

# Prevalence of Hypernatremic Dehydration in Breast Fed Neonates: A Retrospective Study in a Tertiary Care Hospital

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## ABSTRACT

**Introduction:** Neonatal Hypernatremic Dehydration (NHD) is a common occurrence in neonates. Important causes include inadequate breastfeeding, high content of sodium in breast milk, improper preparation of infant formula feeds, diarrhoea, vomiting and rarer causes such as Diabetes insipidus. Hypernatremia carries a high morbidity and mortality and therefore it is important to address the aetiological factors to prevent complications.

**Aim:** To investigate the incidence of NHD, maternal and neonatal risk factors contributing to this problem along with its presenting symptoms and outcome after management.

**Materials and Methods:** This was a retrospective study done in a tertiary centre over a five-year period, where all neonates admitted in Neonatal Intensive Care Unit (NICU) with serum sodium  $>145$  mmol/l were included in the study. Neonatal data and maternal data were noted. Initiation and frequency, technique and any problems of breastfeeding were recorded. Management of hypernatremic dehydration

was done as per the standard unit protocol. The results were plotted in MS Excel and analysed using SPSS 22 (Chicago, IL USA). Results were expressed in mean and SD in tables and compared using the Fisher's-extract test.

**Results:** A total of 68 mothers-neonate dyads were included in the study. The mean day of presentation by the neonates was day 8 of life (SD 3.5). Moderate and severe hypernatremia were noted in 23 (33.2%) and 11 (16.8%) cases with total mortality in 3 cases. Factors that positively correlated with severe disease were primigravida mothers, latching difficulties, breast related problems, feeds less than 6 times/day, severe weight loss ( $>10\%$ ) and decreased urine frequency ( $<4$ /day).

**Conclusion:** Inadequate breast feeding was associated with hypernatremic dehydration hence it is important to take care of breast problems starting from antenatal checkups along with proper education of mothers on breast feeding with advice for early follow-up in baby clinic to detect early breast feeding issues so as to take early corrective steps.

**Keywords:** Breastfeeding, Neonate, Weight loss

## INTRODUCTION

Neonatal Hypernatremic Dehydration (NHD) is a potentially serious condition. It is mainly due to inadequate breastfeeding in the first week of life. Normal neonatal feeding depends on multiple factors like lactogenesis, let down reflex, maternal and infant feeding technique. Hypernatremic dehydration adversely affects the central nervous system, leading to devastating consequences like Intracranial Haemorrhage (ICH), thrombosis and even death [1]. Neonatal hypernatremia is defined as Serum Sodium  $>145$  meq/l. Levels  $>165$  meq/l are often regarded as severe hypernatremia. The condition represents a deficit of water in relation to total body Sodium [2].

Incidence of hypernatremic dehydration varies in different geographical areas. It was previously thought to be unusual in breastfed babies. Nevertheless from 1976-1990s there were

sporadic reports of hypernatremic dehydration occurring in breastfed babies. In the west, prevalence of this condition is 1.8% (81/4280) in breastfed newborn [3]. Recently, there are increasingly appearing reports of hypernatremic dehydration [4,5]. Few studies have been reported from India. There is a need of increased awareness regarding this clinical entity as a result of which many cases tend to be missed or wrongly diagnosed as sepsis due to nonspecific clinical features [6]. In neonates hypernatremia should be suspected, if the weight loss is more than 10% of birth weight at the end of first week or if there are clinical findings of dehydration with hypernatremia [7].

This study was therefore undertaken at the study centre to investigate its incidence, maternal and neonatal risk factors contributing to this problem along with presenting clinical symptoms and complications after management.

## MATERIALS AND METHODS

This retrospective chart review was done in NICU of a teaching hospital of the armed forces. The records of period, from Jan 2015–Dec 2019 were analysed. All term neonates, that were on exclusive breast feeds and admitted to NICU with a serum Sodium >145mmol/l were included in the study. All preterms, sick term neonates, with birth defects, suspected neuromuscular disorders and that were on mixed feeds were excluded from the study.

Neonatal data like age, sex, gestational age, birth weight, present weight and reason for readmission, APGAR score, feeding pattern, number of urination and defecation were noted. Complete blood count, serum electrolytes, blood sugar, sepsis workup, blood gases, renal function and liver function tests of all babies at the time of admission were noted. Cerebrospinal Fluid (CSF) and Magnetic resonance imaging (MRI) cranium were done when clinically indicated. Maternal data like age, parity, education, weight gain during pregnancy, mode of delivery, any pre-pregnancy illness like malignancy, epilepsy, endocrine disorders, collagen vascular diseases, pregnancy related complications like hypertension, diabetes, anaemia were noted. Initiation and frequency of breast feeding, let down reflex, any breast problems, technique of feeding and length of hospital stay were recorded. Breast problems were defined as inverted or cracked nipple or mastitis on physical examination. Position and technique was defined as the classical position of breast feeding. The let down reflex was defined as milk ejection in response to suckling. All breast feeding data was collected through a questionnaire. All the babies were examined by the paediatrician and given appropriate treatment.

