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CLINICAL PROFILE AND OUTCOME OF NEONATES WITH HYPERNATREMIC DEHYDRATION - A TERTIARY CARE HOSPITAL BASED STUDY

Paediatric Medicine

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ABSTRACT

Objectives: Clinical profile and outcome of neonates with hypernatremic dehydration. **Materials And Methods:** Cross sectional study conducted in a tertiary care centre in central India, includes sick neonates aged less than 28 days admitted in hospital for a period from April 2022 to March 2023, who found to have hypernatremic dehydration on admission with serum soidum >150 mEq/L. Clinical and demographic information in relation to mother and baby were recorded. **Results:** Out of total 2076 neonates admitted during the study period, 25 babies were diagnosed as a hypernatremic dehydration, showing an institute prevalence of 1.2%. Median age of presentation was 9 days, with female to male ratio 1.03. 92% of the babies were exclusively breast fed.76 % were born via normal delivery. Maximum presented with not accepting feed (96%), along with fever (64%), decreased urine output (52%), convulsions (28%). Admitted babies had a mean serum sodium level of 173.9 mEq/L, with as high as 200 mEq/L. 9 babies (36%) presented with shock,19 (76%) presented with evidence of kidney injury. Statistically significant correlation was found between percentage of weight loss to mortality and serum sodium levels to mortality. **Conclusion:** Hypernatremic dehydration is a common medical emergency encountered in neonatal ICU and can be caused by poor feeding. Early diagnosis and appropriate treatment are crucial for survival and better prognosis.

KEYWORDS

Hypernatremic Dehydration, serum sodium, percentage of weight loss, mortality

INTRODUCTION

Hypernatremia is defined as serum sodium concentration > 150 mEq/L[1]. It reflects a deficiency of water relative to total body surface and is most often a disorder of water rather than sodium homeostasis[1]. It is also associated with complications like cerebral edema, intracranial hemorrhage, hydrocephalus, disseminated intravascular coagulation and seizures[2]. There has been increase in the number of breastfed infants reported to have hypernatremia with dehydration since 1990s[3].

The breast-fed infant who is below birth weight, who is not gaining weight, or who is gaining weight poorly may be exhibiting symptoms of hypernatremic dehydration and its attendant cardiovascular, renal, and central nervous system sequelae[4].

Figure 1 - 7-day Old Neonate Presented 48% Weight Loss With Serum Sodium 178 mEq/L

Standard practice in many neonatal units is to progress to demand feeding when infants can tolerate 3–4 hourly feeds, are stable and alert, and have no problems with hypoglycaemia. However, no comparative studies were available to allow decisions to be made about the safest or most effective regimens[5]. Adequate breast milk intake depends on several interdependent processes: normal mammogenesis, lactogenesis, and galactopoiesis as well as effective milk delivery to the infant[6].

Typical post-natal weight loss in term infant is 5- 10 % of birth weight. This loss can be up to 15 % in preterm infants. Usually, re-gains to birth weight within 7- 10 days in terms and can go up to 21 days in preterm infants. Goals for weight gain are 15 to 20 g/kg/day for infants <2 kg and 20 to 30 g/day for larger infants[7].

The caretakers may not able to pick the ill neonate in early days may be due to the apparent wellbeing of the baby[6,8]. Neonates with hypernatremic dehydration often do not demonstrate overt clinical signs of intravascular depletion and dehydration until late in the course of the condition. Hypernatremia induced hypertonicity causes water to shift from intracellular to the extracellular compartment, resulting in intracellular dehydration but with relative preservation of extracellular compartment[1].

So, early recognition and appropriate intervention is necessary to prevent the morbidities associated with severe hypernatremic dehydration in neonates. Most of the previous studies did not address the predictors of mortality and morbidity. The aim of our study was to see the presentation, outcome of neonates and the relation between them among babies admitted with hypernatremic dehydration in our hospital.

MATERIALS AND METHODS

Cross sectional study was conducted at a tertiary care hospital in central India. Institutional ethical committee approval taken. Study included all the neonates, admitted in the hospital from the time period of April 2022 to March 2023 for being sick, who found to have hypernatremic dehydration on admission with serum sodium levels > 150 mEq/L, with or without symptoms with age less than 28 days were included in the study. Their inclusion was only after proper parental consent. Those with inherent structural renal abnormality and metabolic abnormality were excluded from the study.

