ORIGINAL ARTICLE

Doi: https://dx.doi.org/10.4314/joma.v7i1.2

PATTERN OF RENAL ANALYTES FOLLOWING RENAL FUNCTION ASSESSMENT OF INFANTS IN A TERTIARY HEALTH FACILITY IN SOUTHERN NIGERIA.

Kelechi U.[1] ,Vincent M. U. [2],Babatope O. A.[3] ,Ogarekpe Y. M.[3] ,Ekpe E. L. [3]

1. Department of Paediatrics, University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria
2. Department of Internal Medicine, University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria
3. Department of Chemical Pathology, University of Calabar Teaching Hospital, Calabar, Cross River State, Nigeria

ABSTRACT

BACKGROUND/ OBJECTIVES:
Electrolyte imbalance is a common finding in infants, and the story is so in the tropical countries, where most patients are usually victims of fluid losses from various etiologies. This study is aimed at assessing the profile and pattern of electrolytes imbalance and other parameters of renal function assessment among infants (0-12 months) in our environment.

METHODS/SUBJECTS:
This cross-sectional study was carried out over a 6-month period on infants who were admitted into University of Calabar Teaching Hospital (UCTH) and investigated for electrolyte, urea and creatine, after a hospital stay of ≥24 hours. Blood samples were taken from such patients, analyzed and values obtained were compared with the reference intervals to ascertain the level of deviation from the expected normal for age.

RESULTS:
The total number of children that participated on the study was 200, made up of 106(53.0%) males and 94(47.0%) females. The children were classified based on their different ages from 0 to 12 months. Children aged 0-1month made up the bulk of the study population (57.0%). Low level of bicarbonate occurred in 65.5% of all the children. Hyponatremia (37.7%) and Hyperkalemia (28.9%), occurred in 0 -1month age group. These derangements have been known to contribute negatively to the outcome of the admitted infant if not corrected. Most of the infants had normal values of the individual electrolytes.

CONCLUSION
In view of the fact that infants are more vulnerable to electrolyte imbalance, prevention of electrolyte imbalances is preferable to treatment.

KEYWORDS
electrolyte imbalance, bicarbonate, hypokalaemia,

INTRODUCTION

Serum electrolytes and other analytes for assessing renal function are useful in assessing the general metabolic processes and their imbalances in infants are not uncommon[1]. The kidney is the primary organ for retention and removal of electrolytes and body fluids. Fluid and electrolytes are lost majorly in the urine and to a less extent in the gastrointestinal tract and skin. Common electrolytes usually assayed in infants are sodium, potassium, calcium, magnesium and occasionally lithium[1]. Imbalance in any of the aforementioned analytes may have leave adverse effects on the affected patients. This may range from increased mortality and morbidity of affected patients, increased length of stay in the hospital, increased financial demand and expenses on the patient and increased overall health expense on the part of the government, among other psychological demands on the patient[2'3]. Globally, electrolyte imbalance is a common finding in infants, and the story is so even in tropical countries; where most patients

CORRESPONDING AUTHOR
DR KELECHI UHEGBU;
kelechi4u2001@gmail.com,
DEPARTMENT OF PAEDIATRICS,
FACULTY OF MEDICINE, UNIVERSITY OF CALABAR
08174859149, 09080952423.

are usually victims of fluid losses from various etiologies. An optimal balance of body electrolytes is critical to overall health and thereby maintaining homeostasis. Electrolytes aid in enhancing muscle functions, maintaining the acid- base status of the body and maintaining the fluid levels[4]. Also, increased health burden on the managing physician and health team is a great consequence of the aforementioned.

Globally, electrolyte imbalance is a common clinico-laboratory finding in infants and , this is so even in tropical countries, where most patients are not well informed about health-related matters, coupled with the high rate of poverty and poor medical facilities. Though electrolyte imbalance is more sensitive in infants than in adults, however infants can tolerate loss of fluids before electrolyte imbalances exist and infants are more vulnerable to electrolyte imbalance[4'5]. Studies on electrolyte metabolism and pattern in paediatric infants are not fully available in our environment. Based on this, this study is aimed at assessing the profile and pattern of imbalances in electrolytes and other analytes for assessing function among in infants (0-12 months) in our environment, with a view to preventing the possible causes related to these problems as prevention of electrolyte imbalances is preferable to treatment.

