Elevated Breast Milk Sodium and Seasonal Variation in Neonatal Hypernatremic Dehydration: A Descriptive Study from Northern Tunisia

Ben Othmen. W [(1)], Barbaria. W [(1)], Hedhili. A [(1)], Bourcheda. M [(1)], Jandoubi. J [(1)], Chelly. I [(1)], Khamassi. I [(1)]

[(1)] University of Tunis El Manar, Faculty of Medicine of Tunis, Hôpital Habib Bougatfa, Department of Pediatrics, Bizerte, Tunisia.

Background :

Neonatal hypernatremic dehydration (NHD) is an underrecognized and a potentially serious condition, particularly in exclusively breastfed infants. Frequently overlooked in the early postnatal period, it may cause severe complications. While postnatal weight loss is a known indicator, the specific role of breast milk composition and environmental factors remains understudied. This study describes the clinical features, contributing factors, management, and outcomes of newborns diagnosed with NHD in a neonatal unit in northern Tunisia.

Methods :

We performed a retrospective descriptive study including all neonates admitted for NHD to the neonatal unit of Habib Bougatfa Hospital (Bizerte, Tunisia) between January 2022 and December 2025. Hypernatremia was defined as serum sodium >145 mmol/L and classified as moderate (150–159 mmol/L) or severe (>160 mmol/L). Demographic, clinical, laboratory data, management, breast milk sodium levels and outcomes were analyzed.

Results :

Thirty-two neonates were included (sex ratio 1.13), with a mean age of 3.85 ± 1.88 days at admission. Most infants (84%) were exclusively breastfed. A striking seasonal clustering was observed, with all cases admitted between May and October. The mean weight loss was 13.5%, and fever was the predominant symptom. The mean serum sodium level was 150.8 ± 4 mmol/L (50% had moderate hypernatremia and 3% severe hypernatremia). The mean breast milk sodium concentration performed in 24 mothers was elevated at 59.3 ± 20.5 mmol/L (normal <7 mmol/L). Functional renal impairment was common (78.1%). All infants recovered fully with controlled fluid correction without neurological sequelae or mortality.

Conclusion :

NHD is preventable and primarily affects exclusively breastfed infants, especially during warm periods. Early recognition of feeding difficulties, monitoring of postnatal weight loss, and controlled correction of sodium imbalance are crucial. Enhanced breastfeeding support and maternal education are essential to prevent this condition while promoting safe exclusive breastfeeding.

Keywords : Hypernatremia, dehydration, neonates, Breastfeeding, Breast milk sodium

Corresponding Author:
Dr Wiem Ben Othmen
Tel: [+216-27596570]
Email: wiem.benothmen@etudiant-fmt.utm.tn

INTRODUCTION

Neonatal hypernatremic dehydration (NHD) remains an underrecognized condition, particularly in exclusively breastfed newborns. Although frequently overlooked in the early postnatal period, NHD can evolve rapidly and lead to severe and potentially life-threatening complications, including seizures, intracranial hemorrhage, cerebral edema, and vascular thrombosis[1]. While inadequate milk intake and excessive weight loss are established risk factors [2], the pathophysiological role of breast milk composition itself (specifically elevated sodium concentration as a marker of delayed lactogenesis) is less frequently documented in clinical cohorts. Furthermore, although clinical experience suggests a seasonal pattern, possibly linked to increased insensible water losses, this association has not been well-characterized in the literature, particularly in the Mediterranean region. This descriptive study from Northern Tunisia aimed to characterize the clinical and biological profile of neonates with NHD, with a specific focus on analyzing breast milk sodium concentrations and evaluating the potential influence of seasonal variation on its incidence.

PATIENTS & METHODS

We conducted a retrospective descriptive study including all neonates hospitalized in the neonatal unit of Habib Bougatfa Hospital in Bizerte between January 2022 and December 2025 who were diagnosed with hypernatremic dehydration. Hypernatremia was defined as a serum sodium concentration >145 mmol/L [2] and classified as moderate (150–159 mmol/L) or severe (>160 mmol/L)[3]. Neonatal dehydration was defined as a weight loss exceeding 5 % of birth weight associated with clinical signs of dehydration such as depressed fontanelle, decreased urine output, dry mucous membranes, or lethargy [4]. The severity of dehydration was classified according to the percentage of weight loss: mild (5–10%), moderate (10–15%), and severe (>15%) [5]. Newborns with incomplete medical records, congenital malformations, metabolic diseases, were not included in the study. Demographic data, clinical presentation, laboratory results, follow-up outcomes, and complications were collected. Feeding practices were documented, including feeding type, frequency and duration of breastfeeding, breastfeeding difficulties. Breast milk sodium concentrations were measured when available and interpreted using established thresholds, with normal values defined as <7 mmol/L[6]. Patients were monitored with serial weight and electrolyte assessments every 6–24 hours based on serum sodium levels. Statistical analyses 6% (n=2) were performed using SPSS 21.0. Values were expressed as mean ± standard deviation and percentages. Student's test was used to compare means. Fischer's test and Chi-square analysiswere used for univariate analysis, as appropriate. p value <0.05 was considered statistically significant.

