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The value of routine evaluation of gastric residuals in very low birth weight infants

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Abstract

Objective—Little information exists regarding gastric residual (GR) evaluation prior to feedings in premature infants. The purpose of this study was to compare the amount of feedings at 2 and 3 weeks of age, number of days to full feedings, growth and incidence of complications between infants who underwent RGR (routine evaluation of GR) evaluation versus those who did not.

Study Design—Sixty-one premature infants were randomized to one of two groups. Group 1 received RGR evaluation prior to feeds and Group 2 did not.

Result—There was no difference in amount of feeding at 2 ($P=0.66$) or 3 ($P=0.41$) weeks of age, growth, days on parenteral nutrition or complications. Although not statistically significant, infants without RGR evaluation reached feeds of 150 ml kg⁻¹ per day 6 days earlier and had 6 fewer days with central venous access.

Conclusion—Results suggest RGR evaluation may not improve nutritional outcomes in premature infants.

Introduction

In the neonatal intensive care unit (NICU), gastric residuals (GRs) are routinely evaluated prior to every bolus feeding in very low birth weight (VLBW) infants.¹ Evaluation of GRs consists of measuring the volume of milk remaining in the stomach at a variable time after a feeding. Depending upon the prescribed feeding schedule, these premature infants can undergo GR evaluation up to 8 to 12 times per day. When the amount of GR is found to be greater than a certain percentage of the previous feeding volume, subsequent feedings are

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often withheld or the feeding volume is decreased, which potentially results in significant delays in progression to full enteral feedings.² In addition, GRs are frequently discarded possibly resulting in the loss of essential gastric enzymes and/or acid, and the act of aspirating GRs may cause damage or irritation to the gastric mucosa. Although the routine evaluation of GRs is a widespread practice in the NICU, there is no conclusive evidence that it improves care^{3,4} or prevents complications such as sepsis, necrotizing enterocolitis (NEC) or feeding intolerance.^{5–7} Therefore, we sought to evaluate the effect of routine evaluation of GRs on progression of enteral feedings in premature VLBW infants. Our primary hypothesis was that infants who did not undergo routine evaluation of GRs prior to every feeding would demonstrate an increased enteral intake at 2 weeks of age and reach full feedings (120 ml kg⁻¹ per day) more quickly compared with infants undergoing routine evaluation of GRs prior to every feeding. Secondary outcomes including differences in enteral intake and growth indices (weight, head circumference and length) at 3 weeks, the number of days parenteral nutrition and central venous access was required, as well as the incidence of sepsis, NEC and parental nutrition-associated liver disease were also measured.

Methods

Study design

Sixty-one ($n = 61$) infants born at a postmenstrual age > 23 weeks but ≤ 32 weeks with a birth weight ≥ 1250 g and without congenital or chromosomal anomalies or gastrointestinal malformations who were receiving some enteral nutrition by 48 h of age were enrolled in the study. Following written parental consent and prior to 48 h of age, infants were randomized to one of two groups: Group 1 received routine evaluation of GRs (RGR) prior to every feeding, and Group 2 did not receive routine evaluation of GRs (NGR) prior to every feeding. The study was approved by the University of Florida's Investigational Review Board prior to study commencement.

Feeding protocol

The clinical team providing care to subjects made all clinical decisions except those regarding routine GR evaluation. Clinical decisions including timing of initiation and discontinuation of parenteral and enteral nutrition, advancement or withholding of feedings, type of milk provided, addition of human milk fortifiers or feeding supplements, feeding volumes, timing of central line discontinuation and the need for abdominal radiographs and laboratory analysis were based upon the NICU's published institutional feeding algorithm (Figure 1).⁸

