Hypernatremia in Early Neonatal Life- Can it be Physiological?

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ABSTRACT

Introduction: Hypernatremic dehydration in neonates is the most dangerous form of dehydration due to complications associated with it as well as its management. This study was planned to study the impact of the significant physiologic changes in body water content on serum sodium concentration in the immediate postnatal period and try to identify risk factors for hypernatremic dehydration.

Material and Methods: Only healthy term/near-term babies were included. They were examined on day four of life in the well baby clinic. These neonates were again examined on days seven and ten of life. Blood samples were collected on days four and ten of life, serum was separated and stored at -20°C. These serum samples were processed subsequently and serum sodium and potassium were estimated and compared with weight lost by the neonates.

Results: 184 neonates were included in the study. Mean serum sodium level was 149 ± 6.0 mEq/l (range 135-172 mEq/l). Hypernatremia of varying severity was detected in 137 neonates. By day 10 of life sodium levels had normalized in all hypernatremic neonates except one, who was hospitalized on day 5 of life with hypernatremic dehydration. Perception of decreased milk production by mother, higher birth order, delivery by cesarean section and decreased urination in the neonate bore significant association with hypernatremia. Signs of dehydration were clinically discernible in nine patients and all of them had hypernatremia, however, most of the babies didn't have obvious dehydration signs and weight loss was comparable between two groups.

Conclusion: Mild to moderate degree of hypernatremia is quite common during physiological dehydration in early neonatal period and adequate breastfeeding appears to be an effective and safe intervention for mild to moderate hypernatremic dehydration.

Keywords: Dehydration, Hypernatremia, Neonates, Sodium

INTRODUCTION

Maintenance of fluid and electrolyte balance is essential for normal cell and organ function during intrauterine development and throughout extrauterine life. Dynamic changes occur in body composition and fluid distribution during intrauterine life, labor and delivery, and the early postnatal period.[1] The fetus has very high total body water, which decreases to approximately 75% of birthweight for a term child. TBW decreases further to 60% of body weight over first year of life and it is the neonatal period that witnesses the most significant changes.[2] Healthy term newborns lose an average of 5% to 10% of their birthweight during the first 4 to 7 days of life; thereafter they establish a pattern of steady weight gain.[1] This is accompanied by significant changes in breast milk sodium concentration. Studies of the electrolyte composition of breast milk have shown a mean sodium value of 64.8 ± 4.4 mEq/L after delivery, dropping to a mean of 21.4 ± 2.3 mEq/L by the third postpartum day (colostrum) and leveling off to a value of 7 ± 2 mEq/L by two weeks (mature milk).[3,4,5] These significant changes in the early neonatal period could also be accompanied by changes in serum sodium concentration as the mechanisms for fluid homeostasis are closely related to sodium homeostasis and sodium is the main determinant of osmolality and volume status.[4] Establishment of adequate breastfeeding is central to prevention of any significant fluid and electrolyte disturbance.[7] Adequate breastfeeding also helps in physiological decrease in breastmilk sodium concentration.[7,3] Association of hypernatremic dehydration with breast feeding, and its rising incidence as per recent reports[7], also suggests that serum sodium concentration may be changing in the neonatal period and disruption of the complex regulatory mechanisms of fluid and electrolyte homeostasis could sometimes lead to hypernatremic dehydration. This study was planned to study the impact of the significant physiologic changes in body water content on serum sodium concentration in the immediate postnatal period and try to identify risk factors for hypernatremic dehydration.

MATERIAL AND METHODS

This study was conducted over a period of six months in the Departments of Pediatrics and Obstetrics of a tertiary care hospital in north India. The babies born in the obstetric department attend the well baby clinic of the Department of Pediatrics for follow up examination and immunization. For

