

Characterization of full term newborns with hypernatremic dehydration

Caracterización de recién nacidos a término con deshidratación hipernatrémica

Del Castillo C. Gabriel^{a,b}, Suares A. Diana^a, Granja A. María^a,
Oviedo E. Bibiana^a, Urbano U. Jhuranny^a, Cabrera B. Nancy^{a,c}

^aFundación Hospital Infantil Los Ángeles, San Juan de Pasto, Colombia

^bUniversidad de Nariño, San Juan de Pasto, Colombia

^cFundación Universitaria Católica del Sur, San Juan de Pasto, Colombia

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What do we know about the subject matter of this study?

Neonatal hypernatremic dehydration, an increasing condition causing admission to neonatal intensive care units, is suspected when there is abnormal weight loss > 10%, irritability, hyperthermia, jaundice, and can lead to kidney failure or central nervous system bleeding.

What does this study contribute to what is already known?

This study identified clinical variables that can help health professionals timely identify risk factors, take preventive and treatment actions, and avoid complications and fatal outcomes.

Abstract

The hypernatremic neonatal dehydration is a severe condition whose incidence has increased in recent years resulting in complications leading to the hospitalization of the newborn. Objective: Describe the clinical and laboratory characteristics of term-newborns with Hypernatremic Dehydration diagnosis. **Patients and Method:** Descriptive observational study of hospitalized term-newborns due to hypernatremic dehydration between a period from 2014 to 2016. Term newborns over 37 weeks with clinical signs of dehydration (dry mucous membranes, depressed fontanel, tearless crying, signs of the cutaneous pleat), and/or excessive weight loss greater than 7% and serum sodium greater than 145 mEq/L were included. Sociodemographic and biochemical variables were recorded for analysis. **Results:** 43 neonates were included. 60.5 percent of their mothers were primiparous, 90 percent of neonates received exclusive breastfeeding, mothers reported breastfeeding problems in 76.7 percent. Incoming neonates reported weight loss compared to birth weight at 15.3% on average. 83.3% had public health insurance. 65.1% had dehydration clinical signs at

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entry and 83.5% transient neurological signs. The average sodium was 155 mEq/L at revenue. The sodium decrease in the first 24 hours of handling was 7.74 mEq/L (0.32mEq/L per hour). The correction of the hypernatremia was 55.8% by oral intake and 4 days hospital stay on average. **Conclusions:** The feeding's problems came up in a (76%), primiparous mothers in an (88.4%). 90.6 percent of this population administered exclusive breastfeeding, results that can help to alert the health professional to timely identification, warning signs, and early post-discharge control and preventive measures.

Introduction

In the 28-day-old newborn, neonatal hypernatremic dehydration (NHD) is a condition characterized by abnormal weight loss, clinical signs of dehydration, and a serum sodium concentration > 145 mEq/L^{1,2}. Physiological weight loss in full-term newborns should not exceed 7%-10% in the first days of life^{1,3,4}. A higher loss is a red flag to evaluate a possible NHD since there is a direct relationship between weight loss and hypernatremic dehydration².

According to worldwide literature reports, its incidence seems to increase considering that between 1-1.8% of neonatal admissions are caused by this pathology⁵.

This relatively common clinical condition is of concern because it has a significant potential for morbidity. The true incidence of the problem has not been clearly determined since studies have not included pre-term infants or patients with problems such as cleft palate, hypotonia, and trisomy 21, among others^{6,7}. NHD has been associated with morbidities such as central nervous system (CNS) bleeding, cerebral venous sinus thrombosis, coagulopathy, apnea, kidney failure, jaundice, and long-term neurological sequelae^{2,7}.

The management of this condition in newborns is still controversial since newborns have less obvious clinical signs of dehydration and are more susceptible to it due to renal immaturity, body water distribution, and because water and sodium needs are different in older children⁸. When newborns are not treated properly, they can have serious complications and long-term neurological sequelae. The objective of this study is to describe the clinical and laboratory characteristics of full-term newborns with hypernatremic dehydration diagnosis in a Neonatal Unit of a reference children's hospital.

Patients and Method

Observational, descriptive, retrospective study of newborns admitted to the *Hospital Infantil Los Angeles* in Pasto, Colombia, between January 2014 and December 2016. For this study, hospitalized full-term

newborns with clinical signs of dehydration and/or weight loss higher than 7% and serum sodium levels higher than 145 mEq/L were included.

