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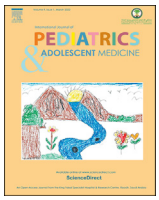

Original article

Weight loss monitoring reduces the occurrence of neonatal hypernatremic dehydration in breastfeeding neonates

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ABSTRACT

Background: Excessive weight loss enhances the incidence of neonatal hypernatremic dehydration (NHD). We compared the effect of a new breastfeeding policy against an old breastfeeding policy on neonatal weight change and the incidence of NHD.

Methods: This was a QA project between two sets of breastfeeding (BF) protocols for exclusively BF newborns. Under our old BF policy, a number of neonates had a significant loss of weight **after birth and were admitted to the NICU due to NHD. We implemented a new BF policy that was used when a newborn loses>5% of previously recorded weight within a 24-h interval. Two groups were compared: the preintervention group (old BF policy) and postintervention group (new BF policy). Additionally, characteristics of newborns admitted to NICU were separately compared with the subgroup of pre- and post intervention dehydration groups.**

Results: Preintervention = 1320 and postintervention = 1450. Neonates with weight loss of ≥ 5% within the first 24-h time interval were higher in the postintervention group (19.7%) as compared to the pre-intervention group (10.2%) ($P < .05$). However, the number of infants diagnosed to have NHD was lower in the postintervention group (0.68%) than in the preintervention group (1.66%), ($P < .03$). Neonatal characteristics were comparable between subgroups of dehydration.

Conclusion: An intervention at ≥ 5% neonatal weight loss markedly reduces the incidence of NHD-associated NICU admissions.

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Introduction

Breastfeeding (BF) possesses tremendous maternal-neonatal health and socioeconomic benefits. It prevents a variety of neonatal infections, improves neurodevelopmental outcomes, and decreases mother-neonate dyad morbidities [1]. However, inadequate and poor BF may lead to several neonatal life-threatening complications including hypernatremic dehydration, hyperbilirubinemia, vascular thrombosis, cerebral edema, seizures, and even death [2,3].

Neonatal hypernatremic dehydration (NHD) is a known complication of unsuccessful BF [4]. Multiple maternal and neonatal factors contribute to the failure of successful BF, such as inadequate milk production, supply, and delivery [5]. Poor milk delivery from the breast leads to a higher sodium concentration in breast milk [6]. In addition, neonatal factors contributing to BF failure include poor latching, improper position, and reduced frequency. Lactation failure is exacerbated in primiparous and young mothers [6,7]. Primiparous mothers produce less breast milk than multiparous mothers [8].

Multiple studies depicted that NHD occurs in 2%–8% of exclusively BF newborns [6,9]. NHD is difficult challenging to identify during the neonatal period due to excessive neonatal extracellular

Abbreviations: BF, Breastfeeding; h, hour; Pre I-group, Preintervention group; Post I-group, Postintervention group; Pre-IDG, Preintervention dehydration group; Post-IDG, Postintervention dehydration group.

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fluid volume [10]. There is no specific clinical presentation of NHD. A diagnosis of NHD is ascribed to a combination of signs/symptoms such as excessive weight loss, low frequency of urination, poor nippling, lethargy, and high serum sodium level.

In the United States, 60% of newborns are breastfed exclusively for at least the first 2 days after birth [11]. In all, 15% of breastfed neonates lose more than 10% of their birth weight within the first few days of birth. Universal weight monitoring is a routine clinical practice, as a lack of monitoring of newborn weight changes may lead to significant complications [12]. Weight loss of more than 7% can lead to dehydration. Newborn weight loss is noticeably affected by hospital policies and guidelines [13]. Emerging evidence indicates the poor physical growth and long-term developmental deficits in infants who suffered from NHD [6,14]. Timely identification of newborns at risk of developing NHD is necessary to avoid significant morbidity and mortality. Hence, a practical weighing policy may be able to identify the early stages of NHD [12,15]. Our baby-friendly hospital developed a new BF policy, which takes effect once a newborn loses ≥5 wt at a 24-h time interval during their hospital stay. The aim of this study was to compare the effectiveness of our new BF policy against an old policy on neonatal weight change and on the incidence of NHD.

