How to Cite:
Kumari, S., Himanshu, A., Rani, P., & Kumar, R. (2022). A prospective study of analysis of electrolytes in pediatric patients admitted in ICU. *International Journal of Health Sciences*, *6*(S7), 2370–2376. https://doi.org/10.53730/ijhs.v6nS7.11863

A prospective study of analysis of electrolytes in pediatric patients admitted in ICU

Sanni Kumari
Senior Resident, Department of Biochemistry, ESIC Medical College, Bihta, Patna

Alok Himanshu
Senior resident, Department of Biochemistry, Darbhanga Medical College laheriasarai, Darbhanga, Bihar

Priti Rani
Senior Resident, Department of Biochemistry, All India Institute of Medical Sciences (AIIMS), Patna

Rishu Kumar*
Senior Resident, Department of Pharmacology, Nalanda Medical College, Patna
Corresponding Author email: dr.rishu.kumar@gmail.com

***Abstract*---**Introduction: Medical practice rests on the foundation of science. Clinicians are constantly making practical decisions and dealing with situations that demand quick and efficient solutions. The extra ordinary complex functions of the human being depend on the narrow range of the volume and composition of body fluids and electrolytes. These electrolytes run the life with help of meticulously regulated control mechanisms that strictly maintain their levels both extracellularly and intracellularly.[1] Materials and methods: This prospective study was conducted over a period of one year and included critically ill children aged 1 month to 12 years admitted to a paediatric tertiary care hospital. Informed consent was obtained from the parents of all the children enrolled in the study. At admission, detailed history was taken and systemic examination was recorded. Venous blood samples were obtained and serum electrolytes were estimated by using Combi line Ion-Selective Electrode (ISE). An Ion-Selective Electrode (ISE), also known as a specific ion electrode (SIE), is a transducer (or sensor) that converts the activity of a specific ion dissolved in a solution into an electrical potential, which can be measured by a voltmeter or pH meter. Results: A total of 220 cases were admitted during the study period, out of which 118 cases did not meet the inclusion criteria, thereby leaving 202 cases for the study. Of the 202 children studied, 122 (60.4%) were boys and 80 (39.6%) girls. Majority (56.4%) was in the age group of 1 month - 4

years, 23.8% of the children were between 5-8 years of age and the remaining 19.8% were between 9-12 years of age. Mean age of the study population was 4.36 ± 4.10 years. Conclusion: The electrolyte balance plays a key role in the treatment of critically ill patients. Also the presence & accurate measurement of the electrolyte imbalance at the time of admission in critically ill children irrespective of the primary disease process is an important prognostic indicator in PICU patients where greater attention and proper analysis of electrolytes is recommended.

***Keywords*---**electrolytes, PICU, Ion-Selective Electrode, pH meter.

Introduction

Medical practice rests on the foundation of science. Clinicians are constantly making practical decisions and dealing with situations that demand quick and efficient solutions. The extra ordinary complex functions of the human being depend on the narrow range of the volume and composition of body fluids and electrolytes. These electrolytes run the life with help of meticulously regulated control mechanisms that strictly maintain their levels both extracellularly and intracellularly.[1] There exists a dynamic equilibrium between inflow of water, inorganic substances (i.e., electrolytes) and organic molecules; their distribution between body water compartments and the near-equal outflow of these substances. In an intensive care setting the management of various electrolyte imbalances forms a vital part in life supportive care, more so in paediatric age group.[2] Dyselectrolytemias are commonly encountered in PICU. They do not always manifest specific symptoms but often share the clinical features of underlying illnesses necessitating high index of suspicion. They can be either a primary or secondary comorbid condition.

In dehydration the colour of the urine appears darker than usual. Sometimes electrolyte imbalance results in confusion, weakness and muscle spasms. At times symptoms like difficulty in breathing, dizziness and increased heart rate is also observed in children with dehydration.[2] If Parents or caretakers notice any of these symptoms, especially if a child has an underlying medical condition or a fever, should immediately rush the child to PICU unit to get evaluated by the Critical care experts. Early diagnosis and instant treatment are extremely important in these conditions. Severe fluid loss with electrolyte disturbance reduces the blood and mineral flow to vital organs including the brain, heart and liver. In some instances, this can make brain tissue swell or shrink, causing seizures, or life threatening disturbances in heart rhythm, known as arrhythmia. Hence electrolyte balance plays key role in maintaining 'homeostasis' along with other body fluids in critically ill paediatric patients in PICU unit of the hospital. The higher and lower value of critical electrolytes like sodium, potassium and chloride can affect cellular processes drastically as it may result in cardiac and neurological complications altering the patient`s status in terms of morbidity and mortality. Electrolyte imbalance significantly affects the quality of life of the patient.[4]

Drugs such as K+-losing diuretics are a frequent cause of mild hypokalaemia. Generally, patients are asymptomatic, although complaints of muscle spasms or cramps are common.[5] Other drugs responsible for hypokalaemia, especially in the intensive care setting include Asthalin nebulisations, glucocorticoids, chemotherapeutic agents and laxatives. Renal failure, adrenal insufficiency, insulin deficiency and tissue damage from rhabdomyolysis, burns or trauma are predisposing factors for hyperkalaemia in critically ill patients.

