

## Research Article

# Neonatal Hyponatremia: Risk Factors, Treatment and Short-Term Outcome

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## Abstract

Serum sodium concentration of  $\geq 150$  mmol/l in neonates is known as neonatal hyponatremia. Variable incidence of hyponatremia depending on countries regions geographic settings or socioeconomic status and it has been increasing over the past three decades.

**Objectives:** To determine risk factors, treatment and short-Term outcome of hyponatremia in Neonates admitted to Al-Obeid Specialized Pediatric Hospital, North Kordofan State Sudan during the period between 2020 and 2022.

**Methods:** Descriptive, observational, cross-sectional and hospital-based study. Data was extracted from the patient records and then re-entered into a predesigned data collection form. Data then entered into Microsoft excel data sheet and analyzed using SPSS version 21.

**Results:** A total of 206 of the participants were included in the study. The birth weight for most 104 (50.5%) of the respondents was found to be from 1.5 to 2.5 kg. Serum Na was found to be 151 mmol/l-170 mmol/l in 124 (68.9%) of the participants 170 mmol/l-190 mmol/l in 41 (22.8%) of the participants 190 mmol/l-200 mmol/l in 10 (5.6%) of them and more than 200 mmol/l in 5 (2.8%) of the participants. The most reported maternal complications were febrile illness in 35 (17%) of the participants 23 (11.2%) were with UTI 20 (9.7%) had PIH. About 173 (84%) delivered by NSVD. Concerning season of delivery, it was summer in 184 (89.3%) of the participants. About 190 (92.2%) were delivered at term 16 (7.8%) were preterm. Duration of treatment of hyponatremia was found to be 1 day in about 40 (19.4%) of the participants 2 days in 42 (20.4%) 3 days in 38 (18.4%) of the participants 4 days in 24 (11.7%) and 8 days in 20 (9.7%) of the participants. Birth weight significantly associated with Hyponatremia (P. value=.000). Those with birth weight between 1 kg-2.5 kg more frequently have sodium level 151 mmol/l-170 mmol/l. Those with impaired RFTs significantly have high sodium level (P. value=.000). High blood urea and serum creatinine significantly associated with sodium level 151 mmol/l-170 mmol/l. The outcome of the most 137 (66.5%) of the respondents was cure and discharge about 50 (24.3%) died 12 (5.8%) referred and 7 (3.4%) absconded.

**Conclusion:** The most common reported contributing risk factors for hyponatremia in neonates in the current study were found to be prematurity and low birth weight. Other complications included sepsis and acute kidney injury. Outcome of more than two-thirds of neonates was cure and discharge. The most common laboratory findings which found to be associated with neonatal hyponatremia was impaired renal function tests.

**Keywords:** Neonatal hyponatremia; Risk factors; Treatment and outcome

## Introduction

Hyponatremia in neonates is defined as a total serum sodium concentration of  $\geq 150$  mmol/l. Newborns are at increased risk of hyponatremia due to inability to control their fluid intake and their large body surface area to weight or height ratio which results in high insensible water losses [1]. Lactation failure [2] and inadequate milk in the first weeks of life are commonly recognized causes of hyponatremia in breastfeed infants [3].

The incidence of neonatal hyponatremia varies widely depending on countries regions geographic settings or socioeconomic status and has been increasing over the past three decades [4]. Resource rich countries report less than 2% incidence whilst in developing countries it ranges between 1.5% and 10% though these studies differed significantly in study designs geographic distribution and the newborn care medical practices [5].

Several problems such as a mother's inexperience in breastfeeding lack of mother's adequate training and the use of supplements may lead to a reduction in milk intake and abnormal weight loss in the first week of neonatal life [6]. An infant with dehydration and sodium retention will defend himself with reduction of urine volume and number of defecation to maintain body water and if this problem is not corrected it can lead to Neonatal Hyponatremic Dehydration (NHD) [7]. The incidence of hyponatremic dehydration in breastfeeding infants is 1%-2% worldwide whereas it is reported to be between 1%-20% in developing countries [8].

