

Hypernatremia in exclusively breastfed term neonates

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ABSTRACT

Background: Hypernatremia is known to occur in exclusively breastfed neonates in the first few days of life, and its clinical presentation is usually nonspecific. Early identification and prompt treatment of this condition are necessary to prevent morbidity and mortality. **Objective:** The objective of the study was to evaluate the clinical features, causative factors, complications, and outcome of hypernatremia in exclusively breastfed term newborns. **Materials and Methods:** A prospective study of exclusively breastfed healthy term neonates with hypernatremia (serum sodium ≥ 150 mg/dl) was carried out from March 2016 to February 2017. The presenting symptoms, clinical signs, birth and feeding history, and laboratory investigations of the subjects were noted and analyzed. **Results:** Hypernatremia was noted in 35 (1.6%) of the total term neonates. The condition was more common in babies delivered by cesarean section (34.3%), firstborn neonates (74.3%), and during the summer months (74.3%). Mean age of presentation was 4.06 ± 1.43 days. The most common findings were weight loss $>7\%$ from the birth weight (74.3%), feeding problems (71.4%), and decreased frequency of urine (60%). Serum sodium levels ranged from 150.5 to 187 mEq/dl. Acute kidney injury was noted in 4 (11.4%) cases. All the patients were discharged, and there was no mortality. **Conclusion:** Hypernatremia is a common condition in exclusively breastfed neonates. It occurs due to inadequate intake of breast milk by the neonate and is exaggerated in hot environment. Daily weighing of the neonates and monitoring the frequency of urine are important for early detection. Addressing feeding problems early is a simple yet effective measure to prevent this condition.

Key words: Dehydration, Exclusive breastfeeding, Hypernatremia, Neonate

Electrolyte and metabolic disturbances are relatively common in neonates [1]. One such electrolyte derangement is hypernatremia. The normal serum sodium levels in the newborn range from 135 to 145 mEq/L. Mild increase in the levels of serum sodium up to 150 mEq/L is fairly common [2]. Hypernatremia occurs due to a decrease in fluid intake, increased fluid loss or excess sodium intake. Hypernatremia can occur in neonates due to inadequate intake of breast milk. Poor drainage of milk from the breast results in high concentration of sodium in the breast milk which exaggerates hypernatremia [3]. Hot environment further worsens dehydration because of increased loss of water from the skin and lungs. Breast milk intake of these babies might not be sufficient to maintain normal hydration. Although the benefits of breastfeeding and breast milk are well established, inadequate breastfeeding by the neonate could lead to a potentially serious condition of hypernatremic dehydration.

Non-specific clinical manifestations make it difficult to diagnose hypernatremic dehydration in neonates [4]. The presenting symptoms which include fever, excessive thirst, slow or poor feeding, and irritability are nonspecific. Furthermore, conventional signs of dehydration such as sunken eyes, depressed anterior fontanelle, and loss of skin turgor are not reliable in newborns. Therefore, it is difficult

to diagnose hypernatremic dehydration in neonates, and the condition might be easily missed or confused with other conditions like sepsis. Failure to diagnose the condition early might lead to complications. Plasma hyperosmolality due to hypernatremia leads to intracellular water loss. Shrinkage of the brain and tearing of the meningeal vessels can cause intracranial hemorrhage [5]. Insufficient perfusion of the kidneys could lead to acute kidney injury (AKI), vascular thrombosis and even death can occur. Management of hypernatremic dehydration with intravenous fluids requires great care and monitoring as rapid correction of hypernatremia can lead to cerebral edema.

Hypernatremic dehydration has been considered to be rare in breastfed babies [6]. However, recently a trend of increase in the number of exclusively breastfed babies with hypernatremia has been observed [7,9]. We, therefore, undertook this project to study the clinical profile, complications, associated risk factors, and immediate outcome of hypernatremic dehydration in healthy, exclusively breastfed term neonates.

MATERIALS AND METHODS

This prospective study was carried out over a period of 1 year from March 2016 to February 2017 at a tertiary care institute in

Ahmadabad, Gujarat. Neonates in the postnatal wards presenting with fever, feeding problems, decreased frequency of urination, and significant weight loss were examined and investigated. Those found to have hypernatremia (serum sodium level >150 mEq/L) were included in the study. Only full-term (gestational age >37 weeks) intramural neonates of ≤ 28 days of age on exclusive breast feeds were included in the study. Extramural, preterm, and formula-fed newborns were excluded from the study. Those with sepsis, perinatal asphyxia, and respiratory distress, metabolic, and endocrine disorders were also not considered. Approval from the Institutional Ethical Committee was obtained for conducting the study, and informed consent was taken from the parents.