SUBJECTS/ MATERIALS AND METHODS

This cross-sectional study was done in conjunction with the Paediatrics and the Chemical pathology departments of the University of Calabar Teaching Hospital(UCTH). Ethical clearance was obtained from the UCTH Hospital Ethics and Research committee.

Over a 6-month period, infants who were admitted into UCTH and investigated for electrolyte, urea and creatine, after a hospital stay of ≥24 hours, were enrolled for the study. The patients were followed up from the time of admission to the period of discharge. Blood samples were taken from such patients for sodium, potassium, chloride, bicarbonate, urea and creatinine. All patients on electrolyte therapy were excluded from the study. Also, congenital electrolyte abnormalities were also excluded. All electrolyte values were obtained by an electrolyte auto analyzers (Labjeniks,Germany) and the results were obtained for each patient after collecting blood into the appropriate sample bottles which were spun and serum electrolytes were obtained. The reference intervals that were marked for each of the parameter assayed are given as Na (135-145mmol/L), K (3.5-5.5mmol/L), Hco3 (22-30mmol/l), Urea (2.5-6.7mmol/l), and creatinine (81.7-120mmol/l). Various values of electrolyte obtained were compared with the reference intervals to ascertain the level of deviation from the expected normal for age.

STATISTICAL ANALYSIS:

Statistical analysis were done using SPSS for windows version 18. Appropriate statistics were used to analyze the data. All variables were reported as mean value ± standard deviation for certain valuables. A value of $p<0.5$ was concluded to be statistically significant.

RESULTS

The total number of children that participated in the study was 200, made up of 106(53.0%) males and 94(47.0%)females. The children were classified based on their different ages and were all aged from 0 to 12 months. The frequencies are represented below (Table1). Children aged 0-1month made up of a bulk of the study population (57.0%)(Table 1). The pattern of electrolyte displayed showed that the common abnormality detected by the studied population was low level of bicarbonate accounting for 65.5% of all the children. This was manifested as metabolic acidosis in children aged 0-1month(Figure 1).It followed that low younger infants had more cases of acidosis (low bicarbonate) than older infants. Also, it was observed that, infants aged 0-1month of age, had the highest prevalence of hyponatremia (37.7%) (Figure 1). Pearson chi-square test was done to ascertain if the difference in electrolyte abnormalities within the age groups were statistically significant at $p\leq 0.05$ (p-value equal or less than 0.05). There were appreciable different levels of electrolyte abnormalities among the different age groups; however, the difference in urea abnormality was statistically significant using chi square test.

High urea levels was highest in the 0 – 1month age group (23.7%); followed by those in 2 - 6month age group with 11.8% prevalence, and then 7 – 12month age group with 9.6% showing a pattern of decreasing high level of urea with increasing age (Figure 2).However, low urea levels did not reveal any particular pattern, whereas the 2-6month age group showed the highest prevalence of 26.5%, while the 7 – 12month was 17.3%, and 0 – 1month reported 11.4% prevalence. Using Chi- Square test of significance, the difference was statistically significant at $p < 0.05$.

Hyponatremia is the highest sodium abnormality with prevalence of 37.7% and was found in the

0 -1month age group, this was followed by the 7 -12month age group with 28.8% hyponatremia and the 2 – 6month age group which recorded 26.5% prevalence of hyponatremia(Fig. 1).Hypernatremia was highest in the 7 – 12month age group with 9.6% prevalence, followed by 4.4% in age group 0 – 1month and then 2.9% in the 2 – 6month age group(Table 3).The difference was not statistically significant at p-value < = 0.05 using chi-square.

Figure 2 revealed a decreasing pattern of hyperkalemia from the youngest age group through to the older age group.The 0 – 1month reportedly had the highest prevalence of hyperkalamia (28.9%), followed by the 2 - 6month age group with 20.6% prevalence; and then the 7 – 12month age group with 7.7% prevalence. But hypokalemia did not follow similar pattern. Rather,the 2-6month age group showed highest prevalence of 11.8%, while 7 – 12month followed with 9.6%, and 0 – 1month reported the lowest prevalence of 6.1% (table 4).

