# Impact of Nurse-Regulated Feedings on Growth Velocity and Weight Gain of 1200-1500 g Preterm Infants

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## ABSTRACT

**Purpose:** To evaluate the impact of nurse-regulated feedings (NRFs) on growth velocity and weight gain of 1200–1500 g preterm infants. **Subjects:** Cohort 1: All preterm infants 1200–1500 g between 1997 and 2001 not on NRF protocol; Cohort 2: All preterm infants 1200–1500 g between 2003 and 2006 on NRF protocol. Both cohorts screened out for small gestation age, major congenital anomalies, intraventricular hemorrhage (IVH), necrotizing enterocolitis (NEC), culture positive infection at birth, meningitis, and those requiring surgery. **Materials and Methods:** A before and after matched cohort study was conducted in the years 1997–2001 and 2003–2006, enrolling infants from Covenants Neonatal Intensive Care unit (Level III) using these studies screening protocol. Data on first 62 enrolling infants from both cohorts were used for this study. Both cohorts were matched using gestational age, birth weight, length of stay, initial length. A modified data tool collection set was used for collecting and analyzing nutritional data, this included intake (cal/kg/d, cc/kg/d, and total intake in cc) and route (initial parenteral feedings, mixed parenteral and enteral feedings, full enteral feedings), NRF, and non-NRF (NNRF). Data collection continued until discharge, initiation of adlib feeding, or greater than 50% of nutrition from breast. **Discussion:** Of the entire population sampled from 1997 to 2006, there were only 59 for NRF and 58 for NNRF. The mean growth velocity (g/kg/d) to reach full enteral feedings for both cohorts was insignificant ($t$=0.233; $P$=0.816). This suggested both groups were well matched up to the point of NRF institution for the 2003–2006 cohort years. **Results:** NRF had a 71% greater growth velocity than NNRF ($P$<0.001, $t$=6.618) at the time of discharge, initiation of adlib feeding, or greater than 50% of nutrition from breast. **Conclusions:** This study demonstrated that the NRF protocol offers a significant advantage in nutritional support than previous feeding regimens in this institution.

**Key words:**
Gestational age, growth velocity (g/kg/d), length of stay, non-nurse-regulated feeding cohort, nurse-regulated feeding cohort

## INTRODUCTION

Early and adequate nutrition is critical to optimize long-term growth and development in preterm infants. However, in utero growth rates determined by the American Academy of Pediatrics (15–20 g/kg/d) are rarely achieved after preterm birth.[1] Lemons *et al.*[2] and Bloom[3] have reported wide variation in growth outcomes and discharge weight for preterm infants that may contribute to less than optimal growth rates. A longitudinal growth study by Morales and colleagues support the fact that practice variations in advancing feedings significantly affect infant growth rates.[4] Historically, the literature emphasizes very low birth weight (VLBW) infants due to more potential life-threatening events; however, Blackwell[5] acknowledges that some attention be directed to healthy but immature infants born between 30 and 35 weeks gestational age, primarily because this population represents about 8% of live births and 35-50% of Neonatal Intensive Care unit (NICU) admissions.[6-8] Similarly to their VLBW counterparts, they too fail to achieve optimal intrauterine growth rate in the NICU.[9]

Traditionally, managing nutrition for preterm infants has been the physician's role; however, a more contemporary approach in neonatology is to evolve the team dynamic, in which collaborative efforts of the healthcare team become essential in attaining adequate growth of the premature infant.[10,11] The amount of time neonatal nurses contribute to feeding, handling, and observing the infant compared to others on the health team is invaluable to the overall support of the infant. In 2002, our NICU division developed a nurse-regulated feeding (NRF) protocol in response to feeding inconsistencies and practice variation observed. Before NRF was established, total daily volume

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and nutritional intake depended on the judgment of the "clinician of the day". Consequently the volume of feedings did not consistently advance for adequate weight gain.

