How to Cite:
Ramadan, O., Rashad, H., Darwish, M., & Dabash, S. (2022). Effect of non-aspirated gastric residual content on preterm infants' health status. *International Journal of Health Sciences*, *6*(S1), 6875–6887. https://doi.org/10.53730/ijhs.v6nS1.6830

Effect of non-aspirated gastric residual content on preterm infants' health status

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***Abstract*---** Background: Gastric residuals (GR) aspiration is considered standard practice for preterm infants in the neonatal intensive care unit (NICU). Unfortunately, there is little information about the dangers and advantages of this routine procedure. Various care procedures, such as the measurement of gastric residual volume (GRV), may contribute to the problem of inadequate calorie intake in preterm newborns. Aim: The current study aimed to evaluate the effect of non-gastric residual aspiration on preterm infant weight, necrotizing enterocolitis, and time to reach full enteral feeding. Methods: A quasi-experimental (control and intervention) design was used in the study. El-Manial University Hospital and Elmonira Pediatric Hospital NICUS cared for sixty preterm infants. Four different tools were used: (I) Neonatal personal information; (II) a gastric residual observational checklist; (III) the Fenton Growth Weight Chart; and (IV) Modified Bell's Staging Criteria for Necrotizing Enterocolitis. The results: The mean number of days required to achieve full enteral intake of 120 ml kg per day in the intervention group was 7.21 ± 0.66, whereas, in the control group, it was 9.72 ± 0.85, a difference that was slightly significant at the p-value < 0.05. Sepsis was diagnosed in a minority of the intervention group, whereas approximately one-quarter of the control group. According to NEC, a

Manuscript submitted: 18 Feb 2022, Manuscript revised: 09 March 2022, Accepted for publication: 27 April 2022

minority of the intervention group experienced definite abdominal distention, compared to less than a third of the control group. Conclusion: Our study implies that routinely assessing GRs in otherwise asymptomatic premature infants may not provide any benefit over not evaluating GRs. Additionally, this study establishes a foundation for additional, comprehensive randomized controlled trials examining the hazards and advantages of not routinely assessing GRs in premature newborns in the NICU.

***Keywords*---**Preterm Infants, Modified Bell's Staging, Necrotizing Enterocolitis, Gastric residual volume and Gastric Residual.

Introduction

Due to anatomical and physiological constraints at birth, preterm infants are born with digestive restrictions. The neural system's development is crucial for gastrointestinal motility (Kumar et al., 2017). Nursing care that is supportive of feeding plays a critical role in improving the nutritional status of LBW newborns. This care necessitates several primary considerations about the feed amount, formula type, duration between subsequent feeds, stomach residual volume, and prevention of related problems. Additionally, infant body position following feeding has been identified as a critical component affecting stomach emptying (Tume, 2018).

Gastric residuals or pre-feeding aspirates are food from a last feeding in the stomach. The process of dealing with a significant residue varies greatly amongst facilities. There is no uniform protocol among health care institutions. Therefore, handling residuals varies greatly (Rysavy et al., 2020). In most neonatal intensive care units (NICUs), primary routine care for preterm newborns includes monitoring the volume and colour of stomach residuals before each enteral gavage. (1500 g) neonates frequently exhibit signs and symptoms of gastrointestinal prematurity, extremely low birth weight (LBW) immaturity, and decreased gut motility.

Although these observations are usually evidence of feeding intolerance, they could be physiological. Although the early start and progression have not been well established in the literature, they have been associated with faster GI system maturation, less feeding intolerance, and improved neurodevelopmental outcomes in preterm children, including LBW newborns (Gözen, Erkut, Uslubaş, & Bilgin, 2021).

As a result of these findings and the decreasing occurrence of necrotizing enterocolitis (NEC), it is now widely accepted that each NICU should adopt and optimize local criteria for the early introduction and advancement of enteral nutrition. Recent research indicates that in the absence of accompanying clinical symptoms, gastric residual volume measures may not be useful indications of feeding intolerance or necrotizing enterocolitis (Rysavy et al., 2020).