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a 2% prevalence of hypernatremic dehydration, with a 2.5% margin of error, a sample size of 121 with 95% confidence interval and sample size of 209 with 99% confidence interval was calculated. All consecutively inborn, term or near-term, exclusively breastfed babies, who were healthy and whose parents gave consent, were included in this study. Babies hospitalized for any reason other than hypernatremia or with congenital anomalies were excluded. The included babies were examined on day four of life in the well baby clinic. Weight was recorded using a digital weighing scale and rounded to nearest 10 grams. This equipment was calibrated each morning before use. Children were examined for any signs of dehydration. History about birth weight, mode of delivery, birth order, type of feeding, frequency of passage of stools and urine was enquired and the data entered in Microsoft excel worksheet. A blood sample was collected and serum was separated and stored at -20°C. The children were again examined on day seven of life upon their visit to the well baby clinic for weight monitoring as per pre-existing protocols. Special attention was paid to any signs of dehydration in the children at time of this visit. The children were again examined in the well baby clinic on tenth day of life. Weight was again recorded, a blood sample collected and serum separated and stored at -20°C. In all these visits, lactation counseling was provided to the mother and any child whose clinical condition warranted hospitalization was admitted in the hospital.

The serum samples previously collected were processed subsequently and serum sodium and serum potassium were estimated in these using Rosche Auto Analyzer equipment. Hypernatremia was defined as serum sodium concentration >145 mEq/l. A table was drawn depicting the birth weight of the child, weight on day four, seven and ten of life and serum sodium on day four and ten of life. A comparison between serum sodium levels and weight loss of child by day seven of life was done. Similarly, serum sodium levels were compared with weight of the child on day ten of life.

Primary outcome was to study change in serum sodium concentration in healthy term and near term neonates in immediate postnatal life. We also aimed to get an idea about risk factors for hypernatremia and possible early interventions in breastfeeding associated hypernatremic dehydration.

To remove any observer bias, all the subjects were examined on all visits by an observer who was blinded to the aims and objectives of the study and the reason for which the blood samples were drawn. The study was approved by the institutional ethics committee.

STATISTICAL ANALYSIS

Statistical analysis was done using GraphPad instant statistical software. For categorical variables Fischer's exact test and chi square test were used. For continuous variables t-test and Mann Whitney test (non-parametric data) was used. *P*-values less than 0.05 were taken as significant.

RESULTS

184 patients were included in the study and screened for hypernatremia on day 4 of life. Out of these, 5 patients didn't return for repeat assessment and follow up. Mean serum sodium level was 149±6.0 mEq/l, with a range of 135-172mEq/l (95%CI 148.5-150.2). Serum sodium levels were normal in 47 patients; hypernatremia of varying severity was detected in the remaining 137 patients. 62 patients had serum sodium levels between 146 and 150

Cat	Hypernatremic neonates	Neonates with normal sodium	P value**
Maternal age	30.1±3.4	28.7±3.9	0.07
Birth wt	3.09±0.46	3.11±0.41	0.77
Present wt	2.88±0.56	2.95±0.48	0.74
Wt loss	0.19±0.08	0.16±0.07	0.57
% Wt loss	6.17±2.71	5.19±2.70	0.29
% Wt loss/d	2.17±0.99	1.65±0.87	0.32
Na level on Day 4	151±4.8	142±2.4	<0.0001
Na level on Day 10	141±3.4	139±3.6	0.22
statistical **analysis by student t-test (parametric) and Mann Whitney test (non parametric)			

Table-1: Comparison of continuous variables between two groups

	Hypernatremic neonates	Neonates with normal sodium	P value**	RR**
Symp/asymptomatic	49/88	7/40	0.009	1.27
Oliguria	13	0	0.04	1.38
Nipple problem	3	0	0.57	1.36
Decreased milk production	21	1	0.016	1.34
Signs of dehydration	9	0	0.11	1.36
Wt loss >10%	13	2	0.36	1.18
Daily wt loss>2%	47	12	0.28	1.1
Caesarean section/Normal Vaginal Delivery	87/50	20/27	0.016	1.25
Birth-order, primi/multi	50/87	26/21	0.026	0.82
statistical analysis by chi square and Fischer's exact test				

