteristics (maternal and infant)**: Information representing maternal factors and infant factors were collected from the medical record at the time of the chart review using the processes as outlined. These data were used to describe the sample and as potential predictors of breastmilk provision at the time of discharge.

  a. *Maternal factors included*: age, race, marital status, use of selective serotonin reuptake inhibitors, and illicit drug or alcohol use.

  b. *Infant factors included*: gestational age at birth, type of delivery (vaginal or caesarean), APGAR scores, provision of surfactant, surgical procedures, respiratory distress syndrome, or intraventricular hemorrhages.