Nursing assessment for early identification of feeding intolerance symptoms has not yet been addressed. It is crucial for neonatology nurses to understand the physical changes when the preterm infant is experiencing feeding intolerance. There are no nursing assessment care guidelines that focus on feeding intolerance symptoms. However, there is noteworthy agreement on the symptoms commonly associated with feeding intolerance and the symptom operational definitions within the literature. These components are necessary for developing a nursing standard of care guidelines that are designed to encourage judicious reporting of early signs/symptoms of feeding intolerance to health care providers, which, in turn, may improve newborn outcomes (Zaky Mohamed & Saied Ahmed, 2018).

Nurses must be proactive to prevent severe problems from feeding intolerance. Frequent symptom reporting needs interdisciplinary team support. Every 4 hours, do a thorough head-to-toe checkup and evaluate the gastrointestinal system before each feeding. If the infant is on continuous enteral feeding, the Gastrointestinal assessment should be done every 3 hours. Even minor changes in evaluation results should be recorded. This will help nurses and physicians understand potential feeding tolerance to intolerance progression. Before providing the next planned enteral feeding, notify the provider of any changes in Tab's institutional practice guidelines or assessment guidelines (Lee & Choi, 2019).

Significance of the study

Routine GR evaluation is standard in the NICU; however, there is no convincing evidence that it improves care or avoids complications such as sepsis, NEC, or FI. Aspiration of GRs can cause a delay in achieving complete enteral feeding, with the implications of extra-uterine growth retardation, cholestasis, and a higher risk of sepsis. However, mixed data support the routine gastric residual evaluation technique, and it is uncertain whether it gives any clinical advantage (Taha, Ali Hassan, Wikkeling-Scott, & Papandreou, 2020).

(Parker et al., 2015)found no evidence that the routine evaluation of GRs helps prevent complications such as NEC or feeding intolerance. The routine evaluation of GRs may 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 GR is discarded. Withholding of enteral feeding or cessation of advancement in the amounts given due to misinterpretation of routine gastric aspirates may have a negative impact on the preterm neonate. This can potentially involve prolonged indwelling of venous catheters, a higher risk of infection and growth restriction with potentially worse developmental outcomes for very low birth weight infants (Ferreira, Martinez, Crott, & Belik, 2018).

Methodology

The current study employed a quasi-experimental approach (control and intervention groups). NICUS at El Manial University Hospital and Elmonira Pediatric Hospital for sixty premature neonates. Four tools were used: (I) Tool: The researcher created personal data about newborns. It contains information about preterm infants' characteristics such as gender, gestational age, age at the start of the study, weight, head circumference and length, date of admission, diagnosis, and laboratory investigations such as C-Reactive Protein (CRP), complete blood count (CBC) with differential, and so on… The researcher developed a checklist for the gastric residual observation that includes the following items: It provides information about the amount and colour of gastric residual, the style of Ryle insertion (nasogastric or orogastric), the kind of feeding, the type of milk, the amount of feeding, the feeding tube size, and the time required to achieve full enteral feeding. The Fenton Growth Weight Chart is a reference guide (III). Instrument (IV) Bell's Staging Criteria for Necrotizing Enterocolitis with Modifications: It was developed by Bell (1978) and is considered valid, with a 0.96% dependability. It was initially used to assess NEC levels in preterm newborns in 1973, marking the beginning of the first attempt to classify NEC according to presentation and severity.

Content validity and reliability

A panel of five expert professors in high-risk newborns and pediatric nursing assessed the content validity of the study tools (I) and (II). The Fenton growth Chart Tool (III) is valid, with a reliability of 0.98%. The Modified Bell's Staging Criteria for Necrotizing Enterocolitis (IV), as specified by Bell (1978), is legitimate and has a 0.96 % reliability. The Alpha-Coefficient test evaluated the dependability of tools (I) (II).

Procedure

After gaining authorization from the Pediatric El Monira and El Manial University Hospital Directors, the researcher explained the study's goal and nature to each child's parents, who matched the inclusion criteria. Then, one of the neonatal parents who met the requirements provided written consent. In the NICUs of Elmonira and El Manial University Hospitals, a control group (G2) was assigned initially, followed by an intervention group (G1). Both NICUs feed premature infants in the same way.