Assessment of outcome parameters

Primary outcome measures included enteral intake at 2 weeks and days to reach 120 ml kg⁻¹ per day of enteral feedings. Secondary outcomes included enteral intake at 3 weeks, days to reach 150 ml kg⁻¹ per day, growth indices (weight, head circumference and length) at 3 weeks, days requiring parenteral nutrition and central line access, and the incidence of NEC, sepsis and parental nutrition-associated liver disease. Secondary outcomes were further defined as the following: a diagnosis of NEC was determined by pneumatosis intestinalis, portal venous gas and/or free intraperitoneal air on radiograph or evidence of NEC at the

time of surgery; indications of sepsis included clinical signs of systemic inflammatory response as defined elsewhere⁹ and abnormal laboratory values including an immature to mature neutrophil ratio (I:T) > 20% or an immature neutrophil count (bands) > 10% of the total, with a positive source of infection, or positive blood, urine, respiratory secretions or cerebrospinal fluid cultures; finally, parental nutrition-associated liver disease was defined as a serum direct bilirubin level > 2.0 for more than 2 weeks with elevated liver enzymes not explained by other infectious or congenital causes in an infant receiving more than 2 weeks of parenteral nutrition.

Statistical analysis

The two groups were compared by a χ^2 -test for categorical variables, Satterthwaite corrected two sample *t*-test for primary outcomes and by a two-sided Fisher's exact test for the Yes/No outcome of secondary outcomes. A *P*-value < 0.05 was considered statistically significant.

Sample size determination

An initial pilot study, completed prior to the implementation of our current feeding guidelines, of 40 subjects that utilized routine GR had a mean ml kg⁻¹ per day intake at 14 days of 72 (s.d. =65). To reach 119 ml kg⁻¹ per day, at 2 weeks of age would require a 65% improvement. At 80% power at *P* = 0.05 (two-sided), this would require 31 subjects per arm.

Results

Characteristics of study sample

From December 2011 through March 2013, 61 subjects were enrolled in the study. Thirty infants were in Group 1 and received routine evaluation of GRs and thirty-one were in Group 2 and did not receive routine evaluation of GRs. The mean gestational age was 27± 2.3 weeks and the mean birth weight was 924± 238 g for both groups combined. There were no significant differences between groups with respect to gender, gestational age, birth weight, length and head circumference at birth (Table 1).

Primary outcomes

Enteral intake at 2 weeks of age did not differ between NGR and RGR groups, respectively. When we examined the day patients reached 120 ml kg⁻¹ per day, no statistically significant differences existed between groups (Table 2).

Secondary outcomes

Enteral intake at 3 weeks of age did not differ between NGR and RGR groups. Growth indices (weight, length and head circumference) at 3 weeks did not differ between groups. Mean length of time on parenteral nutrition was 13.8 days for the NGR group and 15.1 days for the RGR group, and did not differ between groups. Time to reach feedings of 150 ml kg⁻¹ per day did not reach statistical significance but occurred nearly 6 days earlier in the NGR (22.3 versus 28.1 days). In addition, length of time central access required was nearly a week shorter in the NGR group compared with the RGR group (21.3 versus 15.6 days) but

did not reach statistical significance (Table 2). Finally, the rate of adverse outcomes including parental nutrition-associated liver disease, sepsis and NEC did not differ between groups (Table 3).

Discussion

In this randomized controlled trial, we challenged the tradition of routinely evaluating GRs prior to each feeding in premature VLBW infants and found no benefit in performing routine GR evaluation. In addition, although not statistically significant, we found infants who did not undergo routine GR evaluation reached feedings of 150 ml kg⁻¹ per day earlier and required fewer days of central access. Although the routine evaluation of GRs is a common practice in neonatology, insufficient evidence exists to support or refute its routine use. Evaluation of GRs is not only time consuming but due to the lack of evidence-based guidelines, significant confusion exists regarding acceptable GR volumes and the treatment of abnormally large GRs. In addition, the routine evaluation of GRs may actually cause harm when one considers that the negative pressure necessary to withdraw the GR may damage or irritate the fragile gastric mucosa and essential gastric enzymes and acid may be lost if GRs are discarded.

