

# Excess weight loss and hypernatremia in exclusively breastfed infants

Susana Castilho<sup>1</sup>, Ana Margalha Miranda<sup>2</sup>, Cláudia Almeida Fernandes<sup>2</sup>, Manuel Cunha<sup>2</sup>, Rosalina Barroso<sup>2</sup>

<sup>1</sup>Pediatrics Department, Centro Hospitalar do Oeste, Unidade de Caldas da Rainha, Caldas da Rainha, Portugal

<sup>2</sup>Pediatrics Department, Hospital Prof. Doutor Fernando Fonseca, E.P.E., Amadora, Portugal

## Abstract

**Background:** Hypernatremic dehydration (HD) is a situation of high morbimortality in infants, and a crescent number of cases in exclusively breastfed infants has been reported.

**Research aim:** To describe a cohort of exclusively breastfed infants with excessive weight loss (EWL) and/or HD, born at a Baby-Friendly certified Hospital in Portugal, serving a population with high rate of African immigrants.

**Methods:** We performed a retrospective study of exclusively breastfed infants with EWL/HD and no less than 37 weeks of gestational age (GA), delivered between 2013 and 2015.

**Results:** A cohort of 329 infants with EWL/HD was identified, corresponding to 5% of the total of newborns in the studied period. 65.3% of mothers were primiparous; average maternal age was 30 years. 51.7% of infants had a cesarean delivery. The average birth weight was 3,280 grams and the median GA was 39 weeks; 81.5% began breastfeeding within one hour of life. The diagnosis of EWL/HD was made at the Obstetric Nursery in 98.2% of cases, and of these 10.8% were admitted into the Neonatal Intensive Care Unit (NICU). The most commonly associated signs and symptoms were jaundice (64.1%) and hypoglycemia (15.2%); serious neurological complications were rare (0.6%) (seizures in one case and intraventricular hemorrhage in another). The average weight loss was 11.1% and 10.6%, respectively in cesarean and vaginal delivery infants ( $p = 0.02$ ). In 76.1% infants, EWL was diagnosed in the first 72 hours of life; 44.7% had hypernatremia. The most common treatment was supplementation with infant formula (68.1%).

**Conclusions:** EWL/HD were common among the studied population, namely in neonates born to primiparous mothers and by cesarean.

Complications were rare and treatment mainly noninvasive. It seems fair to conclude EWL/HD are potentially serious problems, but with simple, inexpensive solutions when diagnosed early.

### Keywords

Exclusive breastfeeding, hypernatremia, dehydration, weight loss, newborn, Baby-Friendly Hospital Initiative.

### Corresponding author

Susana Castilho, Pediatrics Department, Centro Hospitalar do Oeste, Unidade de Caldas da Rainha, Rua Diário de Notícias, 2500-176 Caldas da Rainha, Portugal; telephone: 00351 967495063; e-mail: scastilho@campus.ul.pt.

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### Background

Weight loss in the first days of life is a well-known physiological event [1]. For exclusively breastfed newborns there is a greater risk for excessive weight loss (EWL;  $\geq 10\%$  birth weight) and hypernatremia, with incidences among this group of approximately 15% and 2%, respectively. The failure to diagnose and intervene in these situations can lead to catastrophic outcomes like cerebral edema, seizures, intracranial hemorrhage, disseminated intravascular coagulation, renal failure and death [2-6].

Although the incidence of breastfeeding-associated hypernatremic dehydration (HD) is apparently low, it is significantly greater than the all-cause incidence of hypernatraemia among hospitalised children, adults or elderly. Furthermore, several studies report a rise in its frequency over the last years [2-5, 7-15]. Because of the well-recognized advantages of breastfeeding to both mother and infant, efforts should be made to detect and correct possible problems and ensure adequate milk transfer. The American Academy of Pediatrics (AAP) recommends daily evaluation of the mother-baby breastfeeding dyad as well as daily weighing of the infant during the postpartum hospital stay. A weight loss greater than 7% from

birth weight should raise suspicion of a possible problem, and prompt intervention is warranted to improve the baby's milk intake [16-18].

In Portugal many hospitals have implemented breastfeeding support practices like the Baby-Friendly Hospital Initiative [19] and there is recognizable effort to promote breastmilk's advantages. The incidence of breastfeeding problems, namely HD, is not known.

