Review Article
Ulutas Med J 2015;1(2):22-25
DOI: 10.5455/umj.201506181158472
ISSN: 2149-0430 **eISSN:** 2149-388X

Hypernatremic Dehydration in Newborn Infants

Jagadish C. Das
Department of Neonatology, Chittagong Medical College, Chittagong, Bangladesh

Background: Hypernatremic dehydration is a lethal condition in neonate which adversely affects central nervous system. Important causes of this condition in neonate are vomiting, diarrhea, improper preparation of infant formula, inadequate breast feeding and diabetes insipidus. Hypernatremic dehydration presents usually around tenth postnatal day. Clinical presentation is variable. Some present with lethargy; others are alert and hungry. Some are dehydrated whereas other are apparently hydrated. Treatment of hypernatremic dehydration consists of an emergency phase where restoration of vascular volume with 10 to 20 ml/kg of isotonic intravenous fluid is achieved followed by rehydration phase where sum of free water deficit and maintenance fluid volume is administered slowly.

Conclusion: Rehydration is achieved with 5% dextrose in 0.2% normal saline, 5% dextrose in 0.45% normal saline or 0.9% normal saline according to serum sodium level. However, if the serum sodium is greater than 175 mmol/L, various amounts of 3% normal saline should be added. The daily maximum correction rate of serum sodium level should be 15 mmol/L. Addressing the etiological factors timely may be the proper way of prevention of such condition in neonate.

Key words: Hypernatremia, dehydration, newborn, management

Introduction

Hypernatremia, a frequently encountered electrolyte disorder, is defined as a serum sodium level greater than 145 mmol/L [*mEq/L*]. Serum sodium of >160mmol/L is often regarded as severe hypernatremia. The condition represents a deficit of water in relation to total body sodium (1). In neonate, hypernatremic dehydration may be suspected as a weight loss of more than 10% of birth weight at the end of first week of life or if there is clinical findings of dehydration with hypernatremia (2,3). Hypernatremic dehydration is a potentially lethal condition in neonate which adversely affects central nervous system, leading to devastating consequences like intracranial hemorrhage, thrombosis, and even death (4). Incidence of hyprernatremic dehydration varies in different geographical areas. In the West prevalence of this condition is 1.8% (81/4280) in breast feed newborn infants (5). In Turkey, 5.6% neonates experience serum sodium concentrations of >145 mmol/L (6). Recently there are increasingly appearing reports of hypernatremic dehydration (7,8). However, surprisingly fewer cases of this condition is reported in India. Probably, this is due to decreased awareness regarding this clinical entity as a result of which many such cases tend to be missed or wrongly diagnosed as sepsis due to common non-specific clinical features associated with both conditions (8). In our area work on this condition on neonate is very lacking. Our health personals may not fully acquaint of this condition on newborn infant. But appropriate

Corresponding author: Jagadish C. Das; Department of Neonatology, Chittagong Medical College, Chittagong, Bangladesh. E-mail: *jagadishcdas@yahoo.com*

Received: May 27, 2015; **Accepted**: June 18, 2015
Published: June 24, 2015

management can improve outcome of hypernatremic dehydration. The review is written to orient our health professionals particularly pediatricians and neonatologists regarding some fundamental aspects of such important issue for early diagnosis and timely management of this condition so that devastating consequences in terms of morbidity and mortality in neonate can be avoided.

Etiology

The etiological list of hypernatremic dehydration in newborn infant is not long. Depending on amount of deficit in total body fluids, hypernatremia is described as either hypovolemic, euvolemic or hypervolemic. Infants are worst affected, because of (a) immaturity of the kidney that hinders its ability to excrete an excess sodium load (b) babies have limited or no ability to express thirst and (c) infants can't feed themselves and depend on caregivers to provide adequate and appropriate fluids and feeds (9). Hypernatremic dehydration may be caused by pure water loss (*diabetes insipidus*), hypotonic fluid loss (*vomiting or diarrhea*), or hypertonic sodium gain (*hypertonic feeding preparations such as improperly prepared infant formula*). Sodium content of breast milk at birth is high and declines rapidly over subsequent days. Sodium content of colostrum in the first five days is (22±12) mmol/L, and of transitional milk from day five to ten is (13±3) mmol/L, and of mature milk after 15 day is (7±2) mmol/L. The Breastfeeding hypernatremic dehydration results when a mother-infant feeding interaction is inadequate. Here, human milk production is limited, and the physiologic decline in human milk sodium concentration does not occur. The infant becomes dehydrated while the kidneys are mature enough to retain sodium ions (1).