Methods

This was a retrospective study of a prospectively maintained quality in-hospital assurance database for newborns born between January 2013 and December 2017. All full-term healthy newborns on exclusive BF were included in the study. Approval for the study was obtained from the hospital ethics committee. Newborns stay for 2–3 days after birth in our hospital. Early discharge was based on health care provider discretion on maternal request.

Our suburban, NICU level 2, hospital achieved a baby-friendly hospital designation in 2013. In our old BP policy (Preintervention policy), we strictly followed the ten steps of successful BF (www.unicef.org/nutrition/index_breastfeeding-ten-steps). An intervention was initiated if a newborn lost ≥10% of birth weight on any day of life. Shortly afterword, we noticed that a number of exclusively BF newborns who lost ≥5% weight in a 24-h time interval developed clinical features that required NICU admission.

We readdressed our BF policy and in June 2015, a new BF policy was implemented. This policy was triggered if a newborn loses ≥5% weight at a 24-h time interval from a previously recorded weight. The 24-h time interval was defined as weight measurements taken 24 h apart, such as, a weight measurement is taken at 24 h of age compared with the weight taken at 48 h of age, and so on. The plan of care in this new policy included a hand expression of breast milk, referral to a lactation consultant, and others (Fig. 1).

To determine the effect of this new BF policy, we compared two sets of groups: the preintervention group (Pre-I group) or old policy (Jan 2013–June 2015) and postintervention group (Post-I group) or new policy (July 2015–December 2017). Those infants who were admitted to the NICU were further evaluated into two subgroups; the preintervention dehydration group (Pre-IDG) and postintervention dehydration group (Post-IDG) to compare the presentation of illness in both dehydration groups.

Dehydration ICD codes 1.9 and 10 were used to extract the data from medical records. The diagnosis of dehydration was made by the attending physician covering the neonatal ICU. The criteria of NHD diagnosis included the combination of clinical signs/symptoms and hypernatremia (sodium ≥146 mg/dl) at NICU admission, with the exclusion of any other associated diseases.

In our study, weight loss of ≥5% from previously recorded weight at 24 h time interval was compared between the Pre-I group and Post-I group until their discharge to home. Maternal and neonatal variables, including birth weight, subsequent weight changes, vital signs (temperature and respiratory rate), and laboratory values were retrieved from medical records. Data related to blood culture, antibiotic use, and maternal diabetes – gestational and chronic were also included in the study.

The criteria of exclusion from the study was infants <37 weeks of gestational age, birth weight <2 kg, maternal drug abuse, formula feeding, NICU admissions within 24 h of birth. Furthermore, neonates with multiple congenital anomalies, cardiac defects, and metabolic disorders were also excluded. Additionally, newborns with no recorded weight besides birth weight and those with immense weight gain or loss (change by more than 10% of previous weight within 24-h) were also removed from the study.

Data were analyzed using descriptive statistic methods. We used the chi-square test of independence or Fisher's exact test for the comparison of categorical variables and the *t*-test and Mann-Whitney test for the comparison of continuous variables. All p-values were calculated at the level of significance of 0.05 ($\alpha = 0.05$). Statistical analysis was performed using the Sigma Stat 3.5 (Systat software, Inc. San Jose, CA, USA).

Results

A total of 2770 newborns were eligible for this study. The Pre-I group had 1320 neonates and Post-I group had 1450 neonates. Young mothers and those who had C-section were significantly more common in Pre-I group than in Post-I group ($P < .01$), (Table 1A). Additionally, primipara and diabetes mothers were more frequent in the Post-I group than in the Pre-I group ($P < .03$).