RESULTS

A total of 32 neonates were included in the study. The cumulative incidence was 0.65%, corresponding to 6.5 cases per 1000 hospitalizations. The sex ratio (M/F) was 1.13 (17 males, 15 females). The mean age at admission was 3.85±1,88 days. Fifteen newborns were delivered vaginally, at a mean gestational age of 38.7 ±0.67 weeks of amenorrhea (range: 37–40 weeks). Only one patient required hospitalization at birth. Twenty-seven (84%) were fed only breast milk and 5 (16 %) with a formula supplement to breast milk. The mean duration of breastfeeding sessions was 18.1 ± 6.2 minutes (median: 20 minutes; range: 10–30 minutes), while the mean breastfeeding frequency was 10.1 ± 2.2 feeds per 24 hours (median: 11 feeds; range: 6–12). The mean birth weight of the cases was calculated as 3403 ± 412 g, and the mean weight at presentation was calculated as 2998± 491 g and the mean postnatal weight loss was 13.5% (range: 5–32%). When the patients were evaluated according to the month of admission, it was found that all the cases were admitted between May and October, when the temperatures were high. The main reason for hospitalization was fever in 78% of newborns (n= 25) and 6% n=2) were admitted for jaundice. On physical examination, fever was observed in 78% of neonates. Signs of dehydration included a positive skin fold test in 12% of neonates, dry mucous membranes 6% (n=2), and a depressed anterior fontanelle in 12% (n=4). No hemodynamic or neurological abnormalities were documented. Biologically, laboratory investigations showed no evidence of systemic inflammation. Functional renal failure was observed in 78% of patients (n=25), with a mean plasma urea level of 0.515±0.255g/L (range: 0.17–1.4g/L) and a mean serum creatinine level of 87.11 ± 16.83µmol/L (range: 45–134 µmol/L). All infants presented with hypernatremia, with a mean serum sodium level of 150.76 ± 3.96 mmol/L (range: 146–176 mmol/L). Hypernatremia was classified as mild in 15 infants (47%), moderate in 16 infants (50%), and severe in one infant (3%). There was no evidence of an association between birth season and the biochemical parameters evaluated at admission, including serum sodium, urea, and creatinine concentrations. The sodium concentration in breast milk was measured in 75% of mothers (n=24), with a mean level of 59.32±20.47 mmol/L. Greater weight loss was significantly correlated with higher admission serum urea (Spearman r = 0.50, p = 0.026), creatinine (r = 0.47, p = 0.035), and sodium levels (r = 0.45, p = 0.045). The demographic characteristics and laboratory findings of the patients are given in Table 1. The management consisted of intravenous rehydration with a total fluid intake of 120–150 mL/kg/day, administered as 10% glucose solution enriched with sodium, and potassium was added once diuresis was adequate. The mean duration of correction was 16,41 hours (range: 6–24 hours), with a correction rate between 0.5 mmol/h

and 1 mmol/h. This process necessitated the adjustment of fluid infusion rates according to sodium levels, which were monitored every six to twelve hours during the initial phase of treatment. Sodium correction showed a progressive decrease over the first 72 hours exhibiting a gradual normalization of analytical parameters, achieving complete sodium level normalization 48 hours after admission. Throughout the treatment period, formula milk was introduced and adjusted per newborn's tolerance. The mean length of hospital stay was 2.86 ± 1.79 days (range: 1–4 days). It was independently associated with hypernatremia severity (OR > 1, p < 0.05). The outcome was favorable in all cases. No cases of seizures or cerebral venous thrombosis were recorded. All patients survived until discharge, yielding a survival rate of 100%. The newborns were discharged after maternal education and optimization of maternal fluid intake.