Materials and Methods

Study design: A prospective study.

Study location: Department of Biochemistry, ESIC Medical College, Bihta, Patna.

Study duration: January 2021 to December 2021 (1 year).

This prospective study was conducted over a period of one year and included critically ill children aged 1 month to 12 years admitted to a paediatric tertiary care hospital. Informed consent was obtained from the parents of all the children enrolled in the study.

Inclusion Criteria:

Children of age group 1 month to 12 years, admitted in the PICU with severe clinical condition requiring intensive care, satisfying the criteria based on the Consensus Guidelines for PICUs in India, Indian Society of Critical Care Medicine (Paediatric Section) and Indian Academy of Paediatrics (Intensive Care Chapter).

Exclusion Criteria:

1. PICU stay of less than 24 hours.
2. Infants < 1 month old.
3. Children transferred in from other service/civil hospital.
4. Children with already diagnosed electrolyte disturbances, e.g. Bartter syndrome.

At admission, detailed history was taken and systemic examination was recorded. Venous blood samples were obtained and serum electrolytes were estimated by using Combi line Ion-Selective Electrode (ISE). An Ion-Selective Electrode (ISE), also known as a specific ion electrode (SIE), is a transducer (or sensor) that converts the activity of a specific ion dissolved in a solution into an electrical potential, which can be measured by a voltmeter or pH meter. If an electrolyte abnormality was diagnosed during ICU stay, complete blood count, random blood sugar, urea, creatinine, urine electrolytes, Arterial Blood Gas analysis (ABG), plasma osmolality and fractional excretion of sodium (FENa) were done. If required special investigations such as USG, x-ray, CT, MRI and other relevant investigations as required for diagnosis and treatment of patient were done.

Hyponatraemia in our study was defined as serum sodium < 135 mEq/L, hypernatraemia as > 155 mEq/L, hypokalaemia as < 3.5 mEq/L and hyperkalaemia as > 5.5 mEq/L.

Statistical Analysis: Data was analysed using Statistical Package for Social Sciences version 19.0. The values were represented in Number (n) and Mean +/- SD. The following statistical values were employed: Mean, Standard deviation, Chi-square tests (x2) and level of significance (p).

Results

A total of 220 cases were admitted during the study period, out of which 118 cases did not meet the inclusion criteria, thereby leaving 202 cases for the study.

Of the 202 children studied, 122 (60.4%) were boys and 80 (39.6%) girls. Majority (56.4%) was in the age group of 1 month - 4 years, 23.8% of the children were between 5-8 years of age and the remaining 19.8% were between 9-12 years of age. Mean age of the study population was 4.36 ± 4.10 years.

Electrolyte abnormality	**Incidence N (%)**	**Age distribution N (%)**			**Sex distribution N (%)**	
		1m-4 y	**5-8y**	**9-12y**	**Boys**	**Girls**
Hyponatraemia	34(16.8)	14(41.2)	6(17.6)	14(41.2)	22(64.7)	12(35.3)
Hypernatraemia	8(4)	6(75)	2(25)	0	6(75)	2(25)
Hypokalaemia	24(11.9)	10(41.7)	6(25)	8(33.3)	12(50)	12(50)
Hyperkalaemia	4(2)	2(50)	0	2(50)	2(50)	2(50)
P		**0.16**	**0.6**	**0.23**	**0.756**	**0.69**

Table 1: Demographic Characteristics and Incidence of Electrolyte Disturbances

	Hyponatraemia (n = 34)	**Hypernatraemia (n = 8)**	**Hypokalaemia (n = 24)**	**Hyperkalaemia (n = 4)**
	N (%)	**N (%)**	**N (%)**	**N (%)**
Respiratory disorders	2(5.9)	0	0	0
Sepsis	4(11.8)	0	2(8.3)	0
GI Disorders	6(17.6)	0	4(16.7)	2(50)
Renal disease	0	0	2(8.3)	0
CVS	2(5.9)	0	0	0
CNS	18(52.9)	8(100)	14(58.3)	2(50)
Haematology	0	0	0	0
Miscellaneous	2(5.9)	0	2(8.3)	0
Total	34 (100)	8(100)	24(100)	4(100)
P Value	0.230		0.70	

Table 2: Spectrum of Illness in Electrolyte Disturbances

Electrolyte Abnormality	1-5 days		6-10 days		>10 days		P value
	N	%	N	%	N	%	
Hyponatraemia (n = 34)	18	52.9	10	29.4	6	17.6	
Hypernatraemia (n = 8)	2	25	0	0	6	75	0.002
Hypokalaemia (n = 24)	14	56.3	4	16.7	6	25	
Hyperkalaemia (n =4)	2	50	0	0	2	50	0.22