When entering the unit to gather preliminary data, research tool No (1) to determine the child's demographic data. This is followed by the third measurement instrument provided by the NEC. There are eight feedings every day (6 a.m., 9 a.m., 12 p.m., 3 p.m., 6 p.m., 9 p.m., 12 a.m., 3 a.m., 6 p.m., 9 p.m., 12 a.m., 3 Rather than extracting the residual stomach, the gastric tube was opened. To empty the stomach of potential residuals, the residue characteristics are examined half an hour before each feeding operation. The internal feeding of the unit is based on the conclusions of those observations. After the third feeding at twelve o'clock in the afternoon, the third and fourth research tools are utilized every day for the rest of the child's stay in the unit.

No Intervention (control group) (G2): The researcher used Tool (1), (II), (III), and (IV) on admission to obtain baseline data. The control group had three hourly feeds (6 a.m., 9 a.m., 12 p.m., 3 p.m., 6 p.m., 9 p.m., 12 a.m., and 3 a.m.) with immediate gastric residuals aspirated by negative pressure. Using a tool, the researcher examined the residual content characteristics (II). The number of enteral feeds was determined using the NICU's monitoring and feeding regimen data. For each preterm before the third meal, tools (III) and (IV) were utilized daily.

Results

In the current study, less than two-thirds of the intervention group were female, while over half were female in the control group. The intervention group's mean gestational age was 32.13 ± 3.34, while the control group was 32.68 ± 2.99. With a p-value > 0.05, the difference between the two groups was mildly significant. The intervention group's mean hospital stay was 13.96 ± 2.56, whereas the control group was 19.11 ± 3.01, with a p-value < 0.05 separating the two groups. Table (1) demonstrated that the intervention group had a mean amount of gastric content of 1.05 ± 0.35 in the first week, compared to 2.53 ± 0.49 in the control group, with a p-value of< 0.05. With a p-value > 0.05, there was no statistically significant difference in stomach content, Ryle insertion, Ryle size, Pattern of nutrition, Type of formula, and Type of fake milk between the intervention and control groups. The intervention group's mean gastric residual amount at the hospital's first week was 1.45 ± 0.35, while the control group was 2.53 ± 0.49, as shown in Figure (1). Concerning the discharge day, the intervention group's mean stomach residual amount was 1.03 ± 0.14, while the control group was 1.34 ± 0.19.

According to a table (2), a minority (13.3 %) of the intervention group suffered abdominal distention, compared to less than one third (30 %) of the control group, with a p-value < 0.05. Related vomiting occurred in a minority (10%) of the intervention group, whereas about one-quarter (26.7%) of the control group did, with a p-value of< 0.05. Difficult breathing affected a minority (10%) of the intervention group. In comparison, with a p-value < 0.05, fewer than a quarter (23.3 %) of the control group experienced difficulties breathing following feeding. Regarding aspiration post-feeding, a minority (6.7%) of the intervention group experienced it, whereas a minority (13.3%) of the control group experienced it, with a p-value < 0.05.

Table (3) revealed that the minority (3.3%) of the intervention group had suspected A, while the minority (13.3%) of the control group had suspected A, with a marginally significant difference at p-value < 0.05. Furthermore, only a minority (3.3 %) of the intervention group was mildly ill, but a minority (10 %) of the control group was mildly ill, with a p-value < 0.05 indicating a marginally significant difference. In the case of advanced NEC, a small percentage (3.3 %) became severely ill and had their bowel perforated.

Figure (2) demonstrated that the mean growth weight chart of the intervention group in the first week was 2103g± 90.88, while the control group was 2085g± 96.5. Concerning weight at discharge, the mean weight of the intervention group was 2560g± 70.13, while the control group was 2.236± 93.40.