A significant number of newborns lost ≥5% of birth weight before intervention in the Post-I group (19.7%) as compared to the Pre-I Group (10%) at 24 h of age, ($P < .001$). After the intervention, a smaller number of neonates lost ≥5% of weight between 24 and 48 h in the Post-I group (12%) relative to the Pre-I group (23%), ($P < .004$). Similarly, between 48 and 72 h, fewer newborns lost ≥5% weight in the Post-I Group (1.2%) as compared to the Pre-I group (4.5%), ($P < .004$). In total, the Post-I group lost more weight before the intervention than they did after the intervention (Table 1B).

During the study period, 32 newborns were admitted to the NICU with the diagnosis of NHD. Twenty-two infants (1.6%) had NHD in Pre-IDG as compared to 10 infants (0.68%) in Post-IDG ($P < .01$), (Table 2A). The majority of infants were Hispanic in the Post-IDG relative to the Pre-IDG group ($P < .03$).

Neonatal characteristics were similar in both dehydration groups at NICU admission. However, a good number of Post-IDG neonates were under phototherapy due to hyperbilirubinemia ($P < .03$) (Table 2B). Fever and tachypnea were the two most common symptoms in newborns who were admitted to the NICU, with the exception of one neonate who had lethargy and hypoglycemia (Post-IDG). Approximately 60% of neonates had a fever in both dehydration groups. Tachypnea was observed in 50% of the Pre-IDG compared to 33% in the Post-IDG (p-ns) group, (Table 2C).

Discussion

This study suggests that the intervention at ≥5% weight loss at a 24-h time interval reduced the incidence of NHD in BF newborns. The rate of dehydration, which was 1.66% in our population, decreased to 0.68% by implementing a new BF policy. This study also exemplifies the fact that the infants of Hispanic mothers were more susceptible to dehydration.

Excessive weight loss is an indicator of impending dehydration [13], but the percentage of weight loss is non-specific and arbitrary in different studies. Previous study indicate that >5% weight loss per day augments the odds of NHD [16]. Another study

POLICY: **Newborns weight after birth, which is based on AAP guidelines, should be assessed daily. A plan should be in place for exclusively breastfeeding newborns that experience a ≥ 5% weight loss in a 24hr period.**

PURPOSE: **To develop guidelines for exclusive breastfeeding newborns who have a weight loss of ≥ 5% in a 24hr period.**

PROCEDURE:

Birth to 24 hours:

1. **Newborn should be weighed at 1 hour of life.**
2. **Skin to Skin and breastfeeding on demand should be initiated in the delivery room.**
3. **There should be an RN assessment of latch, suck and swallow with document at least once a shift in the EMR.**
4. **Provide maternal education regarding skin to skin contact, feeding cues, appropriate latch, & importance of recording of feedings and diapers on the "Diaper Diary."**
5. **Newborns should be weighed during routine night shift assessment.**

If there is a weight loss of greater than 5% in any 24 hour period the plan of care will include:

1. **Notification of the Provider.**
2. **Referral to International Board Certified Lactation Consultant (IBCLC) on unit.**
3. **Encouragement of continued skin to skin contact.**
4. **Have mother offer breast to newborn every 2 hours and document in the EMR**
5. **Assessment of latch, suck and swallow with initial feeding after documented weight loss and document of the assessment in the EMR**
6. **Hand expression of breast with feedings and chart amount of drops in EMR**
7. **Reweighing for additional weight loss 12 hours after previous night shift assessment weight**
8. **Reporting of post intervention weight to the Provider if additional weight loss exceeds 2.5%**
9. **Providers should use the Supplementation Policy (#04-6080-137) as a reference for additional feeding orders as needed**

Fig. 1. Breastfeeding policy 2015.

Table 1A
Maternal and neonatal variables.

