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Estimation of sodium and potassium in sick newborns in first 72 hours: A cohort study

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Abstract

Title of the article: Estimation of Sodium and Potassium in Sick Newborns in first 72 hours: A Cohort study.

Introduction: Electrolytes levels in newborns in early hours of life are affected by physiology and sickness, it can be an important parameter affecting morbidity and mortality.

Aim: To determine the levels of sodium and potassium in the first 72 hours of life and its frequency of abnormalities in sick newborns and its outcome.

Settings and design: Neonatal Intensive Care Unit, Tertiary Care Teaching Hospital, Eastern Uttar Pradesh, India

Material and methods: A single center prospective cohort study was conducted among intramural sick newborns born and arterial blood gas samples were collected on the first three days of life. The incidence of sodium and potassium abnormalities were calculated. Occurrence of electrolyte abnormalities were analyzed with neonatal morbidity and mortality. Chi-square test and fisher exact test were used to determine the statistical significance.

Results: 233 sick newborns were included in the study. 76(32.6%) died. Mean (SD) levels of sodium and potassium at 72 hours were 135.31(±7.97) and 4.30(±0.80) respectively.

Hyponatremia was the commonest electrolyte abnormality present in 102(38.6%) of sick neonates and also significantly observed in expired newborns ($p=0.02$).

Conclusions: Sodium and potassium abnormalities were prevalent; hyponatremia significantly leads to death and post-natal adaption of electrolytes in first 72 hours of life in sick newborns is influenced by co-morbidities.

Keywords: Electrolyte, Physiology, Sick-newborn, Morbidity and Mortality

Introduction

Careful fluid and electrolyte management in term and preterm infants is an essential component of neonatal care. Developmental changes in body composition in conjunction with functional changes in the skin, renal and neuroendocrine systems account for the fluid balance challenges faced by neonatologists on a daily basis. Thus fluid management requires the understanding of several physiological principles [1]. It is further potentiated by neonatal morbidities like asphyxia [2], sepsis [3] and respiratory distress syndrome [4]. Routinely it was recommended to give electrolyte free maintenance fluid for the first 48 hours, then addition of electrolytes in maintenance fluid of sick newborns without understanding the complexity of physiological factors and neonatal morbidities. [1] Moreover, prior reported literature reveals frequency of sodium and potassium abnormalities in sick newborn during hospital courses and there are limited studies in the first 72 hours of life and there were studies regarding their association between sickness and outcome. The present study has been conducted to determine the levels of sodium and potassium in the first 72 hours of life and its frequency of abnormalities in sick newborns and its outcome.

Methods and Materials

This is a prospective cohort study, conducted from October 2020 to October 2022 in tertiary care teaching hospital situated in northern India. Inclusion criteria were newborns with early onset sepsis, hypoxic ischemic encephalopathy, meconium aspiration syndrome and respiratory distress syndrome. Exclusion criteria were failure to obtain consent and death within 72 hours. The study was approved by ethical committee (Dean/2020/EC/2315, dated 07.12.2020) and informed consent was obtained from the parents before the study. Variables recorded were history, clinical examination, anthropometry, laboratory results and outcomes that were noted in predesigned case report forms. Arterial samples on three occasions for sick newborns (first within 0-24 hours, second at 24-48 hours and third at 48-72 hours) while single sample of 58 healthy newborns were collected at 72 hours. Samples were analyzed within 15 minutes with the help of ABL 800 flex analyzer available at NICU. Hyponatremia was defined as serum sodium less than 135 mmol/ L while hypernatremia as sodium more than 145 mmol/L [5]. Hypokalemia has serum potassium less than 3.5 mmol/ L while hyperkalemia has potassium of more than 5.5 mmol/ L [5]. Outcome was defined as either death or survival. All data were entered into excel sheet and analyzed by using SPSS version 21. The numerical data were represented as mean (SD), frequency (n) and percentage (%), difference in proportion were compared by the Chi-square and Fischer exact test and “t” test was used to compared the mean values between day-1

and day-3 and one-way ANOVA (Tukey-Kramer correction) was used to compare the paired means values at three intervals. A p value <0.05 was considered significant.