Presently, no data has been published using NRF protocols. The objectives of this study include: (1) to provide two matched cohorts: non-NRF (NNRF) and NRF; (2) measure and compare growth outcomes between the two groups; and (3) offer a potential concept of a standard optimized feeding protocol for NICUs.

# MATERIALS AND METHODS

## Study design

A retrospective cohort study comparing preterm NICU patient's (1200–1500 g) pre- and post-institution of an NRF regimen was established in 2002.

## Study population

A before-and-after matched cohort study was conducted during 1997 to 2001 and 2003 to 2006 enrolling infants from our level III neonatal population. NRF was introduced in 2002. Infants included were all preterm infants 1200–1500 g, approximately one to two years before 2002 not receiving NRF regimen prior to discharge, and all preterm infants 1200–1500 g, approximately one to two years after 2002 receiving NRF regimen prior to discharge. We studied a homogenous group of healthy, moderately premature infants to minimize the additional effects of case mix and severe illness; thereby, exposing differences in growth, which would reflect differences in nutritional care and possibly reveal more effective feeding strategies. Infants were excluded if they were small for gestational age, had any major anomalies, intraventricular hemorrhage (IVH), necrotizing enterocolitis (NEC), culture positive infection, meningitis or surgery due to potential bias each could introduce into the study. Three end points were determined: 1) discharge; 2) start of ad lib nutrition; and 3) greater than 50% of nutrition from breast. Synergy Medical Alliance's institutional review board approval was obtained for this study.

## Definition and data collection

Clinical data related to infant's growth and nutrition was obtained from a chart review. All content was gathered using a data abstraction tool. Total parental intake (cal/kg/d, cc/kg/d, total cc/d), enteral intake (cal/kg/d, cc/kg/d, total cc/d), and NRF (cal/kg/d, cc/kg/d, total cc/d) were recorded daily until the end points were met. Breastfeeding was defined as any mother's milk feeding from breast and endpoint was determined by greater than 50% of daily feeding by breast. Collected data were reviewed to ensure that all infants included in the analyses met inclusion criteria.

## Statistical analysis

The two populations were compared on the basis of gestational age, head circumference (HC), length (cm), length of stay (LOS), daily weight (kg), daily nutritional intake (cc/kg/d, cal/kg/d, total cc/d), and growth velocity (g/kg/d). Growth velocity (g/kg/d) was calculated by the difference in birth weight and endpoint weight as the numerator and length of stay as the denominator. The calculated sample size was based on 61 infants for both samples ($\alpha$=0.05 and power=0.8). Statistical analysis was done using Student's *t*-test. SPSS version 10.4 was used for all statistical analysis.

## NRF protocol

### *Volume of feeding*

1. Neonatologist/NNP to initiate and advance feedings until full enteral feedings are tolerated by neonate; this full enteral feeds range from 120 to 150 cc/kg;
2. Once full feedings are tolerated by infant, nursing is responsible to daily calculate and advance feeding amounts (only if baby has gained weight) based on fluid cc/kg/day, as prescribed by neonatologist/NNP. If weight gain is greater than 40 g, a neonatologist/NNP will be consulted;
3. Decreasing feeding with loss of weight is not permitted and any loss of weight will be discussed with the neonatologist/NNP;
4. Calculations of daily feeding amounts are to be done by day shift RN staff;
5. Assessment of ordered feeding amount versus actual intake to be done every 12 h; if ordered feeding amount is not tolerated, a neonatologist/NNP will be notified;
6. Weekly nutrition round should include the RN, dietician, lactation consultant, and neonatologist/NNP to discuss nutritional feedings, tolerance, history, and growth chart;
7. If mother is planning to breastfeed, encourage mother to participate in Kangaroo Care, placing infant to breast for non-nutritive and nutritive sucking. Kangaroo care is recommended as soon as baby is stable.