Clinical and demographic information in relation to the mother like birth order, mode of delivery, and about the neonate like weight at birth, weight at admission, percentage of weight loss, any other presenting complaints. Clinical and laboratory parameters at admission like serum sodium, presence of shock, AKI or Meningitis

were also noted. Acute Kidney Injury defined as serum creatinine 1.5 to 1.9-fold from baseline or > 0.3 mg/dl increase[9]. Shock defined as decreased peripheral perfusion evidenced by delayed capillary refill more than 3 seconds or Mean Arterial pressure less than neonates gestational age in weeks[10]. Meningitis defined as CSF with more than 5% PMN with CSF protein > 80 mg/dl, Sugar < 46 mg/dl or less than 2/3rd of parallel blood sugar[11].

The study was conducted from April 2022 to March 2023, with peak incidence of patients in the month of April to June which shows continuous rise in both day and night temperature. In the region May is generally the hottest month of the year with the mean daily maximum temperature at about 42-degree Celsius[12].

Statistical Analysis

Categorical values were summarized as counts, percentages and mean+/-SD. Chi square test was used to analyze relationship between categorical variables, p values less than 0.05 were considered significant. Correlation coefficient was taken for significant parameters.

RESULT

A total of 2076 neonates were admitted during the period from 1st April 2022 to 31th of March 2023, out of these 25 babies were diagnosed to be having neonatal hypernatremic dehydration. It constitutes an institute prevalence of 1.2 %. Almost all of these reported cases where from the months of April to June.

The median age of presentation was 9 days with minimum age of presentation was 3 days and maximum age of 28 days. Among the babies 12 were males and 13 were females, with female to male ratio 1.08: 1. Most of the babies were born to primi mothers (56 %) with median birth order 1, had as high as 5 as birth order.

24 out of 25 (96 %) were term babies and 92 % babies were exclusively breast fed and the rest 8 % were mix fed with breast milk and cow's milk. None of the babies were fed more than 8 times a day. Whopping 80 % had fed their babies less than 6 times per day. Other important characteristics of data are given below in Table 1

Table 1- Demography Data

Sl No	Category	Subcategory	Number			
			Male	Female	Total	Percent
1	Age On Admission	Early Neonate (0-7 Days)	6	6	12	48 %
		Late Neonate (8-17 DAYS)	4	6	10	40 %
		Late Neonate (18-28 Days)	2	1	3	12 %
2	Birth Weight	SGA	3	3	6	24 %
		AGA	9	10	19	76 %
		LGA	0	0	0	0 %
3	Mode Of Delivery	Vaginal Delivery	10	9	19	76 %
		LSCS DELIVERY	2	4	6	24 %
4	Gestational Age	Term	11	13	24	96 %
		Near Term	1	0	1	4 %
		Pre-term	0	0	0	0 %

Out of the total babies, 19 (76 %), were born out of normal vaginal delivery and the rest 6 (24 %) were born out of LSCS. Comparing weight loss and mode of delivery, among LSCS born only 24 % showed weight loss more than 10 %, which showed as statistically significant p value of 0.03, which showed negative correlation with weight loss.

Maximum presented with complaints of not accepting feeds (96 %). Other complaints include fever (64 %), irritability and decreased urine output by 52 % each. Around 28 % presented with convulsions and 8 % presented in gasping.

When serum sodium concentrations were considered, had a mean sodium level of 173.88 Meq/L, with as low as 155 and as high as 200. 12 babies (48.0 %) had serum sodium levels more than 170 mEq/L. 11 out of 12 babies (91.6 %) with serum sodium levels more than 170 mEq/L were fed less than 6 times per day. However no statistical significance was found (p value> 0.05).

Percentage of weight loss on admission weight compared to birth weight, the mean percent of weight loss of 22.84 % and median of 25.33 %. 15 (60 %) of the babies had weight loss of more than 20 % of birth weight. Babies who presented with complications were classified according to percentage of dehydration are attached below. 9 babies (36%) presented with shock, 19 (76%) presented with evidence of kidney injury. Statistically significant correlation was found between percentage of weight loss to death with p value < 0.05, with correlation coefficient of + 0.65, suggesting higher the percentage of weight loss, poorer the prognosis of the baby (Table 2).