Management of hypernatremic dehydration was done after calculating the Free water deficit (FWD=4ml/kg x Pre-illness weight x (Serum Sodium-145) and Solute fluid deficit (SFD=Total fluid deficit-FWD), which was corrected over 48 hours. Rehydration was achieved with 5% Dextrose in 0.2% Normal Saline or 5% Dextrose in 0.45% Normal Saline or 0.9% Normal saline according to sodium levels. 3% Saline was added in various amounts when Serum Sodium was greater than 175 mmol/litre [7].

## STATISTICAL ANALYSIS

The results were recorded and then analysed by using SPSS software version 22.0 (SPSS inc., Chicao, IL USA). Results of the outcome variables were expressed in mean and Standard Deviation (SD), median and inter-quartile range and frequency distribution for categorical variables. Nonparametric tests chi-square and Fisher's-exact tests were applied when necessary. Subgroup analysis was applied between various factors and outcome measures. A p value<0.05 was considered significant.

## RESULTS

A total of 68 mothers-neonate dyads were evaluated in the study. The data obtained were checked for completeness and tabulated into excel sheet. The demographic characteristics and

presentation of cases enrolled were analysed and described in [Table/Fig-1]. Majority of mothers were more than 20-year-old (>90%), primigravida (61.7%), and were at least graduate (82.3%). The average weight recorded was 68 kg (SD 1.65) and average weight gain during pregnancy was 6.5 kg (SD 0.6). Majority of women (67.6%) had normal vaginal delivery.

S no.	Demographic characteristics	Cases (N=68) (%)
<b>1.</b>	<b>Maternal characteristics:</b>	
	a. Age in year±SD	
	<20 y 19±1.5	6 (9.8%)
	20-30 y 26±2.4	40 (58%)
	>30 y 34±3.0	22 (32.3%)
	b. Parity	
	Primigravida	42 (61.7%)
	Multigravida	26 (38.2%)
	c. Education	
	Illiterate/Undergraduate	12 (17.6%)
	Graduate/Postgraduate	56 (82.3%)
	d. Weight (kg)±SD	68±1.65
	e. Mode of delivery	
	Normal vaginal delivery	46 (67.6%)
	Caesarean section	22 (32.3%)
	f. Any prepregnancy illness	12 (17.6%)
<b>2.</b>	<b>Neonatal characteristics:</b>	
	a. Age (days, mean±SD)	8±3.5
	b. Gestational Age(week, mean±SD)	38±1.8
	c. Birth weight (kg, mean±SD)	3.1±0.56
	d. Present weight (kg, mean±SD)	2.5±0.55
	e. Presenting signs and symptoms	N (%)
	Weight Loss	58 (85.2%)
	Lethargy	52 (76.4%)
	Jaundice	40 (58.8%)
	Fever	35 (51.4%)
	Irritability	22 (30.8%)
	Seizures	15 (22.05%)
	f. Serum Sodium level (mmol/L, mean±SD)	N (%)
	Mild (146-155) 151±1.3	34 (50%)
	Moderate (156-170) 164±2.6	23 (33.8%)
	Severe >171 175±4.2	11 (16.17%)

**[Table/Fig-1]: Maternal and neonatal characteristics of the study population.**

The mean gestational age of neonatal cohort at birth was 38 weeks (SD 1.8) and birth weight was 3.1 kg (SD 0.56). The mean age of presentation was day 8 of life (SD 3.5) and weight at admission was recorded to be 2.5 kg (SD 0.55). The major complaints at presentation were weight loss (85.2%), lethargy (76.4%) and jaundice (58.8%). CNS signs were noted in a third of cases. Mild hypernatremia (<155mg%) was noted in

34 neonates (50%) with no mortality. Severe hypernatremia was present in 11 cases (16.17%) with mortality of 2 cases (18.9%). The other significant biochemical parameters were hypoglycaemia 18 (26%), hypocalcaemia 16 (23%) and azotemia 12 (17%).

Maternal age, education, pregnancy complications and mode of delivery were not found to be significant for causing severe forms of disease or mortality [Table/Fig-2]. Infants of primigravida mothers had statistically significant hypernatremia. Breast problems such as cracked or inverted nipples and engorgement and latching difficulties were significantly related to severe forms of hypernatremia. Severe weight loss of more than 10% in neonates, breastfeeding frequency of less than six per day and decreased urine output were also positively correlated with moderate and severe hypernatremia.