Results

Of total, 233 newborns, 134(57.5%) were males and 99(42.4%) were females and 142(60.9%) were preterm. Out of 233 newborns, 76(32.6%) expired and 157 (67.3%) survived. The common morbidities were sepsis 147(63%), respiratory distress syndrome (RDS) 109 (46.7%) and perinatal asphyxia 45(19.3%) respectively. Baseline characteristics were showed in (Table-1).

The mean values of sodium were plotted from day-1 to day-3 (Fig.1) and the mean (SD) values were 133.7(8.21), 134.7(8.86) and 135.3 (7.97) on day-1, 2 and 3 respectively; the difference of mean at three intervals was not significant ($p=0.12$). Whereas mean (SD) value of sodium at 72 hours of life was more as compared to healthy newborns [135.3(7.97) vs 132.08(7.95)] and differences was significant ($p=0.04$). The mean values of potassium were plotted from day-1 to day-3 (Fig.2) and the mean (SD) values were 4.53(1.17), 4.31(0.86) and 4.30 (0.80) on day-1, 2 and 3 respectively; the difference of mean at three intervals was significant ($p=0.01$). Whereas mean(SD) value of potassium at 72 hours of life was more as compared to healthy newborns [4.3(0.80) vs 4.2(0.79)] and differences was not significant ($p=0.86$). The common electrolyte abnormality was hyponatremia 102 (43.7%), followed by hypokalemia 32(13.7%) in sick newborns and frequency of hyponatremia and hypokalemia were equally distributed in preterm and term (Table-2). The mean values of sodium and potassium were equally distributed in sick preterm and full term newborns (Table-2). The mean (SD) values of sodium at 1, 2 and 3 days in newborn with HIE were similar and the difference of mean at three intervals were not significant ($p=0.97$). (Fig.3). The mean (SD) values of sodium at 1, 2 and 3 days in newborn with RDS and sepsis were gradually increasing and the difference of mean at three intervals were not significant ($p=0.20$) and ($p=0.35$) respectively (Fig.3). The mean (SD) values of potassium at 1, 2 and 3 days in newborn with HIE and sepsis were gradually decreasing and the difference of mean at three intervals were significant ($p=0.03$) and ($p=0.02$) respectively. (Fig.4). The mean (SD) values of potassium at 1, 2 and 3 days in newborn with MAS and RDS were similar and the difference of mean at three intervals were not significant ($p=0.33$). and ($p=0.36$) respectively. (Fig.4). Hyponatremia was significantly prevalent in expired newborns ($p=0.02$). (Table-3).

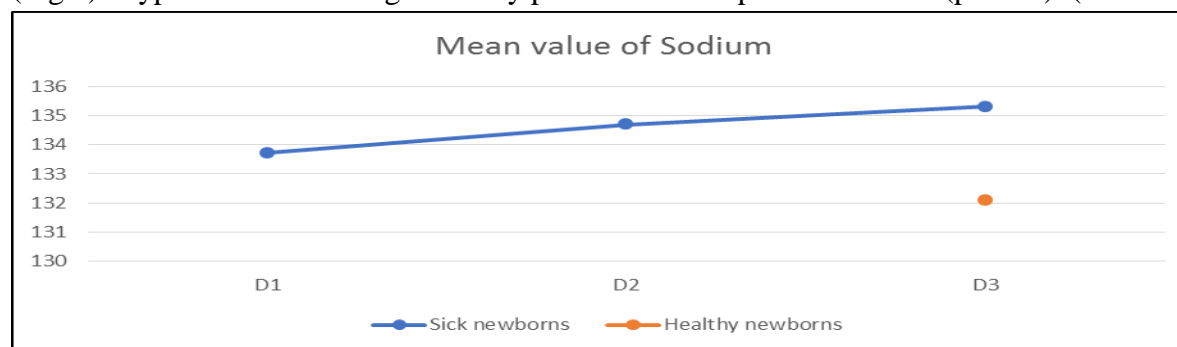


Fig.1. The mean values of sodium were plotted from day-1 to day-3 of sick newborns, the mean (SD) values were 133.7(8.21), 134.7(8.86) and 135.3 (7.97) in sick newborns. The mean (SD) value in healthy newborns at 72 hours was 132.08(7.95).