From the newborns' clinical records, we registered sociodemographic data (age in days, sex, healthcare system); clinical data (feeding problems, jaundice, fever, birth weight, weight at admission, type of feeding, signs of dehydration, neurological signs, enteral and parenteral support behavior, phototherapy, and length of hospital stay); laboratory and radiological data (radiological findings, decrease in serum sodium in the first 24 hours, sodium, calcium, chlorine, creatinine, potassium, and blood sugar level at admission); and mother's clinical data (age, parity, birth route, weeks of gestation). We designed an instrument for collecting information in Excel version 2014.

Full-term newborns over 37 weeks who had clinical signs of dehydration (dry mucous membranes, sunken fontanelle, crying without tears, decreased skin turgor) and/or excessive weight loss greater than 7% and serum sodium levels higher than 145 mEq/L were included. Patients who developed hypernatremia during hospitalization, presented with major congenital malformations, patients who had partial data on the instrument, and incomplete information on the clinical history were excluded.

The information biases were controlled by reviewing the clinical records by 6 of the researchers, who standardized the definitions of the variables, created an organized process for reviewing the clinical records in order to not to overlook details or valuable information, and carried out a pilot test where they recorded and analyzed the first 10 cases of that event.

Data analysis

The data were collected, processed, and analyzed using the SPSS® software, version 21 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, version 21.0. Armonk, NY: IBM Corp.), and the results were presented in Microsoft Word.

All the variables of the study population were described considering their characteristics. For the qualitative variables, absolute and relative frequencies were used, and for the quantitative ones, the average, standard deviation, and media.

The fundamental ethical principles of the Helsinki Declaration were respected. The project was approved by the ethics committee of the *Hospital Infantil Los Angeles* in Pasto, Colombia, on November 27, 2014. This study was classified as “Minimal Risk” according to Article 11 of Resolution 8430 of 1993 - Colombian Ministry of Health.

Results

During the period analyzed for this research, the total number of admissions to the neonatal unit was

505 full-term newborns between January 2014 and December 2016.

Out of them, 43 patients showed clinical signs of dehydration or weight loss greater than 7%, 51% were female, the average age at admission was six days, and 83.7% were in the public health system. The average gestational age in weeks was 39 weeks, 88.4% of the mothers already had a child and were 25 years old on average, and 55% of patients were born vaginally (table 1).

On average, birth weight was 3,238 g (SD \pm 474 g), weight at admission was 2,736 g, and weight loss was 15.3% (SD \pm 7.88%) (table 2). Out of the children analyzed, 90.6% were exclusively breastfed, 76.7% of the mothers reported feeding problems, 65% of this population presented clinical signs of dehydration (oliguria, sunken fontanelle, decreased skin turgor, dry mucous membranes), and 83% presented some neurological signs (irritability, lethargy, hypertonia, somnolence). It was observed that the hypernatremia correction (free water replacement) was mostly performed orally in 55.8%, 30.3% intravenously, and 13.9% was mixed (oral/intravenous) (table 2).

In the clinical variables, 39% presented measured fever and 83.7% jaundice on the physical examination. 6 patients (14%) had neuroimaging studies as follows: 3 patients (6.9%) had transfontanellar ultrasound, 2 patients (4.6%) had a CT scan of the brain, and 1 patient (2.3%) had both procedures; finding in one

Table 1. Sociodemographic and clinical characteristics of mothers of term newborns with hypernatremic dehydration

Characteristic	Variable	Category	43 (%)
Characteristics of the mother	Maternal age (M \pm DE \pm)		25.4 (6.95)
	Parity	1 to 2 children	38 (88.4)
		3 to 4 children	4 (9.3)
More than 4 children		1 (2.3)	
Route of Birth	Vaginal		24 (55.8)
	Caesarean section		19 (44.2)
	Gestational age in weeks (M \pm DE \pm)		39.2 (0.87)

Table 2. Sociodemographic and clinical characteristics of term newborns with hypernatremic dehydration.

Characteristic	Variable	Category	43 (%)	
Sociodemographic and Clinical characteristics of the newborn	Birth weight gr (M \pm DE \pm)		3.238 (474)	
	Weight at admission gr (M \pm DE \pm)		2.736 (452)	
	Weight loss gr (M \pm DE \pm)		15.3 (7.88)	
	Age- days (M \pm DE \pm)		6.3 (4.87)	
	Gender	Male		21 (48.8)
		Female		22 (51.2)
	Health insurance	Private		7 (16.3)
		Public		36 (83.7)
	Feeding type	Exclusive breastfeeding		39 (90.6)
		Artificial formula		1 (2.3)
		Mixed (breastfeeding, formula, aromatic)		3 (6.9)
	Feeding problems			33 (76.7)
	Fever			17 (39.5)
Jaundice			36 (83.7)	
Phototherapy			23 (53.4)	
Signs of dehydration			28 (65.1)	
Neurological symptoms			36 (83.7)	
Correction of hypernatremia	Oral		24 (55.8)	
	Intravenous		13 (30.2)	
	Oral and intravenous (mixed)		6 (13.9)	
Days of hospitalization(M \pm DE \pm)			4.62 (4.59)	