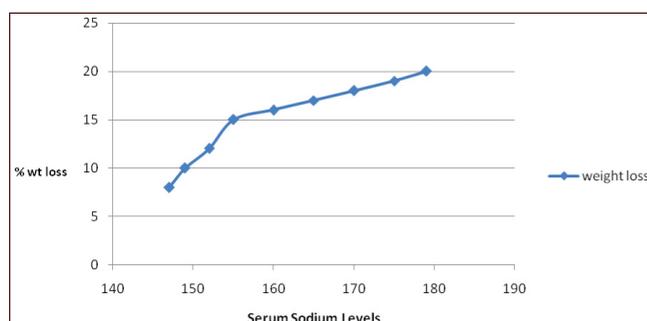
[Table/Fig-3] represents curvilinear graph on plotting the percentage weight loss and serum sodium levels on x and y axis. At higher weight loss the severity of hypernatremia increases disproportionately.

[Table/Fig-3] plots the severity of hypernatremia against morbidity and mortality in patients. As expected, the ratios of mortality and morbidity increased with the severity of hypernatremia at presentation. In the present series, the maximum absolute mortality was noted in severe hypernatremia and maximum absolute morbidity numbers were noted with moderate hypernatremia. It was statistically significant with  $\chi^2$  value of 11.346 and p-value of 0.023. The mortality was noted in a total of 3 cases with an average of 3 days.

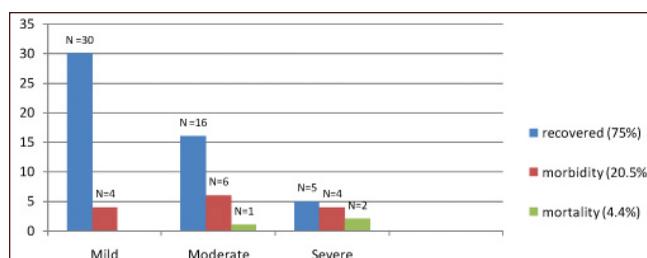
Sl no	Risk factors	Hypernatremia			$\chi^2$ value	p-value
		Mild (N=34)	Moderate (N=23)	Severe (N=11)		
1.	<b>Maternal age</b>				3.199	0.525
	<20 y (n=6)	1	3	2		
	21-30 y (n=40)	21	13	6		
	>30 y (n=22)	12	7	3		
2.	<b>Maternal education</b>				0.90	0.636
	Illiterate/Undergraduate (n=12)	5	4	3		
	Graduate/Postgraduate (n=56)	29	19	8		
3.	<b>Pregnancy related complications</b>				4.184	0.123
	Yes (n=15)	9	5	1		
	No (n=53)	25	18	10		
4.	<b>Mode of delivery</b>				3.052	0.217
	Vaginal delivery (n=46)	25	16	5		
	Caesarean section (n=22)	9	7	6		
5.	<b>Parity</b>				6.424	0.040
	Primigravida (n=42)	16	17	9		
	Multigravida (n=26)	18	6	2		
6.	<b>Breast related problems</b>				6.071	0.048
	Yes (n=36)	13	15	8		
	No (n=32)	21	8	3		
7.	<b>Breast feeding difficulties</b>				9.006	0.011
	Yes (n=14)	2	8	4		
	No (n=54)	32	15	7		
8.	<b>Neonatal weight loss (%)</b>				7.948	0.018
	<10%(n=48)	25	19	4		
	>10%(n=20)	9	4	7		
9.	<b>Neonatal Sex</b>				0.371	0.83
	(Male) (n=32)	15	12	5		
	(Female) (n=36)	19	11	6		
10.	<b>Time of first breastfeed</b>				0.923	0.63
	<30 min (n=48)	23	18	7		
	>30 min (n=20)	11	5	4		

11.	<b>Number of feeds/day</b>				12.036	0.017
	>10 feeds/day (n=27)	20	6	1		
	6-10 feeds/day (n=20)	8	8	4		
	<6 feeds /day(n=21)	6	9	6		
12.	<b>Duration of feed (minutes)</b>				0.214	0.898
	>15 min/feed (n= 29)	15	10	4		
	<15 min/feed (n=39)	19	13	7		
13.	<b>Number of urination/day</b>				7.694	0.021
	>5-8 times/day (n=25)	18	5	2		
	< 4 times /day (n=43)	16	18	9		

**[Table/Fig-2]: Risk Factors associated: with severe disease.**



**[Table/Fig-3]: Relationship between serum sodium and weight loss.**



**[Table/Fig-4]: Outcome of treatment.**

## DISCUSSION

Hypernatremic dehydration is a common problem encountered in healthy term breastfed neonates in the first week of life. During the study period, a total of 2731 babies were admitted to the NICU with the prevalence of hypernatremic dehydration being 68 (2.4%) which is comparable with studies by Trivedi P and Patel AH, (1.6%) and Moritz ML et al (1.9%) [8,9].