Table (4) showed that the intervention group's mean days to full enteral intake of 120 ml kg per day was 5.21 ± 0.666, while the control group was 9.72 ± 0.85, with a marginally significant difference at p-value < 0.05. The intervention group's mean PN days was 2.32 ± 0.34, whereas the control group's mean 4.12 ± 0.65, with a p-value < 0.05 indicating a marginally significant difference. The intervention group's mean days to discharge were 13.96 ± 2.56, whereas the control group's mean was 19.11 ± 3.01, with a marginally significant difference at p-value < 0.05. The intervention group had a minority (13.3%) of patients with sepsis, compared to nearly a quarter (26.7%) of the control group. According to NEC, a minority of the intervention group (3.3%) and the control group (13.3%) had definite NEC.

According to table (5), the F test revealed a highly significant model with a p-value of 001**. This model explained 35% of the range in days to full enteral intake of 120 ml kg per day, as indicated by an R2 value of 0.35. Additionally, it explained why gestational age and chronological age exhibited favourable impacts with a p-value of 0.01**. Simultaneously, the Apgar score had a marginally positive effect with a p-value of 0.05*. Meanwhile, hospitalization showed a negative impact with a p-value of 0.05*. However, with a p-value >0.05*, gender and obstetric history showed no effect.

Table (1)
number and percent distribution of studied preterm infants according to gastric residuals characteristics (n=30)

Items	Intervention (n=30)		Control (n=30)		P value
	n	%	n	%	
Amount of gastric content - (Mean ± SD) at first day	2.80 ± 0.35		3.02 ± 0.49		0.017
Amount of gastric content - (Mean ± SD) at the first week.	1.05 ± 0.35		2.53 ± 0.49		0.039
Content of gastric residual:					
- Undigested	9	30	9	30	0.068
- Creamy	4	13.3	3	10	
- Brownish	2	6.7	3	10	
- Greenish	3	10	4	13.3	
- Yellowish	3	10	4	13.3	
- None	9	30	7	23.3	
Ryle insertion:					0.063
- Nasal	12	40	11	36.7	
- Oral	18	60	19	63.3	
Size of Ryle tube:					
- 6	20	66.7	18	60	0.069
- 8	10	33.3	12	40	
The pattern of nutrition:					
- TPN	8	26.7	6	20	0.058
- Intravenous fluid	17	56.7	18	60	
- Twice	5	16.6	6	20	
Type of formula:					
- Breast milk	8	26.7	9	30	0.066

- Artificial milk - Twice	12 10	40 33.3	11 10	36.7 33.3	
Type of artificial milk: - Premature - FL - AR	(n=12) 7 2 3	 58.3 16.7 25	(n=11) 6 4 1	 54.5 36.4 9.1	 0.140

Table (2)
Number and percent distribution of studied preterm infants according to their feeding problems during the study (n=30)

Items	Intervention (n=30)		Control (n=30)		P value
	Present	Not Present	Present	Not Present	
	N (%)	N (%)	N (%)	N (%)	
Abdominal distention	4 (13.3)	26 (86.7)	9 (30)	21 (70)	0.026*
Vomiting	3 (10)	27 (90)	8 (26.7)	22 (73.3)	0.037*
Difficult of breathing	3 (10)	27 (90)	7 (23.3)	23 (76.7)	0.029*
Aspiration	2 (6.7)	28 (93.3)	4 (13.3)	26 (86.7)	0.016*

Table 3
Number and percent distribution of studied preterm infants according to their Modified Bell's Staging Criteria for Necrotizing Enterocolitis (n=30)

Items	Intervention (n=30)		Control (n=30)		P value
	Present	Not present	Present	Not present	
	N (%)	N (%)	N (%)	N (%)	
Suspected: A B	 1 (3.3) 0 (0)	 29 (96.7) 30 (100)	 4 (13.3) 1 (3.3)	 26(86.7) 29 (96.7)	 0.019*
Definite: Mildly ill Moderate ill	 1 (3.3) 0 (0)	 29 (96.7) 30 (100)	 3 (10) 1 (3.3)	 27 (90) 29 (96.7)	0.026*
Advanced: Severely ill, bowel intact Severely ill, bowel perforated	 0 (0) 0 (0)	 30 (100) 30 (100)	 0 (0) 0 (0)	 30 (100) 30 (100)	

Table (4)
Comparison of the outcome measures between two groups (n=30)