Table 2- Percentage Of Weight Loss V/s Morbidity And Mortality

% Of Weight Loss	Total Number		Shock		Kidney Injury		Death	
<10 %	3	12.0	1	33.3	2	66.7	0	0 %
10- 20 %	5	20.0	0	0.0	3	60.0	0	0 %
20- 30 %	12	48.0	4	33.3	11	91.7	4	33.3 %
> 30 %	5	20.0	4	80.0	3	60.0	3	100 %

On comparing serum sodium and percentage of weight loss, for serum sodium more than 170 meq, 9 out of 12 babies had weight loss more than 20%, which constitutes 75%. Among the 25 babies, 9 babies succumbed to death, giving an institute mortality for hypernatremic dehydration to be 36 %. Among the expired cases, all of them had a serum sodium level more than 170 mEq/ L (Table 3).

Table 3- Serum Sodium V/s Morbidity And Mortality

Serum Sodium Conc	Total Number		Percentage Of Weight Loss				Jaundice		Shock		Kidney Injury		Death	
			<10 %	10-20 %	20-30 %	> 30 %								
150-159	4	16.0	1	1	2	0	0	0.0	0	0.0	1	25.0	0	0.0
160-169	9	36.0	1	3	5	0	4	44.4	1	11.1	8	88.9	0	0.0
170-179	4	16.0	0	1	2	0	3	75.0	1	25.0	3	75.0	2	50.0
180-189	4	16.0	0	0	2	2	1	25.0	4	100.0	3	75.0	4	100.0
> 190	4	16.0	1	0	1	2	0	0.0	3	75.0	4	100.0	3	75.0

In contrasting between hypernatremia with hyperbilirubinema, among the subjects 8 (32.0%) of our neonates had significant hyperbilirubinemia more than their age specific normogram.

For babies with serum sodium more than 170 mEq/L, 9 out of 12 (75%) babies expired. Statistically significant correlation was found between serum sodium levels on admission to death with p value < 0.05, with correlation coefficient of +0.78, suggesting higher serum sodium level on admission, poorer the prognosis of the baby. Outcome when analyzed based on gender, among 12 male babies 16 % had poor outcome, but out of 13 female babies 53.8 % had non favorable baby outcome.

DISCUSSION

During the study period, a total of 2076 babies were admitted to the NICU with the prevalence of hypernatremic dehydration being 25 (1.2 %), which is in correspondence most studies, which showed a bit lower incidence such as by Agarwal Ritu et al (2.4 %), Trivedi P and Patel AH, (1.6%) and Moritz ML et al (1.9%) Koklu et al. (2.1%)[13–16].

Laing and Wong reported an increasing incidence of hypernatremic dehydration in recent times. They suggested that in breastfed infants, hypernatremic dehydration has always been a problem, but was under-reported and had inadequate exposure in medical literature. They recommended that audit should be done to identify babies with >10% loss of birth weight and a strict definition of the condition should be agreed upon[17].

This study has shown the condition to be more common in neonates born to primiparous mothers (56 %) as compared to multiparous women. Results from previous studies have also shown this condition to be more prevalent in primipara being 81.3% in study by Saxena A et al., 74.3% by Trivedi P and Patel AH, 61.7 % by Agarwal Ritu et al, 75.86% by Bhat et al [6,13,15,18]. Jain S et al states those born to primiparous mothers presented with more weight loss and hypernatremia[19].This indicates that monitoring the mother and baby in the first week of life or successful establishment of breast feeding is essential. The mothers

should receive practical advice in breast feeding technique[20]. Most authors put emphasis on increased efforts to establish successful breastfeeding[14]. Even though these values approach just more than 50 %, this may be due to inexperienced, untrained mothers facing more breastfeeding related problems. Ineffective galactopoiesis in primiparous mothers during the initial 2-3 days leads to infrequent suckling by the baby[14], further compounding the problem.

Since our centre caters mainly socioeconomically weaker class, none of the participants had an education more than 10th standard. In a study conducted by Agarwal, R et. al found no significant association between educational status of mother and the incidence hypernatremic dehydration[13].

When babies with excessive weight loss from vaginal delivery were compared with those from LSCS, there was a significant difference (p=0.03) among LSCS born showed significant negative correlation. Similar findings were found with Samayam et al. In contrast to this a study conducted by Jain S et al, noted that hypernatremia was more in babies born to caesarean section mothers[19].