Table-2: Comparison of categorical variables between two groups

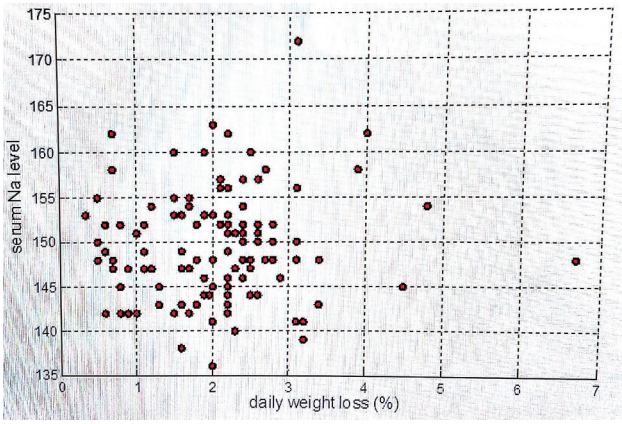

Figure-1:

mEq/l, 62 between 151 and 159 mEq/l and 13 patients had serum sodium ≥ 160 mEq/l. The serum sodium of babies with hypernatremia (152±4.8 mEq/l) differed significantly from babies with normal serum sodium (142±2.4 mEq/l) (p-value <0.0001). The birth weight of babies who had hypernatremia did not differ significantly from those who did not have hypernatremia (3.09±0.46 Kg v 3.11±0.41 Kg; p-value 0.77). The gestational age of the two groups was also comparable (38.2±1.1 weeks v 37.8±1.5 weeks; p-value 0.87).

81% of Caesarean section born and 65% of normally delivered babies developed hypernatremia (Table 1). Babies born by Caesarean section were more likely to develop hypernatremia (p-value 0.016). Out of 76 first-born babies, 50 (66%) had hypernatremia. 80.5% babies born to multigravida mothers had hypernatremia. First-born babies were found to have less risk of hypernatremia (p-value 0.026). Maternal age was not found to be significantly different between the two groups.

All patients were asymptomatic on the day of initial assessment. When specifically asked, 56 mothers gave history of at least one symptom suggestive of inadequate breast feeding like nipple problems, decreased milk production, pain during breast-feeding or decreased micturation in the baby. Out of these 56 mothers, babies of 49 were subsequently found to have some degree of hypernatremia (p-value 0.009). Perception of decreased milk production was the commonest symptom in these mothers, followed by scanty micturation (< 4 urines/ day) in baby. Signs of dehydration, in form of decreased skin turgor, were clinically discernible in only 9 patients and all of them had hypernatremia. However, most of the hypernatremic neonates didn't have clinically evident dehydration (p-value 0.11).

Weight loss (%) also did not differ significantly in the two groups (6.17±2.71% v 5.19±2.70%; p-value 0.29). Weight loss beyond physiological limits was not very common in hypernatremic neonates. However, when present, excessive weight loss suggested hypernatremia. Only 15 patients had excessive weight loss (> 10%) and out of these 13 had hypernatremia (p-value 0.36). 59 neonates had average daily weight loss of >2% (normal 1-2% in term babies) and out of these 47 had hypernatremia (p-value 0.28).

All patients were again examined on days 7 and 10 of life. One patient returned with complaints of lethargy on day 5 and required hospitalization for hypernatremic dehydration. His serum sodium on day 4 was subsequently found to be 172 mEq/l and he had some signs of dehydration on that day. All other neonates had regained birth weight, were healthy and had normal serum sodium on day 10 of life.

DISCUSSION

Hypernatremia is a sodium concentration >145 mEq/L, although it is sometimes defined as >150 mEq/L.[6] Mild hypernatremia is fairly common in children, especially among infants with gastroenteritis. Moderate or severe hypernatremia has significant morbidity, including the result of underlying disease, the effects of hypernatremia on the brain, and the risks of overly rapid correction. Most children with hypernatremia are dehydrated and show the typical clinical signs and symptoms.[6] Hypernatremic dehydration is assumed to be a rare complication of breastfeeding, but recent reports have suggested that the incidence is increasing.[7] The failure to diagnose hypernatremic dehydration can have serious consequences, including seizures, intracranial hemorrhage, vascular thrombosis, and death.[7] It is the most dangerous form of dehydration due to complications of dehydration as well as of its treatment. Considering the major changes in the fluid status in the immediate neonatal period, a need was felt to measure normal serum sodium levels and identify risk factors for hypernatremia and possible early interventions for hypernatremic dehydration.