Items	Intervention (n=30)	Control (n=30)	P value
Days to full enteral intake of 120 ml kg per day	5.21±0.66	9.72±0.85	0.038*
Days of PN	2.32±0.34	4.12 ±0.65	0.042*
Days of life parenteral nutrition was discontinued	5.4±0.26	3.60 ± 0.77	0.041*
Days to discharge	13.96 ± 2.56	19.11 ± 3.01	0.045*
Sepsis	4 (13.3)	8 (26.7)	0.031*
NEC (definite).	1(3.3)	4 (13.3)	0.026*
Death	0 (0)	1(3.3)	0.086

Table (5)
Multiple Linear regression model for Days to full enteral intake of 120 ml kg per day

Item	Unstandardized Coefficients	standardized Coefficients	T	P. value
	B	B		
Gestational age	.299	.189	7.245	.000**
Chronological age	.287	.201	6.098	.002**
Apgar score	.199	.138	3.887	.010*
Gender	.011	.008	1.099	.078
Stay at the hospital	-.244	.167	3,009	.019*
Obstetric history	.013	.009	1.221	.073

Model	R^2	Df.	F	P. value
Regression	0.35	6	7.990	.001**

a. Dependent Variable: Days to full enteral intake of 120 ml kg per day
b. Predictors: (constant): Gestational age, Chronological age, Apgar score, Gender, Stay at the hospital, and Obstetric history.

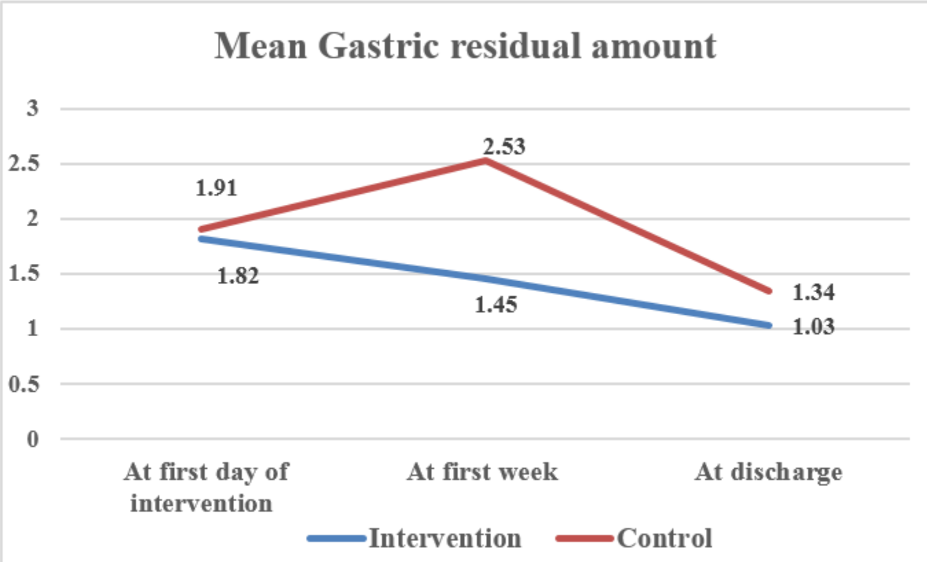

Figure (1) Distribution of studied preterm infants according to mean gastric residual amount (n=30)