Provision of nutrition to the VLBW infant is one of the most challenging aspects of neonatal care and is of paramount importance to facilitate optimal clinical outcomes.^{8,10,11} Two significant challenges regarding delivery of enteral nutrition to premature infants include feeding intolerance and the risk of NEC.^{3,5} It is routine practice in most NICU's to evaluate GRs as a tool to determine when an infant is experiencing feeding intolerance or as an early symptom of NEC.³ As the amount of milk remaining in the stomach at a variable time after a feeding is considered an indicator of gastric emptying (GE), it is thought that a large GR is indicative of feeding intolerance. Compared to term infants, GE is slower in preterm infants due to intrinsic immaturities of the gastrointestinal tract,¹² including suck-swallowing incoordination, immature lower esophageal tone and function, low percentage of gastric electrical slow wave and slower intestinal transit.¹³⁻¹⁶ Shulman *et al.*¹⁷ concluded that GRs were an unreliable indicator to predict attainment of full gavage feeding and there is currently no consensus regarding the volume of GRs as an indicator of feeding intolerance.¹⁸

In our study, we hypothesized that those infants who did not undergo routine GR evaluation would have an increased feeding intake at 2 weeks of life and would achieve full feeds (120 ml kg⁻¹ per day) earlier. Although infants without routine GR evaluation did not have a statistically significant feeding intake at 2 weeks or achieve full feedings of 120 ml kg⁻¹ per day, the mean time to reach a feeding volume of 150 ml kg⁻¹ per day was nearly 6 days earlier in the NGR group. While not statistically significant, infants in the RGR group also required central access 6 days longer than those in the NGR group. Although we did not find statistically significant differences in the primary outcomes between groups, results suggest that the routine evaluation of GRs prior to feedings confers no benefit to preterm infants in terms of enteral intake or time to reach full feeds.

Although the sample size was small, we found no evidence that the routine evaluation of GR helps prevent complications such as NEC or feeding intolerance. Our findings concur with

those of Mihatsch *et al.*,³ who reported that GRs, including green-colored GRs, were a poor indicator of feeding intolerance, and suggested their presence should not delay advancement of feeding volumes in the absence of other clinical signs and symptoms.

Although our results are in contrast to other studies regarding GRs, these studies did not adequately control for confounding variables. For example, in a case-control study of 844 VLBW infants Bertino *et al.*¹⁹ reported that large GRs were indicative of feeding intolerance and predictive of NEC; however, those infants who developed NEC also had a higher incidence of patent ductus arteriosus which is a well-known risk factor for NEC. Similarly, Cobb *et al.*⁴ in a retrospective study suggested that VLBW infants who developed NEC had larger GRs (a maximum volume of nearly 40% of a previous feed). Our data suggest that not only may the routine evaluation of GRs prior to every feeding be an unnecessary practice in the NICU, not routinely evaluating GRs may decrease time to full feedings and time central access is required. A larger, appropriately powered randomized controlled trial is necessary to determine whether routine evaluation of GR is a safe and effective practice in premature VLBW infants.

It is important to note that in contrast to previously published studies, ours is the first to assess the value of routine GR evaluation in a randomized prospective manner. We also attempted to address whether not routinely evaluating GRs may be beneficial to VLBW infants as the presence of GRs may cause significant delay in progression of enteral feedings as well as a prolonged need for parenteral nutrition and central access. Although not statistically significant, infants who received routine GR evaluations required central access a week longer than those in the NGR group. This may be clinically significant as the length of time a central line is in place increases the risk for blood stream infection and sepsis, and ultimately morbidity and mortality of preterm infants.²⁰ Additional research including a randomized controlled trial is necessary to more thoroughly investigate the potential risks and benefits of eliminating routine GR evaluation.

Conclusions

Our study suggests that the routine practice of evaluating GRs may not confer any advantage over not evaluating GRs in otherwise asymptomatic premature infants. In addition, this study provides a baseline for additional in-depth randomized controlled trials evaluating both the risks and benefits of not routinely evaluating GRs in premature infants in the NICU.

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Figure 1.