Information regarding age, gender, birth order, mode of delivery, birth weight, and gestational age (as per modified Ballard score) of the newborns were noted. Feeding pattern including adequacy of breast milk secretion, technique of breastfeeding, and breast problems in the mothers was recorded. The weight of the baby at presentation was measured on an electronic weighing scale. All the symptoms were noted and examination findings including status of hydration assessed. Complete blood count, blood urea, serum creatinine, serum electrolytes, and septic screen were done and analyzed. Jaundice was assessed as per Kramer's criteria, and serum bilirubin was done in cases with significant jaundice.

Weight loss was considered significant if the loss was more than 7% of the birth weight or more than 5% in 24 hr. Decreased frequency of urination was defined as frequency <6 times in 24 h. Fever was considered as an axillary temperature $>37.5^{\circ}\text{C}$ measured by a digital thermometer. Hypernatremia was defined as serum sodium level >150 mEq/L, and serum creatinine level was considered elevated if it was >0.8 mg/dl. Blood urea levels <30 mg/dl were considered normal. AKI was defined as serum creatinine >1.5 mg/dl for at least 24–48 h (provided maternal serum creatinine level was normal), or rate of rise of serum creatinine >0.3 mg/dl in 48 h [1].

All the neonates with hypernatremia were admitted in the Neonatal Intensive Care Unit (NICU) and treated according to the standard protocol with IV fluids (0.45% normal saline in 5% dextrose) as per the fluid deficit and requirement. The rate of sodium reduction was kept at 10–12 mEq/24 hr. Breastfeeding was continued, and mother was counseled regarding the proper technique of breastfeeding and the advantages of breast milk and breastfeeding. The neonates were discharged after normal serum sodium levels were attained and breastfeeding was established. The course of the illness, complications, and outcome was recorded. All the data collected were analyzed and reported as mean \pm standard deviation, range or percentage as appropriate.

RESULTS

There were 2183 full-term neonates born during the study period of 1 year. Out of these, 35 (1.6%) had hypernatremic dehydration. This condition accounted for 6.9% of the total NICU ($n=509$) admissions. Out of the 35 neonates, 19(54.3%)

were males and 16 (45.7%) were females with male:female ratio of 1.2:1. Newborns who presented between 3rd and 7th day of life (range 1–10 days) were 33 (94.2%). An average weight loss of 11.3% from the birth weight was noted (range 0–26.7%). Table 1 shows the maternal and neonatal characteristics of the subjects.

The most common presenting complaints were poor feeding in 25 (71.4%), followed by decrease in the frequency of urine in 21 (60%) and fever in 20 (57.1%) neonates. Mothers of 3 (8.6%) babies had breast-related problems such as short, cracked or inverted nipples. Of the 543 babies delivered by cesarean section during the period of study, 12 (2.2%) developed hypernatremia while 23 (1.3%) babies out of the 1802 babies delivered vaginally had hypernatremia. Table 2 shows the clinical features of the neonates.

The majority of the cases, 26 (74.3%) occurred during the summer months (March–June) when climate was hot. Only 9 cases (25.7%) were recorded during the rest of the year when the climate was relatively cooler. Month-wise distribution of the cases is presented in Fig. 1.

The mean serum sodium level was 156.5 ± 7.4 mEq/dl (range: 150.5–187mEq/dl). AKI was noted in 4 (11.4%) and hyperbilirubinemia was seen in 18 (51.4%) cases. All four patients with AKI had feeding problems and weight loss $>20\%$. Three of them were firstborn and two were delivered by cesarean section. Meantime required for the correction of hypernatremia was 2.69 ± 0.90 days. All the neonates were discharged with normal neurological findings. There was no mortality. Table 3 shows the laboratory parameters at the time of the presentation.

DISCUSSION

Out of the 2183 full-term babies born during the study period, 35 (1.6%) developed hypernatremia which is comparable with studies by Moritz *et al.* (1.9%) and Ahmed *et al.* (1.4%) [4,10]. Male to female ratio was 1.2:1 with no significant gender predominance. Similar observations were made by Kumar *et al.* (1.18:1) and Shivanagauda *et al.* (1.23:1) [11,12]. Out of the 35 neonates, 31 were appropriate for gestational age (AGA) while 4 were termed small for gestational age (SGA).