The aim of this study was to assess the incidence of EWL and/or HD in exclusively breastfed infants born in a Portuguese Baby-Friendly Hospital and identify possible maternal and/or infant factors that interfere with successful breastfeeding.

### Methods

#### *Design*

In order to evaluate EWL/HD in exclusively breastfed neonates, we conducted a retrospective cohort study of all infants born at Hospital Prof. Doutor Fernando Fonseca E.P.E. from January 1, 2013, to December 31, 2015.

#### *Setting*

The study hospital serves an urban population with a huge density and a high rate of immigrants (43%), namely from African countries (26.6%) [20]. In 2010, it was certified as a Baby-Friendly Hospital, after the 10 specific maternity practices that support breastfeeding (created by WHO and UNICEF) had been implemented. There was a need for some changes in the Department, namely: creation of a specialized group in breastfeeding; implementation of lactation rooms; elimination of pacifiers and artificial nipples; implementation of the cup/syringe feeding technique to give formula when medically advised; training of all health care staff on the skills necessary to implement this policy. In our protocol breastfeeding is initiated within one hour of birth and when this is not possible we advise to start milk extraction as soon as possible after birth. Infants are weighted daily and in case excess weight loss and/or breastfeeding difficulties are detected the mothers are given breastfeeding support. Depending on the infant/mother's clinical condition and after medical evaluation an increase in feedings' frequency and/or a milk supplement after each feeding may be advised, preferring breastmilk if available. When clinically justified, the newborn

may be transferred to the Neonatal Intensive Care Unit (NICU) for monitoring and more invasive treatment (e.g., intravenous [IV] hydration).

Normally newborns are discharged 36 hours after birth if it was a vaginal delivery (48 hours if there is any identified risk factor) or after 72 hours if it was by cesarean section.

### Sample

We reviewed all electronic records from infants born at our hospital from January 1, 2013, to December 31, 2015. Infants were included in the study if they were less than 28 days of age at diagnosis, were exclusively breastfed and had been diagnosed with EWL or HD. EWL was defined as a weight loss  $\geq 10\%$  of birth weight. Hypernatremia was diagnosed if serum sodium was higher than 145 mEq/L. Exclusive breastfeeding was defined as having received no human milk substitute, water, glucose water or IV fluids until the diagnosis. Exclusion criteria were a gestational age less than 37 weeks and the presence of suction problems, organic disease or congenital malformations.

A total of 329 infants met the inclusion and exclusion criteria. Not all information was available for everyone, but we didn't exclude any of these cases.

### Measurement

Information was obtained about the mother (age, parity, ethnicity and educational level) and the neonate (gestational age; birth weight; mode of delivery; when breastfeeding was initiated; symptoms and signs related to EWL or HD – namely hypoglycemia, jaundice, hypotonia, irritability, dehydration signs and neurological complications; the maximum weight loss and when it occurred; local of infant admission – NICU, Pediatric Nursery or Obstetric Nursery; and mortality). Infant birth weight was recorded at delivery. Infants were then weighed once on each subsequent hospital day. If it was a readmission, the newborn was weighted in the emergency room. The infant scales used were all the same brand and model (Seca® 727 Electronic Baby Scale), regularly calibrated and measured weight to within 1 gram. Laboratory investigations (glucose, serum total and direct bilirubin, blood urea nitrogen, creatinine and sodium) were carried out in infants only if clinically indicated. We evaluated the treatment needed to correct the weight loss

or HD (breastfeeding support, infant formula supplement or IV fluids). Finally, length of stay in the hospital was calculated using the date of birth and discharge. In case of readmission, length of stay in the hospital was calculated using the date of readmission and discharge.

### Data collection

Infants born at our hospital in the studied period were identified via a database search. Infant charts were linked with maternal charts using maternal identifiers included in the infant's record. The infant's and mother's medical electronic records were retrospectively accessed for data collection.

### Data analysis

Descriptive statistics were computed for all variables. Descriptive data was presented as percentages for discrete variables. For continuous variables with normal distribution, the mean and standard deviation (SD) were calculated. The median, minimum and maximum values were calculated for non-normal distribution variables. The comparative analysis was performed using student t-test for continuous variables. Spearman's correlation was used to correlate the weight loss with parity, mother's age and gestational age. Multiple linear regression procedures were used to correlate weight loss with possible risk factors (parity, mother's educational level and age, route of delivery, type of admission, formula consumption, jaundice and hypoglycemia). We created a possible model that predicts the weight loss, according to the risk factors present. All data were analyzed with IBM® SPSS® Statistics 21 software (SPSS, Inc., Chicago, IL). We defined a p-value of  $< 0.05$  to indicate statistical significance.