This study has shown the condition to be more common in neonates born to primiparous mothers (61.7%) as compared to multiparous women with a significant p-value of 0.040. 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., and 74.3% by Trivedi P and Patel AH, [6,8].

This maybe 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 [10] by the baby, further compounding the problem. Less than 6 feeds per day were noted in 21 (30.8%) infants with 6 infants reporting with severe hypernatremia. A suckling infant generally gets 100 mL of milk on the first two days of life and the milk production rapidly increases to 500 mL/day by the fourth day. But mothers with breast related issues fail to have enough milk leading to dehydration. The importance of breast examination for sore/flat nipples during ante-natal care visits need to be reinforced.

Breastfeeding problems, latching difficulties were also seen in 52.9% of the neonates with a significant p-value of 0.048 making it an important cause of hypernatremic dehydration. A similar percentage of feeding difficulties has been reported in primiparous women by Livingstone VL et al., [11]. Proper technique of breastfeeding needs to be confirmed before discharging a baby home.

Weight-loss is a significant marker [12-14] of dehydration in the early neonatal period. 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 as shown in [Table/Fig-2]. In our study, 20 cases with a highest recorded serum sodium value of 179 mEq/L. There was higher morbidity and mortality among these patients.

The recovery of weight loss [1,12] is expected to occur by the end of 10 days, but due to early discharge policy within 48 hours after birth, it is missed out. Therefore, follow-up visits for weight record and adequacy of breastfeeding at 5-7 days of life has resulted in the early detection of this serious condition.

This study also brings out decreased urine frequency in 43 (63.2%) babies which is an important marker of hypernatremic dehydration with a statistically significant p-value of 0.021. It is also important to prevent Acute Kidney Injury (AKI).

Morbidity in the mild hypernatremic group were fever, jaundice, hypoglycaemia, hypocalcaemia and lethargy which were managed with frequent oral feeding, phototherapy and intravenous fluids in a small percentage. Quantified oral feeding is an effective and safe method of management of hypernatremic dehydration also shown in previous studies by Saxena A et al., and Srinivasan R and Kannappam S, [6,15].

Major causes of morbidity in the moderate and severe hypernatremic groups were seizures seen in 15 (22.05%) and AKI seen in 12 (17.6%). Associated hypoglycaemia and hypocalcaemia were also seen in 18 (26%) and 16 (23%), respectively, which may also be a cause for seizure. Very high incidence of AKI has been reported in earlier studies by Saxena A et al., (46.5%) and Trivedi P and Patel AH et al., (60%) [6,8]. The causes of mortality in this study were intracranial haemorrhage (2) and AKI with septicaemia (1).

### Limitation(s)

There have been attempts to establish that aetiology of hypernatremic dehydration is an unusually high content of breast milk sodium [16,17]. However, the authors couldn't find any records of sodium content of breast milk and couldn't comment on this. Further prospective case-control studies are required to establish it.

Another limitation is the inability to do long term follow-up and neuro-developmental outcome of the patients, since they keep moving out to new locations every few years. Hence, more studies are required from different cross sections of society to determine the long term outcome and prognosis of such patients.

### CONCLUSION(S)

Hypernatremic dehydration is a medical emergency with high morbidity and mortality. Early diagnosis and appropriate treatment is crucial for a better prognosis. Breastfeeding should be the mode of feeding neonates, though the study brings out the association of hypernatremic dehydration due to inadequate breast feeds, breast problems being the main reason. This article and other reports should not deter anyone from continuing to promote breastfeeding. However, it is important to take care of breast problems during antenatal check-ups. Women should be educated about the signs and symptoms of dehydration, adequacy of urine output and weight loss before discharge from the hospital. Early discharge policy demands follow up in well baby clinic to detect breastfeeding issues leading to hypernatremia and immediate corrective steps should be adopted to prevent any complications.

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#### AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? No
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

#### PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: May 22, 2020
- Manual Googling: May 27, 2020
- iThenticate Software: Jun 26, 2020 (12%)

#### ETYMOLOGY: Author Origin

Date of Submission: **May 21, 2020**  
Date of Peer Review: **Jun 06, 2020**  
Date of Acceptance: **Jun 17, 2020**  
Date of Publishing: **Jun 30, 2020**