Clinical Presentation

The clinical presentation of hypernatremic dehydration is usually around ten days with a range from 3 to 21 days. Parents may fail to identify that the infant is ill, and professionals may also falsely reassure about infant's apparent well-being. Signs may be non-specific, including lethargy and irritability. Occasionally there is an acute deterioration which precipitates the infant's emergency admission to hospital. During acute isonatremic or hyponatremic dehydration clinicians may rely on sunken eyes and depressed anterior fontanelle as signs of total body water loss. In hypernatremic dehydration however there may be changes in brain cell osmolality and cerebral oedema, and the resultant fullness of the anterior fontanelle may mislead the underlying dehydration. Clinical examination of these infants at presentation is variable. Some present with lethargy; others may be alert, hungry and clinically dehydrated (1). There may be jaundice, seizure and excessive weight loss (4). In moderate to sever hypernatremic dehydration, skin turgor is normal, there may be fever, tachycardia with poor perfusion and hypotension with hypovolemia. Skin is thick, doughy and may even feel moist due to perspiration. Mucous membrane is dry. An important observation of hypernatremic dehydration is intense thirst (9).

Complications

Brain is the most vulnerable organ from hypernatremia. Plasma hypertonicity and the subsequent intracellular water loss causes the brain cells to shrink, leading to rupture of bridging vessels with hemorrhages in subarachnoid and brain parenchyma and thrombosis (10). Brain responds, over a period of several hours, by acquiring new intracellular solutes known as 'idiogenic osmoles', to protect intracranial volume (9). If rehydration is rapid with relatively hypotonic intravenous fluids, excess water enters cerebral cells leading to rebound cerebral oedema. Permanent cognitive impairment, cerebral dysfunction, spastic paralysis, and seizure disorders have been described (9). Extensive pontine and extrapontine myelinolysis have also been reported (11,12). Children with early onset of seizures or impairment of consciousness have a 50% chance for neurologic sequel (9), Other recognized complications of hypematremia include hyperglycemia, hypocalcemia, renal tubular injury and renal vein thrombosis (13). Mortality in acute cases with serum sodium >160 mmol/L is around 45%, while it is around 10% in chronic hypernatremia (9).

Treatment

Some complications, especially seizures, occur most frequently during treatment. It is recognised that the mainstay of treatment is to rehydrate the child very slowly. If anyone attempts to correct the high sodium concentration quickly, there is severe risk of osmotic changes in the brain of newborn infant which can exacerbate cerebral edema, thus leading to potential brain damage (9). In general, recommendations for treating hypernatremic dehydration consist of an *emergency phase* (restoration of vascular volume with 10 to 20 mL/kg of isotonic intravenous [IV] fluid such as Ringer's lactate solution with 130 mmol/L of sodium or normal saline with 154 mmol/ L of sodium) followed by a *rehydration phase* (the sum of the free water deficit and maintenance fluid requirements administered evenly

over 48 hours)(14). Assuming 70% of the infant's body weight is water, the free water deficit (L) = 0.7 x WT (kg) [1-current sodium/desired sodium]. During rehydration phase, 5% dextrose in 0.2% normal saline (31 mmol/L of sodium) is the usual IV fluid composition (14). In case of higher serum sodium level, 5% dextrose in 0.45% normal saline is usually considered (1). Edema in brain, seizures, and death can occur if hypernatremia is corrected too rapidly (15).

The optimal treatment of hypernatremic dehydration has been debated for years (1). In cases of severe hypernatremic dehydration, management plan is more difficult. If serum sodium is >175 mmol/L, traditionally isotonic IV fluids, which is actually hypotonic in relation to patient's serum is considered. Free water content of IV fluid can be calculated from the formula: Free water (%) = 1- (IV fluid sodium/serum sodium). Thus, when serum sodium is 154 mmol/L, 0.9% normal saline has 0% free water, but if serum sodium is 195 mmol/L, it provides 21% free water. If a patient has a serum sodium level of 195 mmol/L and a large amount of 0.9% normal saline is given to restore vascular volume, serum osmolality may fall rapidly, leading to cerebral edema and death (16). Therefore, if the serum sodium is greater than 175 mmol/L, various amounts of 3% normal saline (513 mmol/L sodium) should be added so that the IV fluid sodium concentration is approximately 10 to 15 mmol/L lower than the serum sodium level (14). If history is suggestive of a potential case of severe dehydration in a breastfed infant, it is likely that serum sodium exceeds 175 mmol/L. In this case, preparation of hypertonic fluids for support and maintenance of volume should be considered. The maximum rate of decrease of serum sodium level should be 0.6 mmol/L per hour or 15 mmol/L per day. The free water deficit should be calculated to lower the serum sodium level by15 mmol/day. The correction time may take longer than 48 hours (16). If serum sodium level is >200mmol/L, peritoneal dialysis should be considered (5).

Frequent monitoring of serum electrolytes (4-6 hourly) along with adjustment of rate of infusion or composition of IV fluid is essential to avoid too rapid correction of serum sodium level (1,5). Addressing the existing complication if any, is important. Clinical examination including close monitoring of vital signs with regular weight recording is definitely important (5). Addressing the underlying factor is another important stream of management strategy.