### Results

During 2013-2015, 6,580 newborn with at least 37 weeks of gestational age were born at our hospital. The study group was composed of 329 subjects, which corresponds to 5% of the total of newborns.

Characteristics of infants and mothers are listed in **Tab. 1**.

The number of infants with EWL/HD had a similar distribution through the months of the year (between 24 to 34 per month). The diagnosis was made mainly during the initial postpartum

hospitalization (98.2%) and only 1.8% of subjects were readmitted afterwards. Of those diagnosed during the postpartum hospitalization, 10.8% needed to be admitted to the NICU. None of the readmitted newborns needed intensive care. On

**Table 1.** Demographic characteristics of infants and mothers.

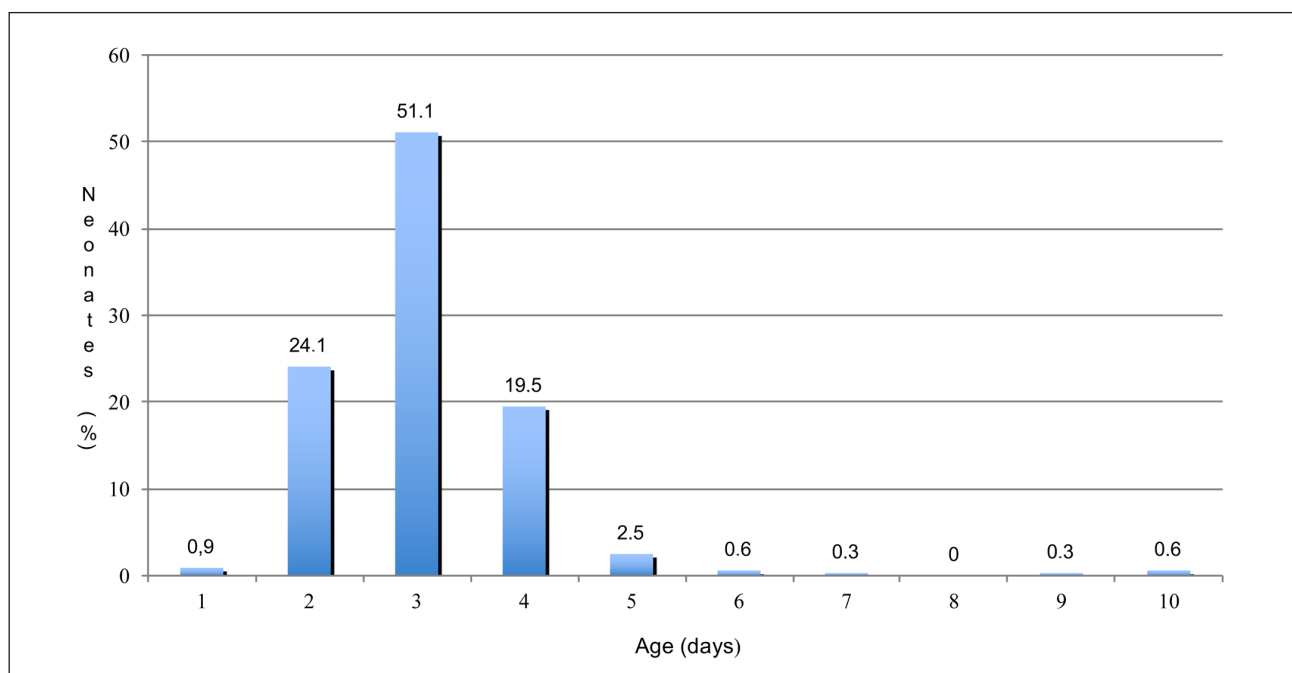
Characteristics of infants (n = 329)	Median (min-max)/ mean $\pm$ SD/ %
Gestational age, wk	39 (37-41)
Infant birth weight, g	3,280 $\pm$ 513
Male infants	47.4
Mode of delivery	
Cesarean	51.7
Spontaneous vaginal	32.8
Vacuum/forceps-assisted vaginal	15.5
Breastfeeding in the first hour of life	81.5
Characteristics of mothers	Median (min-max)/ mean $\pm$ SD/ %
Age, y (n = 313)	30 (15-50)
Primipara (n = 313)	65.3
Education (n = 296)	
Elementary and middle school	25.7
High school or more	74.3
Ethnicity (n = 314)	
Caucasian	54.1
African	38.9
Other	7.0