	Preintervention group (Pre-I group) n = 1320 (%)	Postintervention group (Post-I group) n = 1450 (%)
Maternal age: years (mean [SD])	30 (5.8)	31 (5.7)
Young mothers <20 years	50 (3.7) [a]	31 (2.1)
Advance age >35 years	352 (26.2)	397 (27.3)
C-section delivery	382 (29) [b]	318 (22)
Race	613 (46.4)	714 (49)
White	359 (27.2)	425 (29)
Hispanic	124 (9.4)	124 (8.5)
Black	224 (16.9)	187 (12.8)
Others[##]		
Birth weight: kg (mean ± SD)	3.45 (0.44)	3.4 (0.44)
Weight: <2.5 kg	29 (2.1)	21 (1.4)
Weight >4 kg	99 (7.5)	87 (6)
Maternal diabetes	55 (4.1)	86 (6) [c]
Primiparous	n = 933	n = 1241
	281 (30.1)	479 (38.6) [b]

[d]Others include Asian and non-specific races.
[a] *P* value < .01.
[b] *P* value < .001, and.
[c] *P* value < .03.

Table 1B
Pattern of neonatal ≥5% weight loss between hours of birth.

Age of infants (h)	Preintervention group (Pre-I group)	Postintervention group (Post-I group)
n	1320	1450
Weight loss ≥5% between 0 and 24 h	135 (10.2%)	286 (19.7%)[a]
n	957	1202
Weight loss ≥5% between 24 and 48 h	219 (22.8%)[a]	144 (11.9%)
n	350	470
Weight loss ≥5% between 48 and 72 h	16 (4.5%)[b]	6 (1.2%)

[a]*P* < .001, [b]*P*-<.004.

demonstrated the occurrence of NHD when the weight loss is <10%. Furthermore, a published report revealed that 73% of neonates diagnosed with NHD had lost >10% of birth weight [14]. Flaherman et al., demonstrated the median percent weight loss of BF neonates

Table 2A
Demographic data of neonatal dehydration: n = 32.

	Preintervention dehydration group (Pre-IDG) n = 22	Postintervention dehydration group (Post-IDG) n = 10
Clinical dehydration	22/1320 (1.66%) [a]	10/1450 (0.68%)
Maternal age; years (mean ± SD)	30 (4.9)	31 (7.4)
Primiparous	10 (45.4%)	4 (40%)
Cesarian section	12 (54.5%)	5 (50%)
Birth weight; kg (mean ± SD)	4.0 (0.44)	3.6 (0.56)
Birth weight > 4 kg	5 (22.7%)	3 (30%)
Race	10 (45.4%)	2 (20%)
White	9 (41%)	8 (80%) [b]
Hispanic	3 (13.6%)	0 (0%)
Black		
Maternal diabetes	4 (18.1%)	0 (0%)

[a] $P < .01$ and.
[b] $P < .03$.

Table 2B
Characteristics of neonates admitted to NICU.

	Preintervention dehydration group (Pre-IDG) n = 22	Postintervention dehydration group (Post-IDG) n = 10
Age at NICU admission (average hours + SD) [b]	48.7 (16)	48.1 (14)
Percentage of weight loss at NICU admission (%) + SD	7 (2.48)	9.2 (0.02)
10% weight loss on NICU admission	4 (18%)	5 (50%)
First urine after birth in hours (mean + SD) [b]	8 (6.6)	8.4 (7.5)
Number of voids 24 h prior to NICU admission (mean + SD)	3.5 (1.5)	4 (1.8)
Bilirubin level on NICU admission (mg/dl) mean + SD	9 (4.3)	10.6 (3.6)
Phototherapy before NICU admission	2 (9%)	4 (40%)[a]
Phototherapy after NICU admission	5 (22.7%)	1 (10%)
Infants of diabetes mothers	4 (18%)	0 (0%)

[a] $P < .03$.
[b] A neonate admitted at 22 h and another voided at 26 h of age.

Table 2C
Clinical variables and laboratory values on NICU admission.