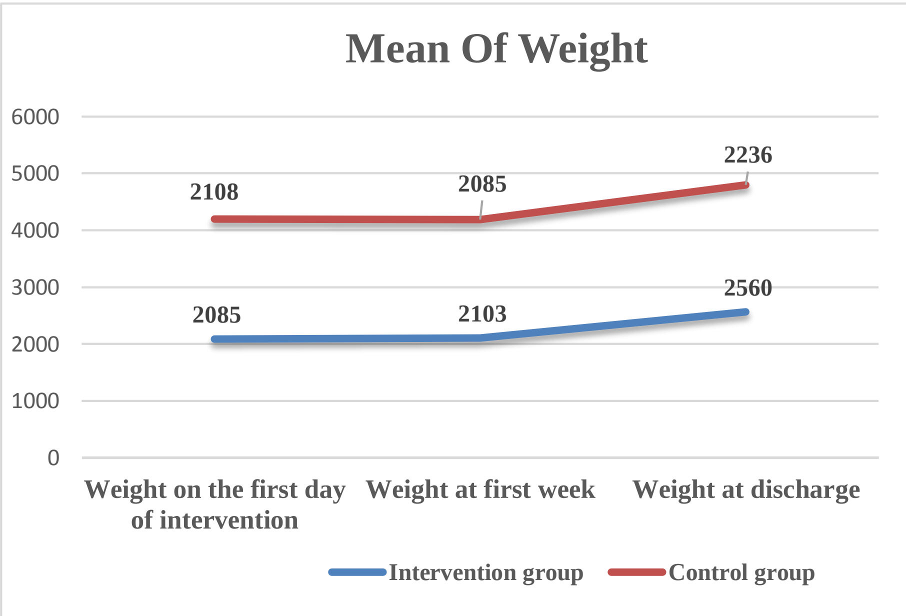

Figure (2) Distribution of studied preterm infants according to mean weight (n=30)

Discussion

Appropriate management of gastric residual volumes is complex because of a lack of standards and wide variability in practice regarding the assessment of gastric tube position, the volume or color of GRV that should be interpreted as pathologic, the optimal frequency for evaluation of gastric residual volumes, and whether the gastric residual volume should be returned or discarded (Lee & Choi, 2019).

Regarding the amount of gastric content, table (7) showed that the mean amount of gastric amount in the intervention group was 1.45 ± 0.35, while the control group was 2.53 ± 0.49, with a p-value <0.05. this result matched with (Sokou et al., 2021), who conducted a study about " Gastric Volume Changes in Preterm Neonates during Intermittent and Continuous Feeding-GRV and Feeding Mode in Preterm Neonates" and showed that the amount of gastric content in studied preterm infants in the control group had of 4.5 mL as compared to 2 mL in the study group with a p-value <0.05.

In addition, there was no significant difference between the control and study groups regarding the content of gastric residual, Ryle insertion, and parenteral nutrition at a p-value >0.05. These results cohort with the study (Akar & Turgut, 2020) about Whether we control gastric residuals unnecessarily in premature newborns? AGRA studied: avoidance of residual gastric aspiration and stated that days of parenteral nutrition in group one was 3.56±6.0 and group two 3.59±5.24 with no significant difference at a p-value of 0.91. Gastric emptying may be affected by infant maturity, medications (e.g., methylxanthines, mydriatics), feed composition (formula versus breastmilk), feeding method (bolus versus continuous feedings), infant position, tube position, and infant state (e.g., respiratory distress, infection) (Rysavy et al., 2020)

According to feeding problems, table (2) revealed that the most common feeding problem among studied preterm infants was abdominal distention. From the researcher's point of view, this result might be due to swallowing material, blood or stress ulcers, or drug-induced. This result is in line with the study (Hassan et al., 2021) entitled "Study of feeding problems in neonates in the neonatal intensive care unit in Minya General Hospital" and showed that the most common feeding problem among studied preterm infants was abdominal distention. However, this result disagrees with (Khashana & Moussa, 2016) entitled " Incidence of feeding intolerance in preterm neonates in neonatal intensive care units, Port Said, Egypt", and showed that vomiting was the most common feeding problem among studied preterm infants.

In terms of Modified Bell's Staging Criteria for Necrotizing Enterocolitis, Table (3) revealed that a minority (3.3 %) of the intervention group had suspected A, while less than one-fifth of the control group had suspected A, with a marginally significant difference at p-value < 0.05. This result was critiqued by (Riskin et al., 2017) in a study entitled "The impact of routine evaluation of gastric residual volumes on time to achieve full enteral feeding in preterm infants," which found that (1.3 % &3.3 %) of the study and control groups had suspected A with no significant difference at p-value >0.05.