average, the neonates diagnosed with EWL/HD in the Obstetrics Nursery stayed 1.6 days longer than the average global length of stay in the initial hospitalization (4.5 versus 2.9 days; this excludes neonates transferred to the NICU).

The average weight loss was 10.89%  $\pm$  1.98%. The percentage of subjects that lost less than 10% of birth weight was 14% and 25.2% had a severe weight loss (more than 12%). The maximum weight loss occurred in the first three days of life in 76.1% cases. At **Fig. 1** we show the distribution of infants per age at diagnosis of EWL/HD.

The serum sodium was measured in 62.6% subjects, allowing to diagnose hypernatremia in 44.7% (n = 146) of the total sample. In this group with HD, mean serum sodium was 148.1  $\pm$  1.9 mEq/L. The hypernatremia was mild (serum sodium 146-149 mEq/L) in 74.8% of subjects and moderate (serum sodium 150-169 mEq/L) in 24.5%. No infants presented with severe hypernatremia (serum sodium higher than 170 mEq/L).

Symptoms, signs and complications related to EWL or HD are shown in **Tab. 2**. There were two infants with neurological complications – one case of intraventricular hemorrhage and one newborn that had a seizure. One newborn (0.3%) was admitted in the NICU with HD with a serum creatinine and urea of 1.3 mg/dL and 110 mg/dL, respectively. The diagnosis of acute renal failure was made because of the rise of serum creatinine



**Figure 1.** Distribution of neonates per age at diagnosis of excessive weight loss/hypernatremic dehydration (EWL/HD).

higher than 0.2-0.3 mg/dL/day. Characteristics of these cases with significant complications are summarized in **Tab. 3**. The mortality rate was zero.

In order to correct the dehydration, infant formula was given to 68.1% subjects. Only 4.3% needed IV fluids. In the remaining cases only breastfeeding support and/or increasing number of feedings were necessary for favorable clinical outcome.

An independent-samples t-test was conducted to compare mean weight loss between infants grouped by different variables (**Tab. 4**). There was a significant difference in the mean weight loss when comparing routes of delivery, type of admission and formula consumption after diagnosis. These results mean that the neonates who were delivered by cesarean lost significantly more weight compared to neonates delivered by other routes. Similarly, neonates admitted to the NICU, as well as neonates

fed with a formula supplement after EWL/HD diagnosis, lost significantly more weight.

All the correlations studied by Spearman's correlation were of very low correlation power and none with statistical significance. A negative correlation was found between weight loss percentage and gestational age ( $R_s = -0.014$ ,  $p = 0.80$ ) and parity ( $R_s = -0.10$ ,  $p = 0.07$ ). As far as mother's age is concerned, we achieved a positive correlation with weight loss percentage ( $R_s = 0.008$ ,  $p = 0.89$ ).

Finally, a multiple linear regression was done between the percentage weight loss and the perinatal risk factors, whose results are presented in **Tab. 5**. The best model that could predict the percentage of weight loss was: Weight loss (%) =  $9.96 + 1.02 * (\text{formula consumption; yes} = 1, \text{no} = 0) + 0.45 * (\text{cesarean; yes} = 1, \text{no} = 0)$ . However, this was a very weak model because it only explains 6.5% of the weight loss variation.

**Table 2.** Symptoms, signs and complications related to excessive weight loss (EWL) or hypernatremia dehydration (HD) (n = 329).

Symptoms, signs and complications	n (%)
Jaundice	211 (64.1)
Hypoglycemia	50 (15.2)
Dehydration signs	12 (3.6)
Hypotonia	11 (3.3)
Lethargy	6 (1.8)
Irritability	4 (1.2)
Fever	0 (0)
Acute renal lesion	1 (0.3)
Neurological complications	2 (0.6)
Death	0 (0)

## Discussion

In parallel with worldwide efforts to promote breastfeeding, many Portuguese hospitals have been implementing breastfeeding supporting policies like the Baby-Friendly Hospital Initiative [19]. With the expected increase in the rate of exclusively breastfed neonates, it becomes of higher importance to detect and prevent lactation problems that can lead to serious consequences like HD.