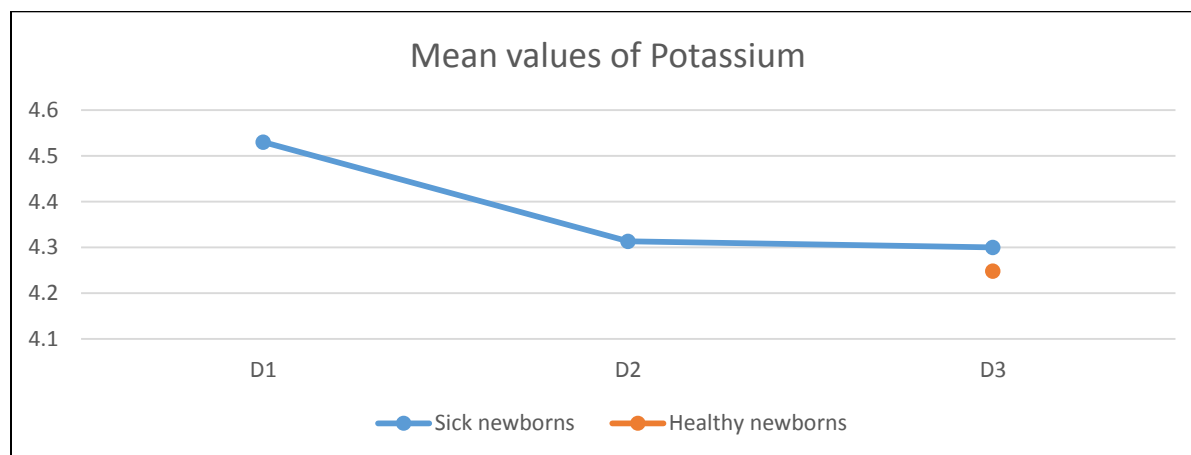


Fig.2. The mean values of potassium were plotted from day-1 to day-3 of sick newborns, the mean(SD) values were 4.53(1.17), 4.31(0.86) and 4.30 (0.80) in sick newborns. The mean (SD) value in healthy newborns at 72 hours was 4.2(0.79).

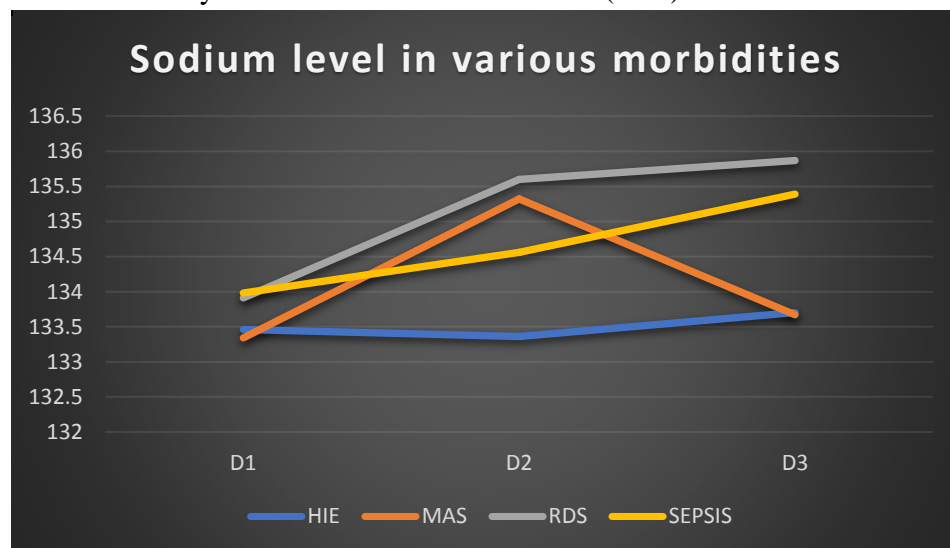


Fig.3. The mean values of sodium in morbidities were plotted from day-1 to day-3 of sick newborns. Neonates with HIE; the mean (SD) values were 133.46(7.30), 133.36(7.49) and 133.70(7.15). Neonates with MAS; the mean (SD) values were 133.34(7.67), 135.32(7.21) and 133.67(4.22). Neonates with RDS; the mean (SD) values were 133.34(7.67), 135.32(7.21) and 135.87(8.33). Neonates with Sepsis; the mean (SD) values were 133.98(8.14), 134.56(8.57) and 135.39(7.61).