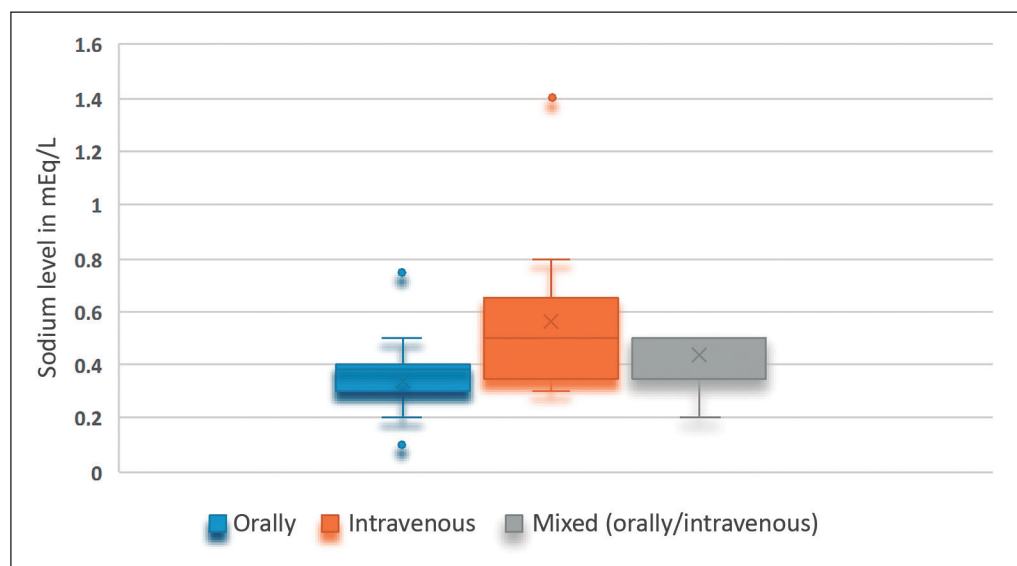


Figure 1. Decrease in sodium in 24 hours per hour according to type of support.

Table 3. Laboratory characteristics of term newborns with hypernatremic dehydration

Characteristic	Variable	(M ± DE)
Laboratory characteristic	Decreased sodium in the first 24 hours	7.7 (8.84)
	Glycemia mg/dl	70 (31.1)
	Creatinine mg/dl	0.92 (0.30)
	Sodium mEq/l	155 (8.06)
	Potassium mEq/l	4.3 (0.61)
	Chlorine mEq/l	117 (19.1)
	Blood urea nitrogen mg/dl	26 (23.9)

case grade I intraventricular hemorrhage. The average sodium level at admission was 155 mEq/L (SD ± 8 mEq/L). The sodium decrease in the first 24 hours of management was 7.74 mEq/L (0.32 mEq/L per hour) (figure 1). Renal function tests evaluated the average of BUN 26.0 mg/dL, creatinine 0.92 mg/dL, potassium 4.3 (SD ± 0.6), chlorine 117 (SD ± 19), and blood sugar levels 70 mg/dL (SD ± 31mg/dl) (table 3).

Discussion

Hypernatremic dehydration (NHD) is a common cause of hospitalization in full-term newborns in the first days of life and has been becoming important due to its increasing prevalence reported in the clinical literature⁹.

The incidence of NHD is variable. Oddie et al. have reported an incidence of 2.5 per 10,000 live births², Mangano et al. an incidence of 7.7% among exclu-

sively breastfed children¹⁰, Uras et al. an incidence of 5.6%¹¹, and Moritz et al. an incidence as low as 1.9% in hospitalized full-term newborns¹.

In this study, there was an 8.5% incidence of admissions to the neonatal unit during the period studied which is remarkably higher than that reported in the literature. It is considered that it is necessary to document this finding and to propose strategies to address a problem that has not yet been resolved.

Similar to the examples in other countries' publications, this situation is more frequent in low socio-economic strata, as represented in this study by those in the public health system. It is also influenced by exclusive breastfeeding and feeding problems reported by the mothers, the latter possibly related to ineffective galactopoiesis in the first hours, in addition to inadequate techniques of both position and latch during breastfeeding. There is also a coincidence with the more frequent occurrence in first-time mothers without experience in the care of the newborn, lack

of education about breastfeeding, early discharge, or problems such as flat and inverted nipples not detected during prenatal control⁶.