## Prevention

Prevention of hyponatremic 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

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insipidus is existent it should be well-checked. Prevention of hypernatremic dehydration secondary to lactation failure should be emphasized. Physician should alert himself regarding possibility of hypernatremic 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 [9]. All breast-fed infant should be weighed at least once several days after discharge. 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 [10].

### Treatment

Some complications especially seizures occur most frequently during treatment. It is recognized 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 [11]. In general recommendations for treating hypernatremic dehydration consist of an emergency phase (restoration of vascular volume with 10 mL/kg 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. During rehydration phase 5% dextrose in 0.2% normal saline (31 mmol/L of sodium) is the usual IV fluid composition [12].

The optimal treatment of hypernatremic dehydration has been debated for years 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. 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 [13]. 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 mmol/L to 15 mmol/L lower than the serum sodium level [14].

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. Clinical examination including close monitoring of vital signs with regular weight recording is definitely important [14].

Hypernatremic dehydration is a potentially lethal condition in neonate which adversely affects central nervous system leading to devastating consequences like intracranial hemorrhage thrombosis and death [15]. This study aimed to orient our health care professionals specially pediatricians concerning some essential aspect of such important issue for early recognition and timely intervention of this condition so that devastating consequences in neonate can be avoided.

### Materials and Methods

A cross sectional, descriptive, observational and hospital-based

study conducted among neonates admitted to Elobied Specialized Pediatric Hospital from June 2020 to June 2022. The study population was all neonates admitted to the hospital during the study period with hypernatremia and had complete hospital record. Those with incomplete hospital records were excluded from the study.

### Data collection and analysis

Data was collected from patient's records using structural questionnaire serial numbers were assigned instead of names to insure confidentiality. Data were cleaned and entered into Microsoft excel data sheet and were analyzed used SPSS version 21. Categorical data were represented in the form of frequencies and proportions. Graphical representation of data: MS Excel and MS word were used to obtain various types of graphs. P value (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests and level of confidence.

### Results

A total of 206 of the participants were included in the study. Of 128 (62.1%) of respondents were on regular antenatal care and follow up and 78 (37.9%) were not on regular antenatal care and follow up (Figure 1). APGAR score was normal in 179 (86.9%) of the neonates and low in 27 (13.1%) of them. Resuscitation was done for all 27 (100%) of the neonates with low APGAR score (Table 1).

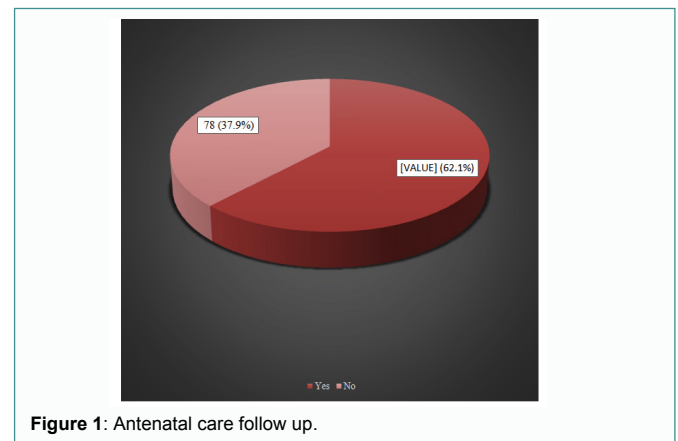


Figure 1: Antenatal care follow up.

Table 1: APGAR score and need for resuscitation.

|               | Frequency (%) |
|---------------|---------------|
| APGAR score   |               |
| Normal        | 179 (86.9%)   |
| Low           | 27 (13.1%)    |
| Resuscitation |               |
| Yes           | 27 (100%)     |
| No            | 0 (0%)        |

120 (58.3%) of the respondents reported that their breast milk is adequate whereas 86 (41.7%) of the participants reported that their breast milk is not adequate as represented (Figure 2). 197 (95.6%) of the participants mentioned that there is no breast problem whereas in about 9 (4.4%) there is breast problem.