Out of 4 term SGA neonates, 3(75%) had serum sodium levels higher than the mean levels of 156.5 meq/dl and also had raised

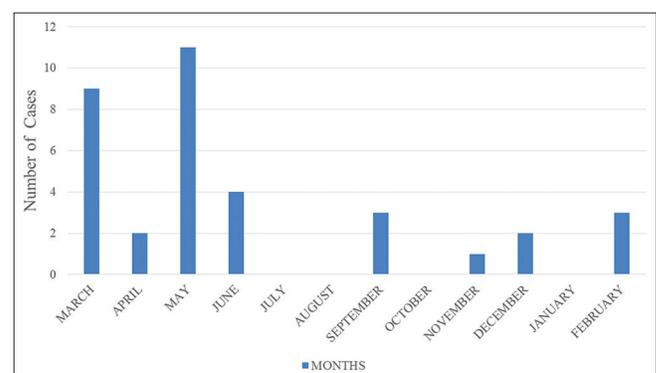


Figure 1: Month-wise distribution of cases of hypernatremia

Table 1: Maternal and neonatal characteristics of neonates with hypernatremia

| Variables | n (%) |
|---|-----------|
| Gender | |
| Male | 19 (54.3) |
| Female | 16 (45.7) |
| Birth weight in relation to Gestational age | |
| AGA | 31 (88.6) |
| SGA | 04 (11.4) |
| Parity | |
| Primiparous | 26 (74.3) |
| Multiparous | 09 (25.7) |
| Mode of delivery | |
| Vaginal | 23 (65.7) |
| Cesarean section | 12 (34.3) |
| Age at presentation | |
| <3 days | 01 (02.9) |
| 3–7 days | 33 (94.2) |
| >7 days | 01 (02.9) |
| Weight loss at presentation | |
| <7% | 09 (25.7) |
| 7–10% | 18 (51.4) |
| >10% | 08 (22.9) |

SGA: Small for gestational, AGA: age, appropriate for gestational age, SGA: Small for gestational age, AGA: Appropriate for gestational age

Table 2: Clinical features of the neonates

| Clinical features | n (%) |
|----------------------------------|-----------|
| Refusal to feed | 25 (71.4) |
| Decreased frequency of urination | 21 (60) |
| Fever | 20 (57.1) |
| Jaundice | 20 (57.1) |
| Lethargy | 11 (31.4) |
| Excessive crying | 09 (25.7) |

Table 3: Laboratory parameters at the time of presentation

| Laboratory parameter | n (%) |
|----------------------|-----------|
| Serum sodium | |
| 150–169 mEq/L | 33 (94.3) |
| ≥170mEq/L | 02 (05.7) |
| Blood urea | |
| <30 mg/dl | 09 (25.7) |
| 30–100 mg/dl | 24 (68.6) |
| >100 mg/dl | 02 (05.7) |
| Serum creatinine | |
| <0.8 mg/dl | 15 (42.9) |
| 0.8–1.5mg/dl | 16 (45.7) |
| >1.5 mg/dl | 04 (11.4) |

blood urea levels suggesting higher severity of hypernatremia as compared to AGA neonates. Pandya *et al.* observed that SGA babies were more prone to develop hypernatremia because of problems related to breastfeeding such as difficulty in latching

and tiring on sucking [7]. Recognizing the feeding problems in such babies and providing them expressed breast milk with spoon, following direct breastfeeding can provide adequate fluid required to prevent dehydration. Association of low birth weight and feeding problems with hypernatremia in exclusively breastfed infants has also been noted by Kaplan *et al.* [5].

In our study, 74.3% of the neonates were born to primiparous mothers, who were anxious and inexperienced regarding the proper technique of breastfeeding (position and attachment). We also observed that primiparous mothers had more problems related to the breast such as inverted, flat, and sore nipples. High incidence of hypernatremic dehydration in neonates of primiparous mothers was also noted by Pandya and Mehta, Kumar *et al.*, and Piparsania *et al.* [7,11,13].

In our study, 2.2% of the babies delivered by cesarean developed hypernatremia, while only 1.3% babies delivered by vaginal route faced the problem. This can be explained on the basis of late initiation of lactation in cases of cesarean deliveries and to the persistence of high levels of sodium in the breast milk.