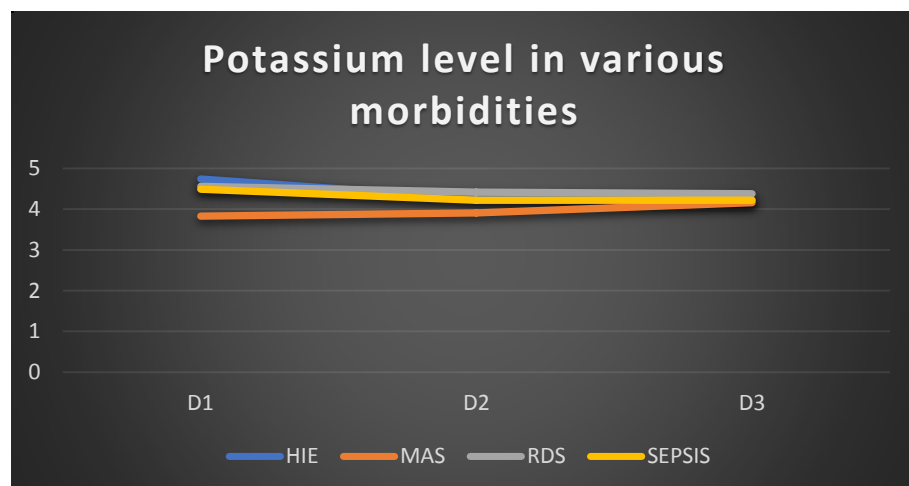


Fig.4. The mean values of potassium in morbidities were plotted from day-1 to day-3 of sick newborns. Neonates with HIE; the mean (SD) values were 4.74(1.40), 4.26(0.72) and 4.23(0.81). Neonates with MAS; the mean (SD) values were 3.83(0.45), 3.91(0.32) and 4.16(0.73). Neonates with RDS; the mean (SD) values were 4.56(1.11), 4.42(0.92) and 4.38(0.76). Neonates with Sepsis; the mean (SD) values were 4.49(1.19), 4.23(0.85) and 4.22(0.83).

Table-1: Baseline characteristics and risk factors of study cohort

Characteristics	Sick newborns, n=233
Males, n(%)	134(57.5)
Preterm(<37 weeks), n(%)	142(60.9)
Term(>37 weeks),n(%)	91(39.05)
Birth weight (kg)	
<2.5, n (%)	129(55.36)
>2.5, n (%)	104(44.6)
Hypoxic ischemic encephalopathy (HIE), n (%)	45(19.31)
Respiratory distress syndrome (RDS), n (%)	109(46.7)
Sepsis, n (%)	147(63)
Meconium aspiration syndrome (MAS), n(%)	10(4.29)
Multigravida, n(%)	119(51.07)
Primi gravida, n(%)	114(48.9)
Hypothyroidism, n(%)	16 (6.8)
Pre-eclampsia, n(%)	16 (6.8)
Eclampsia, n(%)	17 (7.29)
Premature rupture of membrane, n(%)	48(20.6)
Antepartum hemorrhage, n(%)	28 (12.0)
Expired, n (%)	76(32.6)
Survived, n (%)	157(67.3)

Table-2: Sodium and Potassium abnormalities in Term and Preterm at 72 hours

Electrolytes	Preterm, n= 142	Term, n=91	p-value
Sodium, mean(SD)	135.69(8.12)	134.75(7.70)	0.38
Potassium, mean(SD)	4.33(0.84)	4.20(0.73)	0.4
Hyponatremia* n =102	59(41.5)	43(47.2)	0.47
Hypokalemia* n=32	20(14.08)	12(13.18)	1
Hyperkalemia* n =14	11(7.7)	3(3.2)	0.25

* represented as frequency, n (%). The mean values were compared by “t” test and Chi-square test was used to compared frequency except where value of column was less than 10; Fishers exact test was used.

Table-3: Correlation of Sodium and Potassium abnormalities with outcome

Electrolyte abnormalities*	Outcome		p-value [#]
	Expired n (%) n=76	Survived n (%) n=157	
Hyponatremia, n=102	42(55.2)	60(38.2)	0.02
Hypernatremia, n=10	5(6.5)	5(3.1)	0.31
Hypokalemia, n=32	9(11.8)	23(14.6)	0.69
Hyperkalemia, n=14	7(9.2)	7(4.4)	0.23

* The frequencies of electrolyte abnormalities have overlap. # Chi-square test was used to compared frequency except where value of column was less than 10; Fishers exact test was used.