The birth weight for most 104 (50.5%) of the respondents was found to be from 1.5 kg to 2.5 kg 58 (28.2%) having birth weight of 2.5 kg to 3.5 kg 2 (1%) were having birth weight of more than 3.5 kg and none of them had birth weight of less than 1 kg (Figure 3).

Most of the respondents 109 (52.9%) were having newborn in his first week 68 (33%) of the respondents were having a newborn in his second week 16 (7.8%) were having third week neonate and 13 (6.3%)

were having a 4<sup>th</sup> week neonate (Table 2). The outcome of the most 137 (66.5%) of the respondents was cure and discharge about 50 (24.3%) died 12 (5.8%) referred and 7 (3.4%) absconded and this as shown in (Figure 4).

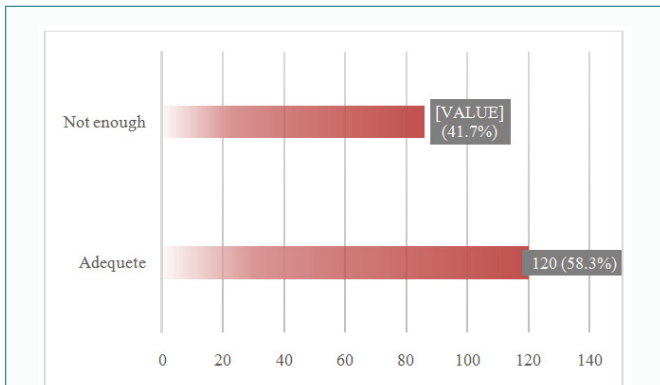


Figure 2: Adequacy of breast milk.

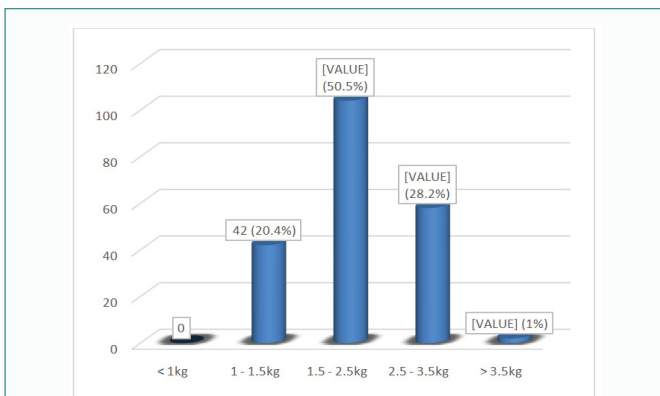


Figure 3: Birth weight of the respondents.

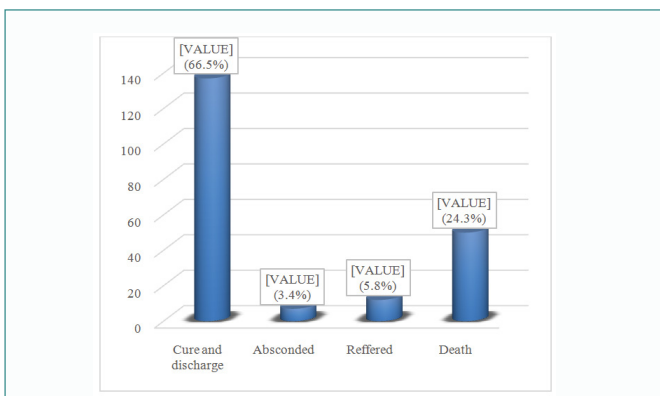


Figure 4: Outcome of the respondents.

In regards to maternal complications; maternal complications were absent in 148 (71.8%) of respondents and complications were present in 58 (28.2%) of them. 2 (1%) of them were with diabetes mellitus, 20 (9.7%) had pregnancy induced hypertension, 35 (17%) had febrile illness, 23 (11.2%) were with UTI, 19 (9.2%) were having malaria, 5 (2.4%) had typhoid and 5 (2.4%) had premature rupture of membranes. Only 1 (0.5%) had blood transfusion (Table 3).