Also, hyperchloremia prevalence was highest among the 7- 12month age group(23.7%);whereas the 0 – 1month age group had the least prevalence. Hypochloremia was highest in the 0 – 1month age group with 4.4% prevalence, followed by 1.9% in the 7 – 12month age group, while the 2 – 6month age group had no case of hypochloremia (0.0%). There was no statistical difference among the various age groups (p= 0.05)(see table 5).Furthermore, the results showed there was no high bicarbonate level among the patients (0% prevalence). For low bicarbonate abnormality, the 7 – 12month age group recorded the highest prevalence of 69.2%, followed closely by the 0 -1month age group with prevalence of 65.8%;and lastly 58.8% prevalence in the 2 – 6month age group(see table 6) .

Table 7 revealed high creatinine level of 10.5% in the 0 – 1month age group and 7.7% among the 7 – 12month age group, while the 2 – 6month age group recorded a prevalence of 2.9%.

For low creatinine abnormality, the 2 – 6 months age group had the highest prevalence of 20.6%, followed by age group 7 – 12month age group(13.5%) and then, 9.6% in the 0 – 1month age group. The difference is not statistically significant (p = 0.05).The highest prevalence of normal creatinine was seen in the age group 0 – 1 month, while age group 2 – 6 months recorded highest prevalence of normal sodium, chloride and bicarbonate with 7 – 12 months age group showing highest levels of prevalence of normal potassium and urea.

TABLE1. AGE AND SEX DISTRIBUTION OF PATIENTS

Sex	Frequency	Percent
MALE	106	53.0
FEMALE	94	47.0
Total	200	100.0
AGE (MONTHS)		
0 -1 MONTH	114	57.0
2 -6 MONTHS	34	17.0
7 - 12 MONTHS	52	26.0
Total	200	100.0