## Management of residuals

1. Residuals less than 4 cc/kg in a 3-h period and in absence of clinical signs (i.e. abdominal distention): re-feed residual and continue to monitor tolerance;
2. Residuals greater than 4 cc/kg in a 3-hour period: assess abdomen, measure abdominal girth, evaluate for apnea, bradycardia, or oxygen requirement; if normal or no change, re-feed residual, if abnormal notify neonatologist/NNP.

### *Spacing of feedings*

When intermittent bolus over 2.5 h ordered, RN may advance as listed

1. Bolus tolerated over 2.5 h×48 h advance to;
2. Bolus tolerated over 2 h×48 h advance to;
3. Bolus tolerated over 1.5 h×48 h advance to;
4. Bolus tolerated over 1 h×48 h advance to;
5. Feeding given over 20–30 min.

All bolus feedings for infants 30 weeks GA or greater should be fed by gravity not pump. Recommend to hold infant during bolus feeding and offer pacifier for nutritive feeding behavior. If mother is planning to breastfeed, recommend Kangaroo care.

### *Advance to nipple feeding*

Neonatologist/NNP must be notified to initiate nipple feeding; RN can then advance:

1. Nipple once/shift, if nippling entire feeding once per shift×48 h advance to
2. Alternate nippling every other feeding, if nippling feeds well×48 h advance to
3. Nipple all feedings when alert and awake
4. When full nipple feeds, discuss with neonatologist/ NNP for ad lib feeding
5. If infant is 34 weeks GA or greater, nipple feedings may be advanced as tolerated. If mother plans to nurse, recommend Kangaroo care.

## RESULTS

### Population

There were a total of 117 patients reviewed; 59 and 58 in NRF and NNRF cohorts; respectively. There were 25 males in both groups and 34 and 33 females in NRF and NNRF, respectively. Cohort 1 (NNRF) were all preterm infants 1200–1500 g, admitted to our NICU between 1997 and 2001; Cohort 2 (NRF) were all preterm infants 1200–1500 g also admitted to our NICU between 2003 and 2006. Both cohorts were matched in gestational age, birth weight, LOS, initial height and weight [Table 1]. Average birthweight for NRF and NNRF was 1378.6 and 1359.2 g, respectively ($P$=0.250; $t$=1.16). Average gestational age for NRF and NNRF was 30.1 and 30.4 weeks, respectively ($P$=0.128; $t$=1.55). Average length of stay was 32.5 and 33.2 days for NRF and NNRF, respectively ($P$=0.616; $t$=0.50). Average initial head circumference for NRF and NNRF was 29.1 and 29.4 cm, respectively ($P$=0.751; $t$=0.32). Average initial body length was 41 cm for both NRF and NNRF, respectively ($P$=0.242; $t$=1.18).

### Weight gain

There was no significant difference in weight between NRF and NNRF at the start of this study ($P$=0.250; $t$=1.16). Weight at full enteral and end point for NRF and NNRF was 1480 and 2091 g, and 1418.6 and 1830 g, respectively. There was no significant difference in total weight gain between the two groups from admission to full enteral nutrition ($P$=0.65, $t$=1.82). Following the establishment of the new feeding protocol to the NRF group, this group demonstrated a significant weight gain advantage at endpoint over the NNRF ($t$=5.56, $P$<0.001).

### Growth velocity

Growth velocity from parenteral nutrition to full enteral was similar in both groups ($P$=0.816, [Figure 1]. Post full enteral nutrition, following the establishment of the new feeding protocol, the NRF cohort gained significant accelerated growth velocity on average towards its endpoint than NNRF, 28.72 and 20.52 g/kg/d, respectively ($P$<0.001, $t$=6.62). Between pre- and post-enteral feeds, the intra-relationship of growth velocities within NRF and NNRF were significantly different ($t$=14.52, $P$<0.001 and $t$=6.56, $P$<0.001, respectively).