Prevention

Prevention of hypernatremic dehydration is very important as it is a devastating condition. Diarrhea, pathological vomiting, hypertonic formula feeding should be addressed properly. Injudicious use of sodium bicarbonate in neonate should be prohibited. If diabetes incipidus is existent, it should be well-cheked. Prevention of hypernatremic dehydration secondary to lactation failure should be emphasized. Physician should alert himself regarding possibility of hyper natremic dehydration in breast-fed newborn infant. Instruction should be given to the mother regarding breast feeding techniques. Parents should inform about '*ten steps of successful breast feeding*'. Follow-up visit of mother and newborn infant is to be conducted to reinforce the signs of successful breast-feeding as well as to detect any problem of baby earlier (17). All breast-fed infant should be weighed at least once several days after discharge (18). If there is a weight loss of greater than 10%, the infant should be weighed on a daily basis until a normal growth velocity can be recorded. Doctors, midwives, community nurses and health visitors should be trained to identify 'at risk' infants, whose feeding is not progressing normally (18).

Conclusion

Hypernatremic dehydration in infancy is a medical emergency with high rates of mortality and morbidity. Early diagnosis and prompt appropriate treatment is crucial for survival and better prognosis. However, diagnosis is often difficult and dehydration is underestimated. Judicious management of the condition is essential. During treatment of the condition, it is essential to see that complications do not occur from hypernatremia itself and correction of it through fluid therapy.

Addressing the etiological conditions timely is another important step in the management of hypernatremic dehydration. Women should be educated about the signs and symptoms of dehydration during prenatal visits and before discharge after delivery of newborn infant. Early discharge demands follow-up the neonate including mother to detect breastfeeding problems before onset of hypernatremic dehydration.

Conflict of Interest

The authors declare that no conflict of interest exists in publishing this article.

Reference

1. Schwaderer AL and Schwartz GJ. Treating hypernatremic dehydration. Pediatrics in Review 2005; 26(4): 148-151.
2. Konetzny G, Bucher HU, Arlettaz R. Prevention of hypernatremic dehydration in breastfed newborn infants by daily weighing. Eur J Pediatr. 2009; 168: 815-818.
3. Cohn A. A simple method for assessing if weight loss is greater or less than 10%. Arch Dis Child 2005;90: 88.
4. Boskabadi H, Maamouri G, Ebrahimi M, et al. Neonatal hypernatremia and dehydration in infants receiving inadequate breastfeeding. Asia Pac J Clin Nutr. 2010;19: 301-307.
5. Bolat F, Oflaz MB, Gu¨ven AS, O¨zdemir G, Alaygut D, Dogan MT et al. What is the safe approach for neonatal hypernatremic dehydration? A retrospective study from neonatal intensive care unit. Pediatr Emer Care 2013; 29: 808-813.
6. Uras N, Karadag A, Dogan G, Tonbul A, Tatli MM. Moderate hypernatremic dehydration in newborn infants: retrospective evaluation of 64 cases. J Matern Fetal Neonatal Med. 2007; 20(6):449-52.
7. Krishnamurthy S, Debnath S, Gupta P. Breast feeding-associated hypernatremic dehydration: A preventable tragedy in newborn infants. Journal of Case Reports 2011;1(1):1-5.
8. Smith RG. Severe hypernatremic dehydration in a newborn infant. Pediatr Child Health 1998; 3(6):413-415.
9. Elamin A and Nair P. Case reports: hypernatremic dehydrationin infancy. Sudanese Journal of Pediartics 2007; 8: 161-170.
10. Hilliard TN, Marsh MJ, Malcolm P, Murdoch lA, Wood BP. Sagittal smus thrombosis in hypernatremic dehydration. Arch Pediatr Adolesc Med. 1998; 152:1147-1149.
11. Brown WD, Caruso JM. Extrapontine myelinolysis with involvement of the hippocampus in three children with severe hypematremia. J Child Neurol. 1999;14: 428-433.
12. Orainy IA, O'Gorman AM, Decell MK. Cerebral bleeding, infarcts, and presumed extrapontine myelinolysis in hypernatremic dehydration. Neuroradiology1999; 41:144-146.
13. Palevsky PM. Hypernatremia. Semin Nephrol. 1998;18: 20-30.
14. Rand SE, Kolberg A. Neonatal hypernatremic dehydration secondary to lactation failure. J Am Board Fam Pract. 2001; 14: 155-158.
15. Van Amerongen RH, Moretta AC, Gaeta TJ. Severe hypernatremic dehydration and death in a breast-fed infant. Pediatr Emerg Care.2001; 17: 175-180.
16. Molteni KH. Initial management of hypernatremic dehydration in the breastfed infant. Clin Pediatr. 1994; 33: 731-740.
17. Oh YJ, Lee JE, An SH, Kim YK, Kang SK, Kim JK et al. Severe hypernatremic dehydration in a breast-fed neonate. Korean Journal of Pediatrics 2007; 50(1):85-88.
18. Laing IA. Hypernatraemic dehydration in newborn infants. Acta Pharmacol Sin 2002; 23(suppl): 48-51.

DOI: **dx.doi.org/10.5455/umj.201506181158472**
***Cite the article as*:** Jagadish C Das. Hypernatremic Dehydration in Newborn Infants: A Review. Ulutas Med J. 2015;1(2):22-25.