FIGURE 1: RELATIONSHIP OF AGE GROUPS WITH LOW ANALYTES LEVEL

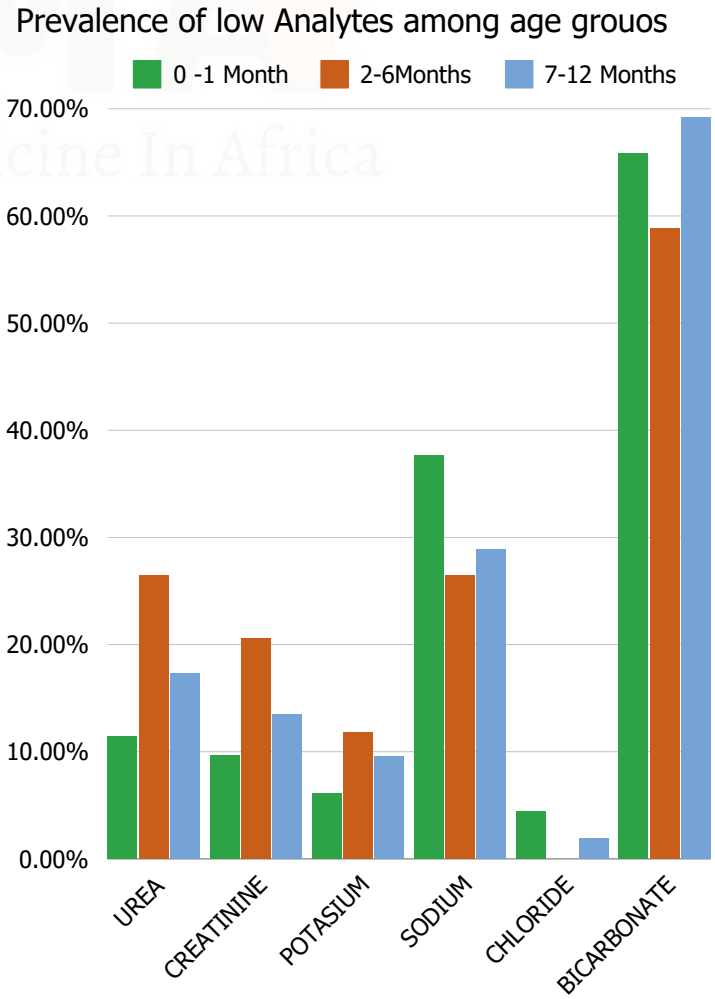

FIGURE 2: RELATIONSHIP OF AGE GROUPS WITH HIGH ANALYTES LEVEL

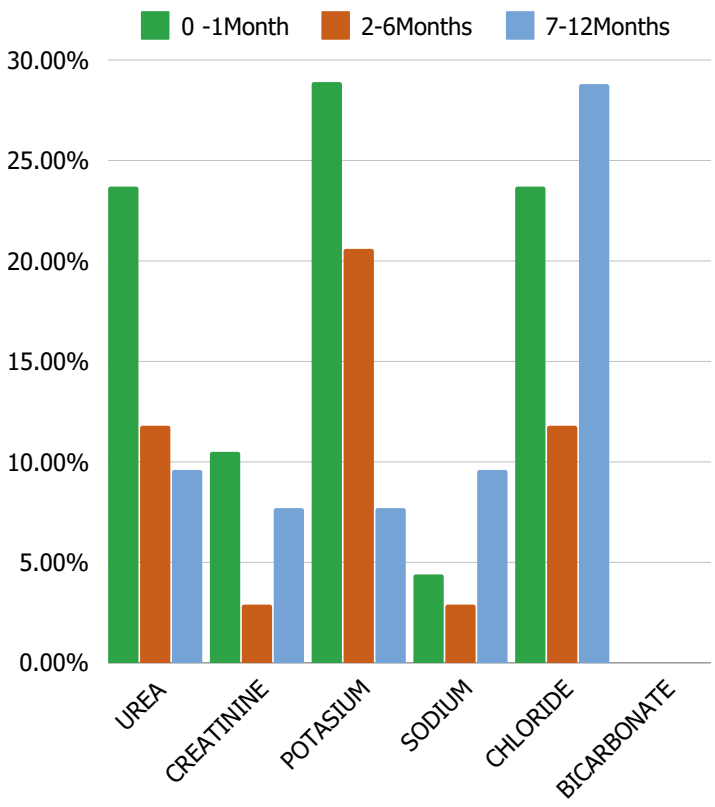

TABLE 2: RENAL ANALYTE VALUES IN THE STUDIED INFANTS

Value	Frequency	Percent
UREA		
LOW	31	15.5
NORMAL	133	66.5
HIGH	36	18.0
Total	200	100.0
SODIUM		
LOW	67	33.5
NORMAL	122	61.0
HIGH	11	5.5
Total	200	100.0
POTASSIUM		
LOW	16	8.0
NORMAL	140	70.0
HIGH	44	22.0
Total	200	100.0
CHLORIDE		
LOW	6	3.0
NORMAL	148	74.0
HIGH	46	23.0
Total	200	100.0
BICARBONATE		
LOW	131	65.5
NORMAL	69	34.5
HIGH	0	0
Total	200	100.0
CREATININE		
LOW	25	12.5
NORMAL	158	79.0
HIGH	17	8.5
Total	200	100.0

TABLE 3. RELATIONSHIP OF ABNORMAL SODIUM LEVEL WITH AGE GROUPS

	Low SODIUM	Normal SODIUM	High SODIUM	TOTAL
AGE				
0-1 month (n=114)	43 (37.7%)	66 (57.9%)	5 (4.4%)	114 (100%)
2-6 month (n= 34)	9 (26.5%)	24 (70.6%)	1 (2.9%)	34 (100%)
7-12 month (n=52)	15 (28.8%)	32 (61.5%)	5 (9.6%)	52 (100%)
TOTAL	67 (33.5%)	122 (61.0%)	11 (5.5%)	200 (100%)