	Preintervention dehydration group (Pre-IDG) n = 22	Postintervention dehydration group (Post-IDG) n = 10
Temperature >100.4 F	14 (63%)	5 (50%)
Tachypnea >60 b/min	11 (50%)	3 (33%)
Tachypnea and temperature >100.4 F	6 (27.2%)	1 (10%)
Hypoglycemia (<40 mg/dl)	0	2
Serum sodium (mean [SD])	149.3 (3.4)	150.1 (1.9)
Serum. bicarbonate <20 mg/dl	6 (27%)	7 (70%)
White blood cell count (mean [SD])/mm^3	15 (4.2)	15.6 (3.4)
Band count (mean [SD])/mm^3	1 (1.4)	2 (1.8)

Note: p-value-ns.

was 4.2%, 7.1%, and 6.4% at 24, 48, and 72 h of age, respectively [11]. Boer et al. suggested the use of weight change standard deviation scores to identify infants prone to dehydration [12]. Hence, a weight-monitoring policy not only provides a tool to identify neonates who require additional BF support to avoid dehydration, but it also supports mothers to continue BF [15]. Our BF policy of intervention at ≥5% weight loss within a 24-h interval showed promise in reducing the risk of significant weight loss and incidence of NHD in BF neonates.

In our study, 10%–20% of newborns lost ≥5% birth weight within the first 24 h after birth. The majority of these newborns were from the Post-I group. This was probably due to the large number of primiparous mothers belonging to this group. Newborns of primiparous mothers lose more weight during first few days of birth [17]. Furthermore, a large number of neonates lost ≥5% weight at a 24-h time interval at 48 or 72 h of birth in the Pre-I group as compared to the Post-I group. The Pre-I group had significantly higher numbers of young mothers and neonates who were delivered by C-sections. Both these factors may influence weight loss during the newborn period [18,19].

The clinical presentation of neonatal dehydration is subtle and unreliable [20]. Because of the increasing rate of BF, fever is emerging as an important indicator of BF-associated NHD [21,22]. Previous investigators demonstrated the occurrence of fever in 15% of NHD newborns. In our study, 68% of BF newborns developed a fever and were admitted to NICU; of which 63% of neonates were in the Pre-IDG and 50% belonged to the Post-IDG group. A similar rate of fever was also noted by Korgali et al. in their study of fever in NHD infants [23]. Neonatal fever can occur in other conditions like sepsis, metabolic disorders, and in infants under phototherapy [23]. In our study, neonates admitted to the NICU after 24 h of birth had a septic workup and received antibiotics for 48 h; none of these infants were diagnosed as having clinical sepsis or bacteremia.

In our study, respiratory distress emerged as an indicator of NDH. To our knowledge, it has never been reported in any previously published study. Tachypnea was noted in 50% of the Pre-IDG and 33% in the Post IDG group. Together, 21% of newborns developed both fever and tachypnea. Late onset respiratory distress in a newborn may indicate conditions like heart disease and metabolic disorders. None of the neonates in our study had any such

condition. As reported earlier, metabolic acidosis may be induced by dehydration [24]. Tachypnea probably occurred as compensation for metabolic acidosis, because 40% of NHD neonates had bicarbonate levels <20 mg/dl.

Our study had several limitations. The effects of maternal preexisting physical and mental conditions such as obesity, hypertension, and psychiatric issues on successful BF were not elucidated [25,26]. Similarly, the role of maternal medications and the use of intrapartum fluid administration, which may interfere in breast milk supply were not addressed.

Conclusion

Our study demonstrated that the incidence of NHD is common in newborns during their short stay in their birthing hospital. Early identification of dehydration by strict monitoring of weight change, and intervention at ≥5% weight loss, may curb the incidence of NHD.

Role of contributors

Zia M.T.K: co-led all aspects of the study concept, design, and analysis and drafted the initial manuscript.

Sabrina Nitkowski-Keever: contributed to the design of the study, and participated in revision of the manuscript.

Paudel U: co-led all aspects of the study concept, design, and analysis.

Golombek S: contributed to the design of the study, led the data management, and participated in critical revision of the manuscript.

Ethics approval

Approval was obtained from the NYP-Hudson Valley Hospital ethics committee for this study.

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Declaration of competing interest

We declare that none of the authors have any conflict of interest or have received support for any of the products described.

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Visual abstract

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