137 (74.4%) neonates, who were otherwise healthy, had some degree of hypernatremia on day 4 of life. Serum sodium concentration ranged from 135 to 172mEq/l, with a median of 149mEq/l. 50 (27.1%) babies had serum sodium level ≥ 155mEq/l and 13 (7%) had severe hypernatremia (≥ 160mEq/l). However, all these neonates were well-appearing and asymptomatic and only a few had signs of dehydration or excessive weight loss. Only one patient returned after 24 hours with complaints of lethargy and needed hospitalization for hypernatremic dehydration. His serum sodium concentration on day 4 of life was subsequently found to be 172mEq/l and though well appearing, he had complaints of decreased urination and signs of dehydration as well. Parents had been advised about proper breast feeding, as in all other cases and were asked to follow closely. All the remaining neonates came for follow up on days 7 and 10, were healthy, showed restoration of birth weight and normalization of serum sodium on day 10 of life.

Presence of symptoms of failure to establish adequate breast feeding was significantly associated with hypernatremia (Table 2). Perception of decreased milk production by mother and decreased urination in the neonate were commonest symptoms and bore significant association with hypernatremia. Their association with hypernatremia has been studied by others studies as well.[8,9] Signs of dehydration like dry mucosae, depressed fontanelle and decreased skin turgor were found in only 9 (6.6%) patients and all of them had hypernatremia. However, these signs lacked sensitivity as most of the patients with hypernatremia didn't present

with these signs. Also, they did not have a significant relationship with hypernatremic dehydration. Absence of dehydration signs in hypernatremic dehydration, due to relative preservation of extracellular fluid compartment and predominantly intracellular dehydration, is a well established fact.[6,10] A weight loss of up to 10% in initial 4-7 days, a daily weight loss of 1-2% and regaining birth weight by 10th day are considered normal in term babies.[1,11] We did not find any significant association between weight loss and serum sodium levels because most of the neonates with hypernatremia had weight loss within physiological limits; though most of the patients with excessive weight loss had hypernatremia. Uras N et al[12] found a cut-off value of only 7% significant for dehydration complications and screening. Weight loss after delivery is universal and is not always accompanied by hypernatremia. In our study, 25% neonates did not show hypernatremia even when they had physiological weight loss after delivery (Figure 1). Thus we can infer that though hypernatremia usually accompanies weight loss in neonates, the relationship is not predictable.

Babies born by caesarean section had significantly more chances of developing hypernatremia compared to vaginally born babies. This association has been found in some other studies as well.[13] We also found hypernatremic dehydration more likely in babies of higher birth-order as compared to first-born babies, although the difference was not statistically significant. First-born babies are otherwise known to be more susceptible to hypernatremic dehydration.[14]

Except for the one neonate who required hospitalization, all other neonates were doing well on follow up in the neonatal period. Even though later analysis revealed hypernatremia of mild to moderate severity in most of them, clinical features warranted evaluation and management in only one child. So, it looks safe to presume that hypernatremia is a rule rather than an exception in postnatal period. Besides, proper breastfeeding or even formula feeding appears to be a safe and cost effective management strategy for mild to moderate hypernatremic dehydration in otherwise healthy appearing neonates. We are not sure up to what serum sodium level this approach is safe, but 12 of our babies with serum sodium 160-167mEq/l were safely treated by this approach. Only one patient who had serum sodium level of 172mEq/l needed to be hospitalized on day 5 of life. Though some degree of hypernatremia is usual, limits of this physiological rise are yet to be defined. There is also a need to redefine the criteria for hospitalization of hypernatremic neonates. Besides we do not feel screening well-appearing babies with weight loss outside physiological limits and with no signs of dehydration, is cost effective. They only need proper feeding guidance and close follow up. However, more studies on a larger sample are required to draw further conclusions.

CONCLUSION

Hypernatremia in early neonatal period seems to be physiological. Mild to moderate hypernatremic dehydration is very common in early neonatal period and adequate breastfeeding is an effective management option. An incidental finding of hypernatremia in early neonatal period should not be a criterion for hospitalization if the baby otherwise appears healthy and warrants close follow up only. There is a need to define physiological hypernatremia and set criteria for pathological rise from larger studies.

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