TABLE 4. RELATIONSHIP OF ABNORMAL POTASSIUM LEVEL WITH AGE GROUPS

	Low POTASSIUM	Normal POTASSIUM	High POTASSIUM	TOTAL
AGE				
0-1 month (n=114)	7 (6.1%)	74 (64.9%)	33 (28.9%)	114 (100%)
2-6 month (n= 34)	4 (11.8%)	23 (67.6%)	7 (20.6%)	34 (100%)
7-12 month (n=52)	5 (9.6%)	43 (82.7%)	4 (7.7%)	52 (100%)
TOTAL	16 (8.0%)	140 (70.0%)	44 (22.0%)	200 (100%)

TABLE 5. RELATIONSHIP OF ABNORMAL CHLORIDE LEVEL WITH AGE GROUPS

	Low CHLORIDE	Normal CHLORIDE	High CHLORIDE	TOTAL
AGE				
0-1 month (n=114)	5 (4.4%)	82 (71.9%)	27 (23.7%)	114 (100.0%)
2-6 month (n= 34)	0 (0.0%)	30 (88.2%)	4 (11.8%)	34 (100.0%)
7-12 month (n=52)	1(1.9%)	36 (69.2%)	15 (28.8%)	52 (100.0%)
TOTAL	6 (3.0%)	148 (74.0%)	46 (23.0%)	200 (100.0%)

TABLE 6. RELATIONSHIP OF ABNORMAL BICARBONATE LEVEL WITH AGE GROUP

	Low BICARBONATE	Normal BICARBONATE	High BICARBONATE	TOTAL
AGE				
0-1 month (n=114)	75 (65.8%)	39 (34.2%)	0 (0.0%)	114 (100.0%)
2-6 month (n= 34)	20 (58.8%)	14 (41.2%)	0 (0.0%)	34 (100.0%)
7-12 month (n=52)	36 (69.2%)	16 (30.8%)	0 (0.0%)	52 (100.0%)
TOTAL	131 (65.5%)	69 (34.5%)	0 (0.0%)	200 (100.0%)

TABLE 7. RELATIONSHIP OF ABNORMAL CREATININE LEVEL WITH AGE GROUPS

	Low CREATININE	Normal CREATININE	High CREATININE	TOTAL
AGE				
0-1 month (n=114)	11 (9.6%)	91 (79.8%)	12 (10.5%)	114 (100.0%)
2-6 month (n= 34)	7 (20.6%)	26 (76.5%)	1 (2.9%)	34 (100.0%)
7-12 month (n=52)	7 (13.5%)	41 (78.8%)	4 (7.7%)	52 (100.0%)
TOTAL	25 (12.5%)	158 (79.0%)	17 (8.5%)	200 (100.0%)

DISCUSSION

This study evaluated the frequency and characteristics of electrolytes and other renal function parameters in children aged 0-12months. Children aged 0-1month which is the neonatal age group, made up the bulk of the study population (55.9%) admitted into the tertiary facility. This is in keeping with the fact that children within this age range are more susceptible to infection, thus leading to increased hospital visits[5]. Balalaji et al corroborated this in their study where children less than one year had higher prevalence of electrolyte derangement when compared with other age groups[6]. Notably, most of the study population had normal range electrolyte pattern as well as other renal function parameters. This may be attributable to the fact that most of the study population was not severely ill as at the time of sample collection and none was nursed in the intensive care unit. Some studies have shown that most ill infants requiring intensive care usually have deranged electrolyte patterns[5'6'7].