We noted that the majority of the cases (26) occurred during the months of March–June which are hot summer months. Most of the studies on hypernatremic dehydration in neonates have been conducted in the summer season (March–June) [7,8,11]. Piparsania *et al.*, who studied the condition over a period of 2 years, noted clustering of cases at the peak of summer season with no cases during the rest of the year [13]. This suggests that high environmental temperature is a significant factor responsible for the occurrence of hypernatremia in neonates. Increased incidence of hypernatremic dehydration during periods of high environmental temperature is due to increased water loss from the skin and lungs leading to dehydration. However, we also recorded 6 cases during cold season (November–February), which indicates that a high environmental temperature alone is not responsible for hypernatremic dehydration. Inadequate feeding by neonates is also an important contributory factor.

A total of 94.2% neonates presented between 3rd and 7th days of life (mean – 4.06 days). Kumar *et al.* and Goyal *et al.* noted the time of presentation as being 4.31 and 4.19 days, respectively [11,14]. However, studies by Pandya and Mehta, Shah and Javadekar, and Piparsania *et al.*, noted a late presentation of the condition at 8–10 days and also more cases of severe hypernatremic dehydration [7,8,13]. This could be explained by the fact that they included extramural neonates who were discharged early and presented late with advanced clinical features. Hypernatremic dehydration is usually more common in the 1st few days of life, during the phase of physiologic lactational inadequacy.

In our study, the main symptom was poor feeding followed by decreased frequency of urine and fever. These findings are comparable with studies done by Kumar *et al.* and Piparsania *et al.* [11,13]. Fever, also known as dehydration fever, was an important concern of parents and caretakers. Fever occurs due to poor heat dissipation mechanism of the neonates, especially in a hot environment. It is one of the most common noninfectious causes of the fever in the neonatal period. Improper treatment of

this fever with antipyretics and antibiotics worsens the situation. Jaundice was noticed in 57.1% of neonates, which was similar to other studies [12,13]. Moritz *et al.* showed an association of hypernatremia with severe hyperbilirubinemia and concluded that both the conditions together could cause severe depression of the central nervous system and lead to brain injury [4].

An average weight loss of 11.3% from birth weight was noted, of which 74.3% had a weight loss of >7%. Normally, a newborn loses 1–3% of its birth weight per day in the 1st few days and regains its birth weight by the 10th day of life. If there is a weight loss of >3% per day or a total weight loss of >7–10%, feeding problems and dehydration should be suspected in the newborns. Livingstone *et al.* in their study concluded that a weight loss >7% warrants feeding assessment [15].

In our study, all the neonates, who had a weight loss >20%, had AKI. Clinical signs of dehydration such as depressed anterior fontanelle, dry mucosa, and loss of skin turgor are less pronounced in cases of hypernatremic dehydration because of a comparatively well-preserved extracellular fluid volume. Significant weight loss and decreased urine output are sensitive indicators of dehydration. Therefore, the danger signs to be watched for are excessive thirst, irritability, poor feeding, lethargy, fever, decreased frequency of urine, and weight loss.

Raised levels of blood urea were noted in 74.3% neonates which were similar to the study by Kumar *et al.* [11]. Serum creatinine was increased in 54.3% cases. The number of patients with raised blood urea levels was more than those with raised serum creatinine and is suggestive of predominant prerenal failure. All the 4 cases of AKI responded to fluid therapy, and none of them required dialysis. Serum sodium levels >170 mEq/dl were noted in 2 patients who had AKI. Such high levels of sodium are a known risk factor for adverse outcome and mortality. There was a lower incidence of complications and no mortality in our study because we included only intramural neonates in postnatal wards who were monitored daily for feeding problems and weight loss.

Our study was limited by small sample size and a short duration of the study. Further studies are required with a bigger sample size conducted at multiple centers for a longer duration and also on preterm neonates.

CONCLUSION

Hypernatremic dehydration is a common condition in exclusively breastfed neonates. In our study, we found that neonates who were delivered by cesarean section, born to primiparous mothers and who were SGA were more likely to suffer from hypernatremic dehydration, particularly in the hot season. Hypernatremia occurs due to inadequate intake of breast milk and is exaggerated in a hot

environment. Poor feeding decreased frequency of urine, fever, and weight loss >7% was the most common clinical findings noted. It is important to ensure adequate breastfeeding with the correct technique, by counseling mothers. A high index of suspicion with close supervision and prompt treatment is necessary to prevent morbidity and mortality.

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