123 (59.7%) were delivered at home whereas 80 (40.3%) delivered at hospital. 173 (84%) delivered by NSVD, 1 (0.5%) delivered by

assisted vaginal delivery, 20 (9.7%) were delivered by elective C/S and 12 (5.8%) delivered by emergency C/S. 120 (58.3%) of delivery outcome were males and 86 (41.7%) were females. Concerning season of delivery, it was summer in 184 (89.3%) of the participants 13 (6.3%) were in autumns, 9 (4.4%) (Table 4).

190 (92.2%) were delivered at term, 16 (7.8%) were preterm of those who were preterm; 14 (87.5%) were 30-35-week gestational age preterm and 2 (12.5%) were 25-30 week gestational age preterm and none of the preterm was less than 25 week of gestational age (Table 5). Time of diagnosis was found to be day 1 in 150 (72.8%) of the participants, 56 (27.8%) were diagnosed at (day 2, 3 & 4).

Duration of treatment of hypernatremia was found to be 1 day in about 40 (19.4%) of the participants, 2 days in 42 (20.4%), 3 days in 38 (18.4%) of the participants, 4 days in 24 (11.7%) and 8 days in 20 (9.7%) of the participants (Table 6).

Birth weight significantly associated with Hypernatremia (P. value=0.000). Those with birth weight between 1 kg-2.5 kg more frequently have sodium level 151 mmol/l-170 mmol/l. Those with impaired RFT significantly have high sodium level (P. value=0.000). High blood urea and serum creatinine significantly associated with sodium level 151 mmol/l-170 mmol/l.

Table 2: Time to diagnosis.

| Time to diagnosis   | Frequency (%) |
|---------------------|---------------|
| Early (Day 1)       | 150 (72.8%)   |
| Late (day 2, 3 & 4) | 56 (27.2%)    |
| Day 2               | 27 (48.2%)    |
| Day 3               | 27 (48.2%)    |
| Day 4               | 2 (3.6%)      |

Table 3: Maternal complication of the participants.

| Complication      | Frequency (%) |
|-------------------|---------------|
| Absent            | 148 (71.8%)   |
| Present           | 58 (28.2%)    |
| DM                | 2 (1%)        |
| PIH               | 20 (9.7%)     |
| Febrile illness   | 35 (17%)      |
| UTI               | 23 (11.2%)    |
| Malaria           | 19 (9.2%)     |
| Typhoid           | 5 (2.4%)      |
| PROM              | 5 (2.4%)      |
| Blood transfusion | 1 (.5%)       |

## Discussion

Assessing the risk factors, treatment and outcome of hypernatremia in pediatrics considered as an important issue as it reflects the nature of elevation of serum sodium levels and outcome which could be one of the indicators of management quality and assessment of the most common and possible risk factors will result in development of more effective preventive measures.

About half (50%) of respondents were of rural residence and the other half of urban residence. Nearly two-thirds (62.1%) of respondents were on regular antenatal care and follow up and (37.9%) were not on regular antenatal care and follow up. Birth weight for about half (50.5%) of the respondents was found to be from 1.5 kg to 2.5 kg less than one-third of the participants (28.2%) were having birth weight of 2.5 kg to 3.5 kg (1%) were having birth weight of more than 3.5 kg and none of them had birth weight of less than 1 kg. Low birth weight is a risk factor for hypernatremia as reported in the parallel study conducted by Uras et al. [16] in which found that body

**Table 4:** Place, mode, outcome and season of delivery.

| Place of delivery         | Frequency (%) |
|---------------------------|---------------|
| Home                      | 123 (59.7%)   |
| Hospital                  | 83 (40.3%)    |
| Mode of delivery          |               |
| NSVD                      | 173 (84%)     |
| Assisted vaginal delivery | 1 (.5%)       |
| Elective C/S              | 20 (9.7%)     |
| Emergency C/S             | 12 (5.8%)     |
| Outcome of delivery       |               |
| Male                      | 120 (58.3%)   |
| Female                    | 86 (41.7%)    |
| Season of delivery        |               |
| Summer                    | 184 (89.3%)   |
| Autumn                    | 13 (6.3%)     |
| Winter                    | 9 (4.4%)      |
| Spring                    | 0 (0%)        |