Much attention has been given to this subject in previous years, as many case reports and series described dramatic cases of HD with high morbidity rates [3-4]. This increasing incidence

**Table 3.** Characteristics of cases of infants with hypernatremic dehydration (HD) with significant complications (n = 3). Adapted from Mujawar and Jaiswal, 2017 [26].

Case number	Serum sodium (mEq/L)	Weight loss (%)	Day of maximum weight loss	GA (weeks)	Mode of delivery	Maternal information		Clinical characteristics	HD treatment
						Age (years)	Parity		
1	150	13.6	4	39	Vaginal	24	Primi	Hypotonia, lethargy, jaundice, intraventricular hemorrhage	Increased number of oral feedings, formula supplement
2	154	15.2	3	38	Vaginal	34	Primi	Hypotonia, jaundice, seizures	IV hydration, oral formula supplement
3	146	11.7	3	39	Vaginal	22	Primi	Dehydration signs, hypotonia, jaundice, hypoglycemia, acute renal failure	IV hydration, oral formula supplement

GA: gestational age; HD: hypernatremic dehydration; Primi: primipara; IV: intravenous.

**Table 4.** Comparison of mean weight loss between groups (n = 329).

Variable		Mean weight loss (%)	SD (%)	t	p
Gender	Female	11.0	1.79	1.48	0.14
	Male	10.7	2.17		
Route of delivery	Cesarean	11.1	1.65	2.36	0.02
	Vaginal	10.6	2.26		
Breastfeeding in the 1 <sup>st</sup> hour	Yes	10.9	2.09	-0.44	0.66
	No	11.0	1.39		
Parity	Primipara	11.1	1.87	1.89	0.060
	Multiparous	10.6	2.04		
Type of admission	NICU	12.2	2.71	3.23	0.003
	Obstetric Unit	10.7	1.78		
Jaundice	Yes	10.8	2.21	-1.22	0.22
	No	11.0	1.48		
Hypoglycemia	Yes	10.8	2.15	-0.14	0.89
	No	10.9	1.95		
Formula consumption after EWL/HD diagnosis	Yes	11.2	1.90	4.00	< 0.001
	No	10.3	1.95		
Educational level	Elementary and middle school	11.0	1.89	-0.64	0.52
	High school or more	10.9	1.96		
Mother > 35 years	Yes	10.8	1.93	-0.80	0.42
	No	11.0	2.06		
Mother < 18 years	Yes	10.1	2.13	-1.21	0.23
	No	10.9	2.02		

Note: independent t-test.

NICU: Neonatal Intensive Care Unit; EWL: excessive weight loss; HD: hypernatremia dehydration.

**Table 5.** Multiple linear regression between mean weight loss and perinatal risk factors.

	1 B (Std. Error)	2 B (Std. Error)
Gender	-	-
Route of delivery	-	0.45 (0.23)
Parity	-	-
Gestational age	-	-
Jaundice	-	-
Hypoglycemia	-	-
Formula consumption	1.07 (0.26)	1.02 (0.26)
Breastfeeding in the 1 <sup>st</sup> hour	-	-
Educational level	-	-
Mother > 35 years	-	-
Mother < 18 years	-	-
Adjusted R square (%)	5.4	6.5
p	< 0.001	< 0.001

Note: stepwise method; standard deviations from the mean, standard errors reported in parentheses.

described in the literature can be a result of both higher breastfeeding rates, with consequently higher rates of breastfeeding failures, as well as higher awareness for these problems.

In this study, we identified a significant percentage of neonates with EWL/HD (5% in a

population of 6,580 neonates). The vast majority of cases were detected during the postpartum hospitalization, with a low rate of transfers to the NICU, and only a residual number of neonates readmitted after discharge (1.8% of 329). In previous literature we found a much higher rate of readmissions, as well as higher morbidity rates [2, 7-8, 10, 12].

Also, even though neonatal HD is classically described to present at 10 days of life on average [10], in our study most of the neonates lost the maximum amount of weight in the first 72 hours of life.