In our study, median age of presentation is 9 days, with minimum at 3 days, maximum at 28 days. It corresponds well with mean age of around 10 days in related studies, Verity H. Livingstone et al (8 days)[21], Hassan Boskabadi et al (9 days)[22]. Jain S et al reported that in exclusively breastfed term and near-term infants, mean day of presentation of neonatal hypernatremic dehydration was 5.30±2.33 days[19].

The volume of human milk consumed by a neonate depends on the frequency and duration of feeds and pattern of breast use. Normally it's usually on demand every 2-3rd hour, with a range of 10-70ml per feed over a period of 5- 20 minutes[23]. Hypernatremia is because of water deprivation and a secondary accumulation of sodium in an attempt to maintain circulatory volume[24].

In our study out of the total babies none were fed more than 8 times per day, 20 (80%) of the babies were fed less than 6 times per day. Among them 12 infants reported to have serum sodium levels more than 170 mEq/L. Thus, it suggests that the most common cause of excessive weight loss and hypernatremia is decreased feeding frequency as it is in our case.

Out of 25 neonates, 22 (88.0%) of neonates had weight loss > 10%, with a mean percentage of weight loss of 22.85 %, ranges from as low as 2.7 % to as high as 48 %. Study by Moritz et al showed a mean weight loss of 13.7 %[14]. Percentage of babies with weight loss more than 10% were noted to be less in studies conducted by Samayam P et al (6.22 %) and Caglar et al (33. 3%)[25,26], as compared to our study which showed 88 % of babies with weight loss more than 10%.

Even though the percentage of weight loss increases with serum sodium concentration, no statistical significance was found in our study (P value > 0.05) can be due to a smaller number of sample size. Similar findings were found in study conducted by Bhat et al[6].

Weight-loss is a significant marker of dehydration in the early neonatal period [27,28]. Weight loss, of upto 10% maybe acceptable during the first 8-10 days. But with an increase in the percentage of weight loss there is a disproportionate rise in serum sodium levels. In our study, mean sodium level was 173.88 Meq/L, with as low as 155 and as high as 200. 12 cases had serum sodium more than 170 mEq/L. Meena et al in their study showed a mean serum sodium level of 177.12, with most of the babies (n=46, 49.5%) had serum sodium levels exceeding 180 mmol/L[29].

There was higher morbidity and mortality among these patients. A statistically significant correlation was found between serum sodium levels and mortality with a p value of 0.02.

The association of hypernatremia with hyperbilirubinema, which occurred in 8 (32.0%) of our neonates. It is in correlation to the study conducted by Meena et al, which showed jaundice for 22.6 % of the cases[29]. Even this showed no statistical significance, it might contribute to impairment of blood brain barrier and cause bilirubin to diffuse into the brain causing bilirubin encephalopathy[22]. Hypernatremia and hyperbilirubinemia cause central nervous system depression among infants with lethargy and poor suck. These factors can lead to a cycle of worsening dehydration, jaundice, and hypernatremia, which in combination can lead to brain injury.

This study also brings out decreased urine frequency in 13 (52.0%) babies, which is an important marker for acute kidney injury. Agarwal Ritu et.al in her study held in an army teaching hospital noted a 63.2 % of babies had decreased urine output, which showed a statistical significance to hypernatremic dehydration[13]. In a study conducted by Meena et al, decreased urine output was the most common presentation (n=90, 96.8%), followed by poor acceptance of feed (n=76, 81.7%), fever (n=74, 79.6%), seizures (n=39, 41.9%)[29].

Major causes of morbidity in the moderate and severe hypernatremic groups were seizures seen in 7 (28.0 %) and kidney injury were seen in 19 (76.0 %). It is in concordance with earlier studies by Saxena A et al., (46.5%) and Trivedi P and Patel AH et al., (60%)[15,18].The causes of mortality in this study were disseminate intravascular coagulation and AKI with septicaemia.

Strengths And Limitations

The study was able to predict the association of mortality with the level of serum sodium and percentage of weight loss which was not addressed in any previous studies.

The limitation of this study is the small number of subjects. Long term follow-up of the subjects was not possible. Due to non-availability of resources maternal breast milk sodium levels were not assessed.

CONCLUSION

Hypernatremic dehydration is a common medical emergency encountered in neonatal ICU and can be caused by poor/ faulty feeding. Early diagnosis and appropriate treatment are crucial for survival and better prognosis. However, diagnosis is often difficult due to apparent well-being and underestimation of dehydration.

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