### Nutritional dynamics

#### *Parenteral (admitting) nutrition*

All subjects initially fed parenterally. Mean time on parenteral nutrition was 2.72 and 3.24 days for NRF and NNRF; respectively ($P$=0.240, $t$=-1.188). Average cc/kg/d was 86.1 and 86.6 cc/kg/d for NRF and NNRF; respectively ($P$=0.880,

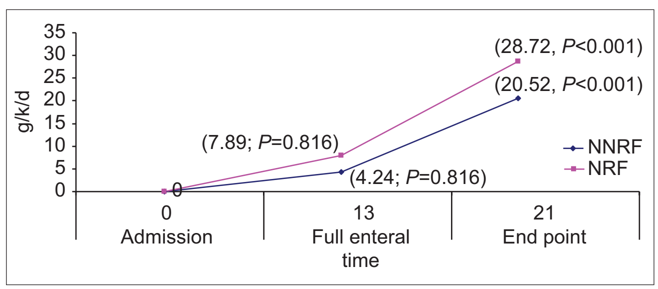


**Figure 1:** Growth velocity (g/k/d) comparison of NRF vs NNRF

**Table 1: Demographic comparison of NRF and NNRF cohorts**

| *n*=59 (NRF), *n*=58 (NNRF) | NRF Mean | NNRF Mean | SE | *t* | *P* (two-tailed) |
|---|---|---|---|---|---|
| Birth weight (grams) | 1378.6 | 1359.2 | 17.32 | 1.16 | 0.250 |
| Gestational age (weeks) | 30.1 | 30.4 | 0.23 | 1.55 | 0.128 |
| Length of stay (days) | 32.5 | 33.1 | 1.67 | 0.50 | 0.616 |
| Initial head circumference (cm) | 29.1 | 29.4 | 0.80 | 0.32 | 0.751 |
| Initial length (cm) | 41 | 41 | 0.36 | 1.18 | 0.242 |

NRF – Nurse regulated feeding; NNRF – Non-nurse regulated feeding *t*=0.151). A significant difference in average cal/kg/d was observed: 44.1 and 34.8 cal/kg/d for NRF and NNRF, respectively (*P*=0.003, *t*=3.154). However, overall total intake per day was insignificant, 117.4 and 114.78 total nutrition per day for NRF and NNRF; respectively (*P*=0.662, *t*=0.440).

### *Parenteral-to-full enteral nutrition*

Mean time for both cohorts to engage full enteral feeds was 13 days (*P*=0.932, *t*=0.085). There was no significant difference in the time spent during full enteral nutrition for both groups (*P*=0.36, *t*=0.927). However, NNRF significantly acquired more cc/kg/d on average than NRF group, 135.64 and 124.67 cc/kg/d, respectively (*P*=0.002, *t*=3.21). In addition, NNRF significantly acquired more cal/kg/d on average than NRF, 111.09 and 105 cal/kg/d, respectively (*P*=0.005, *t*=2.887). Consequently, NNRF had a significantly higher total nutritional intake on average than NRF (*P*=0.038, *t*=11.25).

### *Full enteral nutrition and NRF to end point*

Mean time for NRF and NNRF on full enteral feeds reaching endpoints were insignificant, 21.37 and 20.22 days, respectively (*P*=0.625, *t*=0.492). In the NRF cohort, average time to NRF protocol was 3.7 days (18% of total time on full enteral feeds) and the average time on NRF protocol was 16.5 days (82% of total time on full enteral feeds). Per NRF protocol, NRF had on average a significantly higher cc/kg/d, cal/kg/d, and total nutritional intake per day towards the endpoint than NNRF, 160 and 150 cc/kg/d, 128.4 and 111.7 cal/kg/d, and 291 and 235 ml total nutrition per day, respectively (*P*<0.001, *t*=5.215; *P*<0.001, *t*=10.915; and *P*<0.001, *t*=9.323).