DISCUSSION

In this study, we identified several notable findings. First, NHD predominantly affected exclusively breastfed infants (84%) despite apparently adequate breastfeeding frequency and duration. Second, all cases occurred during the warm season (May–October), suggesting an environmental contribution. Third, breast milk sodium concentrations were markedly elevated in affected mothers, consistent with inadequate milk production or delayed lactogenesis. Finally, with appropriate management, all infants recovered fully without neurological sequelae These finding reinforce that while exclusive breastfeeding is recommended for the first six months of life [7–9], it is not always instinctive or straightforward; it is a learned skill that requires appropriate guidance and support. Infants who experience difficulties with breastfeeding are at risk of developing malnutrition and hypernatremic dehydration, which can lead to seizures as well as permanent neurological and vascular damage if not promptly recognized and treated [8,10]. The major risk factors for breastfeeding-associated NHD include primiparity, maternal breast abnormalities, pre-pregnancy overweight, lack of previous breastfeeding experience, cesarean delivery, and delayed initiation of breastfeeding [3]. In our cohort, twenty-six mothers were primiparous, pregnancies were uneventful, and the majority of deliveries were by cesarean section, which may have hindered early mother–infant bonding and the timely initiation of breastfeeding. The initial clinical presentation is often dominated by signs of extracellular dehydration, including a sunken fontanelle and decreased skin turgor. Signs of intracellular dehydration, primarily fever, were also observed in the majority of cases [11]. In our series, despite significant weight loss and a high frequency of functional renal impairment, the clinical presentation was predominantly preclinical or mild, dominated by fever, with no severe neurological complications as reported in other studies [3,12,13]. This profile suggests a pattern of earlier detection compared to cohorts with more severe outcomes. The pathophysiological cornerstone of breastfeeding-associated NHD is inadequate milk intake, which may result from low maternal milk production, ineffective milk transfer to the infant, or a combination of both [11,14]. Reduced breastfeeding frequency is associated with elevated sodium levels in breast milk. Sodium levels in breast- milk are typically low (<7 mmol/L). Persistently high levels are a recognized biomarker of delayed lactogenesis or low milk volume, as the mechanism for sodium removal from milk is flow dependent [1,15].One case report documented breast milk sodium levels twice the normal range up to day 30 postpartum, suggesting that delayed maturation of breast milk may be a risk factor for NHD [16]. This aligns with the profile of our cohort, where primiparity (59% of mothers)—a known risk factor for delayed onset of lactation—was common. Therefore, measuring breast milk sodium is not merely diagnostic but offers insight into the underlying maternal lactation physiology, moving the assessment beyond infant weight loss alone. The finding that all 32 cases presented during the warm season is striking and underscores the role of environmental context. We hypothesize that high ambient temperatures act as a significant stress multiplier in this setting. Increased insensible water losses through the skin in neonates, coupled with potentially inadequate maternal hydration affecting milk volume, may accelerate the trajectory from suboptimal feeding to clinical dehydration. This seasonal pattern has been poorly documented in the literature, particularly in Mediterranean climates. It represents a modifiable risk factor for targeted preventive education. The management of hypernatremic dehydration involves identifying and addressing the underlying cause, alongside controlled correction of sodium levels using intravenous fluids. Sodium correction should proceed at a rate of 0.5–0.6 mEq/L per hour to prevent complications from rapid shifts, particularly cerebral edema [11,17]. Despite the potential severity, most affected neonates recover fully without long-term sequelae [11,18,19]. Our findings show that hypernatremia severity was significantly associated only with the length of
hospital stay, whereas no maternal, perinatal, or biological parameter demonstrated a significant relationship. The longer hospitalization observed in moderate or severe cases likely reflects the need for careful correction of serum sodium and closer clinical monitoring. This study has several limitations. First, its retrospective design may have led to incomplete or missing data and limited control over potential confounding factors. Second, the relatively small sample size may have reduced the statistical power of the analysis and limited the generalizability of the findings. Third, as this was a single-center study, the results may not fully represent the characteristics of the broader neonatal population. In addition, some

important clinical variables related to breastfeeding practices and maternal factors were not systematically documented in the medical records, which may have influenced the occurrence and recognition of neonatal dehydration.

CONCLUSION

This Tunisian cohort study showed that NHD is linked to two key, modifiable elements: abnormally high sodium concentration in breast milk (a biomarker of delayed secretory activation) and exposure to a warm environmental climate. Maternal education, breastfeeding support, and close follow-up play a key role in prevention, ensuring both the safety and well-being of newborns while promoting successful exclusive breastfeeding.