Feeding algorithm. ^aIf waiting for breast milk (BM) availability, initiation of feedings should not be delayed by more than 24 h. ^{a,b}In infants with a low Apgar score < 3, hypoxic-ischemic encephalopathy stage 2 or 3, or hypotensive, consider holding off on initiating feeding for 48 h or provide lower volumes. ^cFor infants receiving trophic feedings, expect residuals to be the same amount as feeding volume. Nonbilious residuals should be refed as part of total feeding volume. ^dCurrently, in most NICUs, ampicillin and gentamicin would be first-line antibiotics. Metronidazole administration should be considered in severe cases or if surgery is needed. May consider screening laboratory results (CBC/CRP) and/or scheduling frequent KUBs. If abnormal, treat as NEC. Adapted from Torrazza and Neu.⁸ CBC, complete blood count; CRP, C-reactive protein; IVF, intravenous fluids; KUB, abdominal X-ray; NG, nasogastric; OG, orogastric.

Table 1
Baseline characteristics (mean $\pm$ s.d.)

Characteristic	Check GR (N = 30)	No check GR (N=31)	P-value
Birth weight, g	918 $\pm$ 261.00	929.81 $\pm$ 218.90	0.84
Gestational age, weeks	27.03 $\pm$ 2.51	27.32 $\pm$ 2.10	0.62
Head circumference at birth, cm	24.43 $\pm$ 2.20	24.56 $\pm$ 1.97	0.80
Length at birth, cm	34.85 $\pm$ 3.58	34.94 $\pm$ 3.32	0.92
Male sex—no./total no. (%)	14/30 (45.67)	14/31 (45.19)	1.00
<i>Type of milk—no./total no. (%)</i>			0.33
Exclusive formula	2/30 (6.7)	1/31 (3.2)	
Exclusive human milk	11/30 (37)	18/31 (58)	
Mix (formula and human milk)	17/30 (57)	12/31 (639)	
<i>Mode of delivery—no./total no. (%)</i>			
Vaginal	9/30 (30)	5/31 (16.13)	0.24
C-section	21/30 (70)	26/31 (83.87)	0.24

Abbreviation: GR, gastric residual.

Table 2
Specific outcomes measured (mean $\pm$ s.d.)

Outcomes	Check GR (N = 30)	No check GR (N=31)	P-value
Enteral intake 2 weeks after birth	106.73 $\pm$ 53.74	112.20 $\pm$ 42.81	0.66
Enteral intake 3 weeks after birth	134.20 $\pm$ 39.44	141.00 $\pm$ 29.29	0.41
Days to full enteral intake of 120 ml kg ⁻¹ per day	16.8 $\pm$ 12.4	14.3 $\pm$ 12.5	0.29
Day to full enteral intake of 150 ml kg ⁻¹ per day	28.1 $\pm$ 3.9	22.3 $\pm$ 11.7	0.19
<i>Growth parameters:</i>			
Weight at 3 weeks	23.8 $\pm$ 19	23.6 $\pm$ 21	0.98
Length at 3 weeks	7.1 $\pm$ 5	6.4 $\pm$ 5.5	0.58
Head circumference at 3 weeks	8.6 $\pm$ 5.9	7.8 $\pm$ 3.9	0.51
Day of life parenteral nutrition was discontinued	15.1 $\pm$ 11	13.8 $\pm$ 5.9	0.57
Day of life central access was discontinued	21.3 $\pm$ 20.7	15.6 $\pm$ 5.9	0.17

Abbreviation: GR, gastric residual.

Table 3
Clinical complications measured (%)

Outcomes	Check GR (N=30)	No check GR (N= 31)	P-value
PNALD	4/30 (13.3)	4/31 (12.9)	1.00
Sepsis	11/30 (36.7)	9/31 (29)	0.59
NEC	3/30 (10)	1/30 (3.2)	0.35

Abbreviations: GR, gastric residual; NEC, necrotizing enterocolitis; PNALD, parental nutrition-associated liver disease.