Delivery outcome ratio: Male:Female=1.4:1

**Table 5:** Gestational age.

| GA      | Frequency (%) |
|---------|---------------|
| Term    | 190 (92.2%)   |
| Preterm | 16 (7.8%)     |
| < 25wk  | 0 (0%)        |
| 25-30wk | 2 (12.5%)     |
| 30-35wk | 14 (87.5%)    |

**Table 6:** Duration of treatment.

|        | Frequency (%) |
|--------|---------------|
| 1 day  | 40 (19.4%)    |
| 2 days | 42 (20.4%)    |
| 3 days | 38 (18.4%)    |
| 4 days | 24 (11.7%)    |
| 5 days | 16 (7.8%)     |
| 6 days | 10 (4.9%)     |
| 7 days | 16 (7.8%)     |
| 8 days | 20 (9.7%)     |
| Total  | 206           |

weight of less than 7% of normal standard weight is a risk factor for hypernatremia [16].

Serum sodium was found to be 151-170 in in about two-thirds (68.9%) of the participants 170-190 in one fifth (22.8%) of the participants 190-200 in (5.6%) of them and more than 200 in (2.8%) of the participants.

The outcome of about two-thirds (66.5%) of the respondents was cure and discharge, (24.3%) died, (5.8%) referred and (3.4%) absconded. Similar findings were reported in the congruent study carried out by Bolat et al. [17] in which neonates with hypernatremia were divided into three groups group 1=150 to 160 mmol/L group 2=161 to 170 mmol/L and group 3=171 to 189 mmol/L and outcome of the most participants was in group 1 and group 2 was recovery and but about two-thirds of the participants from group 3 died [17].

In regards to maternal complications; maternal complications were absent in more than two-thirds (71.8%) of respondents and complications were present in less than one-third (28.2%) of them. This percentage of participants with maternal complications is higher when compared to the congruent study carried out in by Singoma et al. [18] in Rwanda in which prevalence of maternal complications was found to be 5.4% [18]. The most reported maternal complication was febrile illness in (17%) of studied group, followed by urinary tract infection in (11.2%) of the participants then pregnancy induced hypertension and malaria in contradiction to the parallel Indonesian study which reported anemia as the most common cause of maternal

complication [19].

More than half (59.7%) were delivered at home whereas (40.3%) delivered at hospital. The vast majorities (92.2%) were delivered at term and (7.8%) were preterm. The majority (87.5%) of those who were preterm were 30-35-week gestational age preterm and (12.5%) were 2-30 week gestational age preterm and none of the preterm was less than 25-week of gestational age. APGAR score was normal in most (86.9%) of the neonates and low in (13.1%) of them. APGAR score was found to be normal in all of the participants with hypernatremia in the study which conducted by Boskabadi et al. [20] in which reported normal APGAR scores among all neonates including those with hypernatremia [20]. Birth weight significantly associated with hypernatremia as those with birth weight of 1 kg-2.5 kg more frequently have sodium level 150-170.

## Conclusion

The most common reported contributing risk factors for hypernatremia in neonates in our study were found to be prematurity and low birth weight. Other complications included sepsis and acute kidney injury. Outcome of more than two-thirds of neonates was cure and discharge. The most common laboratory findings which found to be associated with neonatal hypernatremia was renal function tests represented as urea and creatinine.

## Recommendations

1. We recommended to routinely check-up of renal function tests with electrolytes to all hospitalized neonates.
2. Increase the awareness among doctors regarding neonatal hypernatremia and careful fluid management.
3. We strongly recommended to fully hydration to all neonates (by increase the breast-feeding) during summer period.
4. The frequency of neonatal hypernatremia in this study may not be a true indication of actual prevalence rates. A larger study in the future is essential for clarification.

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## Consent

Ethical approval for this study was obtained from the Research and Ethics Committee of Sudan Medical Specialization Broad and Research Department, Ministry of Health, North Kordofan State. A written informed consent was obtained from Al-Obied Specialized Pediatric Hospital Administration.

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