Conflicts of interest:
There are no conflicts of interest.

Acknowledgments:
This study was conducted without external funding from public, commercial, or non-profit agencies.

REFERENCES :

[1] Lavagno C, Camozzi P, Renzi S, Lava SAG, Simonetti GD, Bianchetti MG, et al. Breastfeeding-associated hypernatremia: a systematic review of the literature. J Hum Lact. 2016;32:67–74. doi:10.1177/0890334415613079

[2] Adrogué HJ, Madias NE. Hypernatremia. N Engl J Med. 2000;342:1493–9. doi:10.1056/NEJM200005183422006

[3] Del Castillo-Hegyi C, Achilles J, Segrave-Daly BJ, Hafken L. Fatal hypernatremic dehydration in a term exclusively breastfed newborn. Children (Basel). 2022;9:1379 doi:10.3390/children9091379

[4] Moritz ML, Manole MD, Bogen DL, Ayus JC. Breastfeeding-associated hypernatremia: are we missing the diagnosis? Pediatrics 2005;116:e343-347. https://doi.org/10.1542/peds.2004-2647.

[5] Pocket Book of Hospital Care for Children: Guidelines for the Management of Common Childhood Illnesses. 2nd ed. Geneva: World Health Organization; 2013.

[6] Boumahni B, Pyaraly S, Randrianaly H, Robillard PY, Renouil M. Déshydratation hypernatrémique et allaitement maternel. Arch Pediatr. 2001;8:731–3. doi:10.1016/S0929-693X(00)00307-9

[7] National Institute of Child Health and Human Development. What are the recommendations for breastfeeding? 2017 [cited 2026 Jan 4]. Available from: https://www.nichd.nih.gov/health/topics/breastfeeding/conditioninfo/recommendations

[8] Eidelman AI. Breastfeeding and the use of human milk: an analysis of the American Academy of Pediatrics 2012 breastfeeding policy statement. Breastfeed Med. 2012;7:323–4. doi:10.1089/bfm.2012.0067

[9] Gupta A, Mathur GP, Sobti JC. World Health Assembly recommends exclusive breastfeeding for first six months. J Indian Med Assoc. 2002;100:510–1, 515.

[10] Victora CG, Bahl R, Barros AJD, França GVA, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effects. Lancet. 2016;387:475–90.doi:10.1016/S0140-6736(15)01024-7

[11] Durrani NUR, Imam AA, Soni N. Hypernatremia in newborns: a practical approach to management. Biomed Hub. 2022;7:55–69. doi:10.1159/000524637

[12] Akdeniz O, Celik M, Samanci S, et al. Evaluation of term newborn patients with hypernatremic dehydration. Turk Arch Pediatr. 2021;56:344–9.doi:10.5152/TurkArchPediatr.2021.20153

[13] El Masri M, Samotiy-Hanna L, Ghabril R, Nassif Y, Al Hamod D. Too much salt to my taste: an entity to think about in neonatal hypernatremia. Case Rep Pediatr. 2024;2024:8838362 doi: 10.1155/2024/8838362

[14] Maryam Z, Forough R, Ali M, Asal R, Hassan B. Evaluation of maternal risk factors for neonatal hypernatremic dehydration: a systematic review. J Matern Fetal Neonatal Med. 2024;28:70–9. doi:10.34763/jmotherandchild.20232701.d-24-00007

[15] Morton JA. The clinical usefulness of breast milk sodium in the assessment of lactogenesis. Pediatrics 1994;93:802–6.

[16] Peters JM. Hypernatremia in breast-fed infants due to elevated breast milk sodium. J Am Osteopath Assoc. 1989;89:1165–70.

[17] Yapicioglu H, Demirel N, Ince Z, et al. Turkish Neonatal Society guideline on fluid and electrolyte balance in the newborn. Turk Pediatri Ars. 2019;53:55–64. doi:10.5152/TurkPediatriArs.2018.01807

[18] Saxena A, Kalra S, Shaw SC, Venkatnarayan K, Sood A, Tewari VV, et al. Correction of hypernatremic dehydration in neonates with supervised breastfeeding: a cross-sectional observational study. Med J Armed Forces India. 2020;76:438–42. doi:10.1016/j.mjafi.2019.05.002

[19] Laing IA, Wong CM. Hypernatraemia in the first few days: is the incidence rising? Arch Dis Child Fetal Neonatal Ed. 2002;87:F158–62. doi:10.1136/fn.87.3.F158.