In terms of comparisons of the two groups' outcomes, there was a clear difference in how many days it took the intervention and control groups to achieve full enteral feeding. The intervention group took less time than the control group. Researchers (Akar & Turgut, 2020) investigated whether it is necessary to control gastric residuals in premature newborns and found that the answer was yes. There was no significant difference in the number of days of parenteral nutrition between groups one and two, with a p-value of 0.91, when AGRA examined the avoidance of residual gastric aspiration. Even though NEC, weight at discharge, and length of hospitalization were all comparable in the groups that did not have routine residual control ($p>0.05$), the duration of parenteral nutrition was significantly shorter in the group that did not have routine residual control ($p<0.05$).

Regarding the study's outcomes, the results showed a clear difference between the two groups in terms of exposure to gastrointestinal necrosis, incubator infection, and the child's weight upon discharge from the hospital. These results cohort with the study (Akar & Turgut, 2020) about Whether we control gastric residuals unnecessarily in premature newborns? AGRA studied: avoidance of residual gastric aspiration and stated that the group without routine residual control had a shorter time to full enteral intake (p 0.05). Each group's parenteral nutrition duration, grade 2 NEC, weight at discharge, and hospital stay were comparable. This finding disagrees with (Abiramalatha, Thanigainathan, & Ninan, 2019), who conducted a study about "Routine monitoring of gastric residual for prevention of necrotizing enterocolitis in preterm infants" and illustrated that there is a non-significant difference between the study and control group regarding growth weight chart.

In terms of linear regression, the current study explained 35% of the variation in days to complete enteral intake of 120 ml kg per day as measured by R2 value 0.35. It also indicated that increasing gestational and chronological age resulted in a shorter time to full enteral intake. On the other hand, an Increased Apgar score results in a shorter time to full enteral intake. Meanwhile, the more extended hospital stay causes a delay in reaching the full enteral intake. Gender and obstetric history, on the other hand, had no effect at p-values more significant than 0.05*. These findings are backed by a research published in 2018 by Patwardhan et al., who found that 37 of 304 hospitalized infants died before reaching full feeds. The median (interquartile range) gestation, birth weight, and time to full feed (TFF) were respectively 31.4 (30–33.05) weeks, 1210 (1066–1400) g, and 11 (8–15) days. TFF was inversely related to gestation and birthweight, but low Apgar scores, sepsis, patent ductus arteriosus (PDA), and respiratory distress syndrome were directly connected to TFF. Growth-restricted infants showed considerably shorter TFF compared to adequate for gestational age infants, most likely due to increased gestational age.

Conclusion

Pre-feed gastric residual evaluation has been standard care for decades because large amounts of residual gastric contents have been considered to represent feeding intolerance, the risk for aspiration and ventilator-associated pneumonia, or possibly a sign of a serious intestinal disease. Until now, there has never been any substantial evidence that omitting residual gastric evaluation would impact preterm infant outcomes or suggest that it was an unnecessary procedure. The study found that infants who did not undergo the procedure had more positive outcomes, including more feedings, improved weight gain, and fewer episodes of abdominal distension. Also, infants who did not receive residual gastric evaluation were able to go home six days earlier than the infants who did receive the procedure.

The significance of these findings is that we can omit a routine procedure done eight to 12 times a day on extremely preterm infants in neonatal intensive care units. This will also save a substantial amount of the nurse's time devoted to performing these evaluations. This study suggests that it is unnecessary to do a residual gastric assessment before every feeding. It's a question that has been frequently asked through the years, but we have always been too afraid we may miss something if we do not do it.

I believe the preterm babies who did not undergo the evaluation did better because they did not have their feeds discontinued, decreased, or not advanced due to the amount of gastric contents aspirated. However, the procedure still has merit in certain circumstances. For example, it is appropriate and necessary to do the residual gastric evaluation in a preterm infant with signs of feeding intolerance, intestinal disease, or other illness.

To summarize, the majority of neonatal critical care units continue to handle gastric residuals routinely prior to each feeding. The body of data concludes that routine gastric residual management should be avoided in the absence of further clinical problems requiring enteral intake expansion. By omitting routine gastric residual care before each feeding, the time required to achieve full enteral intake is decreased without increasing the incidence of NEC or the duration of parenteral feeding. Additional well-designed multicenter randomized controlled studies are necessary to better understand this problem, particularly with larger groups of low-birth-weight infants.

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