Normal serum sodium ranges from 135 mEq/L to 145 mEq/L, so any increase over 145 mEq/L is considered hypernatremia^{1,11}. In this study, hypernatremia was defined as a sodium level > 145 mEq/l. Some publications define as neonatal hypernatremia values above 150 mEq/L^{12,13}.

Most of the studied population presented at least one of the clinical signs of dehydration such as oliguria, sunken fontanelle, dry mucous membranes, or decreased skin turgor, which are non-specific and occur in a wide variety of diseases in the neonatal period.

One of the most specific clinical signs is weight loss, an important finding to establish the diagnosis as supported by other studies reviewed^{1,10,14}. However, in the literature of recent years, it is not clear what percentage of weight loss is normal in the first days of life of full-term newborns who are exclusively breastfed, and there are no reliable physiological data. Some articles estimate that weight loss in the first week of life is 10%^{1,3,4}, where a loss greater than 10%, increases 47 times the risk of developing hypernatremic dehydration. However, other authors state that a loss greater than 7% in the first three or four days of life is a red flag and it is necessary to identify its cause^{10,15,16}. In this study, the patients had an average weight loss of 15.6% over birth weight (table 2). With an average age at admission of 6.3 days, these results correlate with the literature^{3,16}.

According to the literature, the therapeutic goal in the management of NHD is to correct hypovolemic shock and decrease de serum osmolarity through a sodium reduction not exceeding 0.5 mEq/l per hour¹⁴. For this study, the reduction was 0.32 mEq/l per hour on average in the entire population, and, as recommended, oral treatment reduced the sodium 0.3 mEq/hour, intravenous treatment 0.5 mEq/hour, and mixed (oral and intravenous) 0.35 mEq/hour (figure 1).

In this study population, the most used strategy for sodium correction was the oral route since it is easy to manage, reduces costs in intravenous fluids, requires less frequency in monitoring sodium levels, and facilitates its use in less complex health centers¹⁷. It is important to mention that the decrease in sodium levels was slower with the oral route than with the intravenous one (figure 1). According to Erdemir et al, this route is chosen if it is well tolerated and there are no contraindications¹⁷.

It should be noted that NHD could cause long-term neurological sequelae¹. In this research, we found that most patients presented some transitory neurological signs at admission, but there was no long-term follow-up after hospitalization. In those patients who

underwent neuroimaging, we found one case of grade 1 intraventricular bleeding, the rest of the cases were normal.

The literature suggests that among the clinical signs in patients with NHD, jaundice is at the top of the list^{14,16}. In this study, jaundice was the most frequent sign accounting for 83.7% of the newborns presenting it on physical examination and required treatment with phototherapy, in contrast to the study conducted by Saxena et al. who found a lower percentage of children with jaundice¹⁸.

Regarding the characteristics of the mothers of this study, the average age was 25 years and 88.4% of them already had a child.

Several studies have related feeding problems as an important factor associated with NHD in apparently healthy full-term newborns¹⁹. In Iran, the study by Boskabadi reported that 50% of the NHD cases in their series were associated with this problem²⁰. In Canada, the Livingstone study found that 70% of mothers with dehydrated infants and feeding failure were first-time mothers²¹ as in the Caglar and Ozzer study, which also concluded that 44% of the mothers of babies with NHD and feeding problems presented the same characteristic¹⁵. The studies suggest that there is an increased risk of NHD in the children of first-time mothers^{3,22-24} as evidenced in this study. None of the patients included in this review died during their hospital stay.

This type of study only allows us to explore some characteristics of the population that was admitted to the hospital. Considering its design, it should be bear in mind that there are some limitations such as the initial selection of clinical records according to the ICD-10, which could cause the non-inclusion of clinical records of patients with NHD. In addition, another limitation was the collection of data from the clinical records that did not always present all the variables defined.

Conclusions

In this study, important clinical and socio-demographic variables were identified that should alert the health professional to identify the newborn with hypernatremic dehydration, among which the following stand out: first-time mothers, significant weight loss, feeding problems, and clinical characteristics that include neurological manifestations as signs of dehydration.

An important finding was the high frequency of feeding problems. In a future study, it would be worthwhile to explore their causes and their true importance, in order to take the appropriate preventive measures, such as ensuring an adequate breastfeeding technique before discharge, as well as a timely outpa-

tient follow-up with nursing or pediatrics, especially in mothers and/or newborns that present some risk factors.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Financial Disclosure

Authors state that no economic support has been associated with the present study.

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