In an Italian prospective study, Manganaro et al. [21] found that during the first days of life, a weight loss exceeding 10% of the birth weight occurred in 7.7% of 686 exclusively breastfed term neonates. Flaherman et al. [22] developed weight loss nomograms for both vaginally and cesarean delivered newborns in the first days of life, and demonstrated that almost 5% of vaginally delivered newborns and 10% of those delivered by cesarean had lost more than 10% of their birth weight 48 hours after delivery. Our study reinforces this notion that EWL has higher frequency and occurs earlier than previously thought, unrelated to hypernatremia.

Commonly reported risk factors for breastfeeding-associated hypernatremia include cesarean delivery, primiparity, excessive pre-pregnancy maternal body weight, delayed first breastfeeding and low maternal education level [8-9, 11, 13, 23-25]. Accordingly, in our sample most infants were firstborns and there was a higher rate of cesarean deliveries when compared to the general population (50% versus 32%). Cesarean delivered infants also lost significantly more weight than vaginally delivered neonates. This reinforces the need to focus on the education and reassurance of first-time mothers. More assistance should also be warranted to mothers after cesarean, as in these cases lactation may be further compromised by other factors such as prolonged mother-child separation, surgery-related pain and immobility and delayed lactogenesis in the absence of labor [24].

As for other studied risk factors, we identified a positive trend of early breastfeeding, since most infants were breastfed during the first hour after birth. Due to the retrospective aspect of our study, we were not able to collect enough data to determine pre-pregnancy maternal body weight or the presence of breast anomalies.

Clinical detection of dehydration and hypernatremia without relying on daily weight measurements was difficult. Hypoglycemia and jaundice were the most frequent presenting features and other studied manifestations were rarely reported. The paucity of clinical manifestations may be one of the factors contributing to the development of more serious complications, because hypernatremia can stay undetected and therefore undiagnosed for many days. To get around this, regular weighing remains an important tool, providing objective criteria for identification of mothers who need lactation support, as recommended by the AAP [16-18].

Our complication rate was low: major morbidity like neurological problems and acute renal failure were found in less than 1% of our sample. This contrasts with other publications, where major complications were far more frequent. For instances, in another Portuguese retrospective study, Gomes et al. [8] identified 19 infants with HD, of which 21% had neurological complications. In a larger sample of 149 infants with hypernatremia, Bilgin et al. [7] found neurological complications in about 5%, and a 33% incidence of prerenal azotemia. In their

cohort of 686 infants with EWL, Manganaro et al. [21] identified 79% with elevated blood urea nitrogen, although there were no cases of neurological or cardiovascular complications.

When analyzing treatment modalities, it becomes clear that the common problem in infants with EWL/HD is insufficient fluid intake, which was easily corrected by the introduction of an infant formula supplement in most cases. Less than 5% of these newborns needed IV fluid replacement.

We believe that the high awareness of the medical staff and systematic monitoring of breastfeeding practices and infant weight allowed for early detection and intervention in breastfeeding failures. This contributed to the low readmission rate after the initial postpartum hospitalization, low NICU admission and low complication rate. This is also consistent with other reports: after the implementation of an early weighing policy in a group of UK facilities, Iyer et al. [6] reported earlier recognition of HD, lower percentage of weight loss and smaller increase in serum sodium when compared to the pre-policy period.

Also, when detected early, EWL can be easily treated by increasing milk transfer by correcting inadequate breastfeeding techniques, and in some cases by offering the baby a formula supplement. It seems fair to conclude that EWL/HD are potentially serious problems, but with simple, inexpensive solutions when diagnosed early by the appropriate tools. Other than weight loss greater than 7% of birth weight, possible indications to consider initiation of supplemental feedings could be jaundice, low urine or stool output, lethargy, fever, agitation or inconsolable crying, feeding difficulties or other evidence of delayed lactogenesis [3].

## Conclusion

In conclusion, although there is no published data that allows us to compare our data with other national centers, we believe that our results show a positive trend in neonatal care. EWL/HD were relatively common problems, but complications were rare, and the treatment was mostly noninvasive. These findings are important to reassure the clinical staff that their effort is making a positive impact. More data is needed to evaluate Portuguese incidence of HD and to design national programs to help prevent, detect and treat infants both during the initial hospitalization and after discharge.

## Declaration of interest

The Authors have no conflicts of interest or financial ties to disclose.

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