Discussion

Normally there is salt and water diuresis in the first 48-72 hours of life and we also observed mean (SD) of sodium at 3 days in healthy newborns was 132.08(7.95), which reflect post-natal natriuresis and diuresis [1]. Among the sick newborns, observing the sodium values during first 72 hours of life, a slowly rising mean was seen (Fig.1) and there were significant differences in the mean(SD) values of sodium [135.3(7.97) vs 132.08(7.95)] (p=0.04), between sick and healthy newborns at 72 hours of life, which reflects delayed post-natal natriuresis and diuresis in sick newborns. However, this inference was not generalized because present cohort is heterogeneous (preterm and term) and different morbidities, which could influence neuroendocrine systems. Therefore, trend of sodium levels in first 72 hours of life in sick newborns should be interpreted in view of individual comorbidity. It can be seen that the lower levels of sodium were seen in case of perinatal asphyxia, which can be attributed to the fact that in neonates with asphyxia there is increased secretion of anti-diuretic hormone (ADH) which leads to water retention and hence dilutional hyponatremia [6]. Similar results were found in study done by Thakur et al [7], Basu P et al [2] and Varma et al [5]. Therefore, restriction of fluid is required till serum sodium values return to normal in neonates with asphyxia. Preterm infants were presented as RDS, we observed gradually increasing sodium values in first 72 hours

of life, however, difference was not significant and 59 (41.5%) of preterm infant developed hyponatremia at 72 hours of life. This was different from the study by Morena et al [19] which showed that most of the hyponatremia cases occurred within first 12 hours of life. This might be because immature kidney may be further compromised in the presence of hypoxia and acidosis due to RDS and preterm requiring positive pressure ventilation may lead to increased secretion of aldosterone and ADH, leading to water retention [7]. Therefore, restriction of fluid has a beneficial effect on the incidence of patent ductus arteriosus, bronchopulmonary dysplasia, necrotizing enterocolitis and death in RDS [7]. The addition of sodium in first 48 hours of fluid therapy is debatable in preterm, however, Bischoff et al [16]. and Jochum et al [17], recommend at least 1–3 mEq/kg in the intravenous fluids or parenteral nutrition from the first hours of life in preterm with respiratory morbidity [10]. In neonatal sepsis increased secretion of ADH, acute tubular necrosis and renal failure predisposes to hyponatremia and we observed that gradually increasing sodium values in first 72 hours of life, however, difference was not significant. Targeting underlying cause is main stay of treatment in case of sepsis with organ support. We did not review the potassium trends and comparative analysis in first 72 hours of life, however, we observed general trend of gradual decrease in levels in first 72 hours of life, which suggested that to add potassium after 48 hours of life once diuresis has been started. In a descriptive study by Mirza et al [3], hyperkalemia was the most common electrolyte disorder in newborns with sepsis, which is contrary to our finding of hyponatremia as the most common electrolyte abnormality in sepsis.

In present study, we found equally distributed values of sodium and potassium in sick preterm and full term newborns and frequency of hyponatremia and hypokalemia were similar in preterm (41.5% and 14.08%) and term (47.2% and 13.18%). This observation might be because morbidities influences postnatal adaptation and study cohort is heterogeneous. The common electrolyte abnormality was hyponatremia 102 (43.7%), followed by hypokalemia 32(13.7%) in sick newborns and hyponatremia was significantly associated with mortality ($p=0.02$) and 23/59 (38.9%) and 19/43(44.1%) of death were contributed by preterm and full term respectively. This is similar to the results by Allaudin M et al [11], who found increase in death rate by 50% in case of hyponatremia. These findings correlate with Rao et al [12]. They found the risk of mortality is increased by 3-3.5 times in patients with hyponatremia compared to those with normal serum sodium levels. Hossain MM et al [13] found that the case fatality in hyponatremia is 59.6%. Prasad et al [14] also observed the same result. However, our study didn't find any significant difference in mean values of sodium and potassium among newborns with meconium aspiration syndrome that may be because of less number of newborns with MAS. The present study had some limitations as we could not measure loss of weight, osmolality in first week of life and study cohort heterogeneous. We concluded that sodium and potassium abnormalities were prevalent; hyponatremia significantly leads to death and post-natal adaption of electrolytes in first 72 hours of life in sick newborns is influenced by comorbidities, it could be early or late, needs further studies to established.

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