Generally, renal function is altered in neonates when compared with adults on account that the kidneys of the newborn are functionally immature and still developing[8'9]. Most of the study population had metabolic acidosis of which children aged 7-12 months had the highest frequency. The second commonest electrolyte abnormality seen was hyponatraemia as reported in other studies[10'11]. Hyponatremia is globally seen as the commonest electrolyte abnormality seen in hospitalized patients. In this study, when comparing the age range and frequency, hyponatremia was highest in the 7-12 month age group. This emphasizes the need for critical fluid management in the children while on admission[12]. The difference in the frequency of both analytes abnormalities was statistically significant. This is different from the study by Elala et al in Ethiopia, where the predominant electrolyte derangement was hyponatraemia followed by hypokalaemia5. Okposio et al in their study in Benin City also differed as hyponatreamia was the most prevalent parameter of renal function assessment but this was specific for acute watery diarrhoea[7]. Some researchers are of the opinion that electrolyte abnormalities in newborns could be a reflection of the mother's electrolyte state which is reflected in the breastmilk[12]. The pH and electrolyte pattern in the mother's breastmilk tend to vary from the neonatal period and throughout infancy. This may suggest the reason for the electrolyte abnormalities seen in the 2-6 months age group when compared with other age groups; though emphasis on breastfeeding was not noted in this study. Also, electrolyte abnormalities such as acidosis could be some basic health challenges at this age range such as infection, jaundice, or it may even be a reflection of the diet, especially when certain complementary feeds are introduced[13]. In this study, acidosis was seen in the 7-12months age group which is the age when complementary feeds are started. Despite the above, the clinical status of the study group may have been a strong contributor to the pattern of abnormalities in electrolyte and other parameters of renal function seen in this study.

CONCLUSION

Most of the infants had normal values of the individual electrolytes and other analytes. The commonest abnormality in the profile was metabolic acidosis followed by hyponatreamia. These derangements have been known to contribute negatively to the outcome of the admitted infant, if not corrected[14]. Therefore the emphasis on prompt recognition and treatment of these electrolyte derangements is fundamental to newborn patients' management.

REFERENCES

1. Verbalis JG, Goldsmith S.R, Greenberg A.,Schrier RW, Sterns RH. Diagnosis, evaluation, and treatment of hyponatremia. expert panel recommendation. The American Journal of Medicine 2013;12: 10A
2. Espay AJ: Neurologic complications of electrolyte disturbances and acid –base balance. In: Handbook of Clinical Neurology.2014;(114): 365-382.
3. Kraft M, Btaiche IF, Sacks G S, Kudsk KA, Treatment of electrolyte disorders in adult patients in the intensive care unit. American Journal of Health-System Pharmacy. 2005; 62:1663-1682.
4. Bengus A, Babiuc RD. Hyponatremia – predictor of adverse prognosis in Cirrhosis. J Med Life 2012. Jan 12,5(2): 176-178.
5. Elala J, Shimelis D. Pattern of electrolyte abnormality in children 0-15years of age admitted to pediatric emergency and intensive care unit of a tertiary hospital. IOSR Journal of Dental and Medical Science 2018. 17(2):12-16.

6. Balaji J, Ekambaranath S. Clinical profile, etiology, management, and outcome of electrolyte disturbance in children admitted in PICU. Int J of Res in Med Sc. 2017; 5(6):2546.
7. Okposio MM, Onyiriuka NA, Abhulimen-Iyoha IB. Point of admission serum electrolyte profile of children less than five years old with dehydration due to acute diarrhea. Trop Med Health 2015; 43 (4):247-252
8. Morley J.E. Dehydration, hypernatremia and hyponatremia. Clinics in Geriatric Medicine 2015; Aug 31(3): 389-99.
9. Artherton J.C. Regulation of fluid and electrolyte balance by the kidney. Anaesthesia and Intensive Care Medicine 2006; 7(7):227-233
10. Harley J.K. Symptomatic Hyponatremia in Nephrotic syndrome. Am J Dis Child 1980; (34(2):214-206.
11. Sahay M, Sahay R, Hyponatremia A practical approach . Indian Journal of Endoc Metab 2014, 18(6): 760-771.
12. Yelamali B.C. Study Of Mortality In Children With Electrolyte Abnormalities In Pediatric Intensive Care Unit. Global Journal for Research Analysis.2020; 9 (10):2277-8160
13. Powers, K.S. Dehydration:Isonatremic, hyponatremic, and hypernatremic recognition and management. American Academy of Pediatrics- Pediatrics in Review July (2015): 36(7):274-285.
14. Balaiche P, Madnani S., Kamat S.Clinical profile of patients admitted with hyponatremia in the medical intensive care unit. Indian J. Crit Care Med 2017;21(12):819-824.
15. Adrogue H.J. Consequences of Inadequate management of hyponatremia. American Journal of Nephrololgy 2005,25:240-249.

CONFLICT OF INTEREST
None