## DISCUSSION

The primary objective of this study was to demonstrate a difference in the growth velocity between two cohorts (NRF and NNRF) with different feeding protocols. The study showed a significant increase (72%) in growth velocity in the NRF cohort (*P*<0.001). This is the only study we know of to date that has compared this type of nutritional support between two matched cohorts. The study illustrates that the NRF group reflected significant advantage in total weight gain and growth velocity post full enteral feed. Prior to instituting the new protocol, the baseline growth velocity was similar for both cohorts. In other words, both groups had statistically similar growth velocities upon reaching full enteral nutrition. Mean times for NRF and NNRF on full enteral feeds reaching endpoints were also not significantly different. However, once the NRF protocol was instituted, a significant increase in growth velocity change occurred in this cohort. The results support the advantage in applying the NRF feeding protocol to our preterm population. NRF intervention is based on adjusting the feedings as a function of the current weight by the bedside nurse daily and a target cc/kg/d set in place by the neonatologist. This avoided delays in advancing feeding volumes with increase in weight albeit small and offered consistent increases in total volume intake per day. Variation in average nutritional intake had the largest impact on explaining the differences in growth velocities between the two cohorts. Although the selection bias in this study is possible, careful attention was made to select cohorts that shared similar baseline characteristics until the point of intervention. Improved nutrition with NRF had a significant and positive effect on growth in these premature infants. Further study is needed to strengthen nutrition improving regimens associated with better growth velocities in healthy moderately premature infant population. Possibly designing a prospective randomized control trial might confirm the dramatic significance of the results obtained in this retrospective design.

## REFERENCES


1. Clark RH, Thomas P, Peabody K. Extrauterine growth restriction remains a serious problem in prematurely born neonates. Pediatrics 2003;111:986-90.
2. Lemons JA, Bauer CR, Oh W, Korones SB, Papile LA, Stoll BJ, *et al.* Very low birth weight outcomes of the national insitute of child health and human development Neonatal research network, January 1995 through december 1996, NICHD neonatal research network. Pediatrics. 2001;107:E1.
3. Bloom BT, Mulligan J, Arnold C, Ellis S, Moffitt S, Rivera A, *et al.* Improving growth of very low birth weight infants in the first 28 days. Pediatrics. 2003;112:8-14.
4. Morales L, Staiger D, Horbar J, Carpenter J, Kenny M, Geppert J, *et al.* Mortality among very low birthweight infants in hospitals serving minority populations. American Journal of Public Health. 2005;95:2206-12.
5. Blackwell MT, Eichenwald EC, McAlmon K, Petit K, Linton PT, McCormick MR, *et al.* Interneonatal intensive care unit variation in growth rates and feeding practices in healthy moderately premature infants. J Perinatol 2005;25:478-85.
6. Horbar JD, Badger GJ, Lewit EM, Rogowski J, Shiono PH. Hospital and patient characteristics associated with variation in 28-day mortality rates for very low birth weight infants. Pediatrics. 1997;99:149-56.
7. Arias E, MacDorman MF, Strobino DM, Guyer B. Annual Summary of vital statistics. Pediatrics 2003;112:1215-30.
8. Kramer MS, Demissie K, Yang H, Platt RW, Sauve R, Liston R. The contribution of mild and moderate preterm birth to infant mortality. Fetal and infant health study group of the Canadian perinatal surveillance system. JAMA 2000;284:843-9.
9. Lee JS, Richardson DK, Clark RH. Postnatal growth of infants 30-34 weeks GA: A comparison of 63 NICUs. Pediatric Res 2001;49:358A.
10. Olsen EI, Richarson DK, Schmid CH, Ausman LM, Dwyer JT. Dietitian involvement in the neonatal intensive care unit: More is better. United States: American Dietetic Association; 2005. *P.* 1240.
11. Bragdon D. A basis for the nursing management of feeding the premature infant. JOGN Nursing (supplement). Framingham, MA: Journal of Obstetric, Gynecologic, & Neonatal Nursing;1983. *P.* 51-7.


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