Table 3: Length of Stay in Electrolyte Disturbances

Electrolyte Abnormality	Inotrope Usage (n = 22)		Mechanical Ventilation (n = 18)		Mortality (n = 14)	
	N	%	N	%	N	%
Hyponatraemia (n = 34)	10	29.4%	8	23.5	4	11.8
Hypernatraemia (n = 8)	0	0	0	0	0	0
Hypokalaemia (n = 24)	4	16.7	4	16.7	2	8.3
Hyperkalaemia (n = 4)	0	0	0	0	0	0

Table 4: Inotrope, Mechanical Ventilation and Mortality in Electrolyte Disturbances

The overall incidence of hyponatraemia in our study was observed as 16.80% (n=34), hypernatraemia was 4% (n = 8), hypokalaemia was 11.9% (n = 24) and hyperkalaemia was 2% (n = 4) respectively.

Mortality was 1.9 times higher in children with hyponatraemia and 1.2 times higher in children with hypokalaemia compared to normal serum levels. Mortality was significantly higher among the ventilated group (77.7%) as compared to the non-ventilated study population (0%).

Discussion

Electrolyte abnormalities were observed in 34.6% of the children getting admitted to PICU. Hyponatraemia was the commonest accounting for 16.8%. This is in contrast to incidence observed by Singhi et al at 29.8% and Subba Rao et al 9.5%, variation could be due to varied disease characteristics. Hypernatraemia in present study was noted in 4% of the critically ill children. This finding is in consistent with the studies by Michael D. Waite et al, Richard Conway et al and Singhi et al who observed hypokalaemia in 4.9% and 5.4% respectively, which were nearly comparable with our results.[6]

There was no statistical significance between sex predilection of the study population and the incidence of hypo and hypernatraemia. Stelfox et al and O'Donoghue et al reported hypernatraemia in 40% females and 60% males consistent with our results. The higher male preponderance in our study can be attributed to the higher male study population. Hypokalaemia and hyperkalaemia were reported at equal incidence in boys and girls.[7]

The observations in present study were consistent with the prospective study by Subba Rao et al, wherein CNS cause accounted for 41.6% of the hyponatraemic admissions. Sitaraman S et al found meningitis/encephalitis as single most important cause of hyponatraemia accounting for 20.54% of cases. Different causes reported by Singhi et al in their study were pneumonia (20%), acute gastroenteritis (20%), meningoencephalitis (12%), sepsis (8%), renal, CVS and liver causes (6.7%).[8]

The overall mortality rate in our study population was 7%. Subba Rao et al in their study observed that the risk of mortality is increased by 3 - 3.5 times in patients with hyponatraemia, when compared to those with normal sodium levels.[9] Hyponatraemia had been associated with poor prognosis regardless of the clinical cause in the present study.[10]

This emphasises the need for early detection and institution of rational therapy for hyponatraemia. In hypokalaemic group, mortality was estimated to be 1.2 times higher than normokalaemia consistent with results by Richard Conway et al, Singhi et al and Subba Rao et al noted 27.7% mortality in hypokalaemic children.

Conclusion

The electrolyte balance plays a key role in the treatment of critically ill patients. Also the presence & accurate measurement of the electrolyte imbalance at the time of admission in critically ill children irrespective of the primary disease process is an important prognostic indicator in PICU patients where greater attention and proper analysis of electrolytes is recommended. Disturbances in the serum sodium and potassium levels during the ICU stay predicted an increased length of hospital stay. Early detection through regular monitoring and early correction may help in improving the outcome.

References

1. Agarwal N, Rao YK, Saxena R, et al. Profile of serum electrolytes in critically ill children: a prospective study. Indian J Child Health 2018;5(2):128-132.
2. Bhadoria P, Bhagwat AG. Severity scoring systems in paediatric intensive care units. Indian Journal of Anaesthesia 2008;52(Suppl 5):663-675.
3. Cummings BM, Macklin EA, Yager PH, et al. Potassium abnormalities in a pediatric intensive care unit: frequency and severity. J Intensive Care Med 2014;29(5):269-274.
4. Darmon M, Timsit JF, Francais A, et al. Association between hypernatraemia acquired in the ICU and mortality: a cohort study. Nephrol Dial Transplant 2010;25(8):2510-2315.

5. Hauser GJ, Kulick AF. Electrolyte disorders in the PICU. In: Wheeler DS, Wong HR, Shanley TP, eds. Pediatric critical care medicine. London: Springer-Verlag 2014:147-161.
6. Laville M, Burst V, Peri A, et al. Hyponatremia secondary to the syndrome of inappropriate secretion of antidiuretic hormone (SIADH): therapeutic decisionmaking in real-life cases. Clin Kidney J 2013;6(Suppl 1):i1-i20.
7. Panda I, Save S. Study of association of mortality with electrolyte abnormalities in children admitted in pediatric intensive care unit. International Journal of Contemporary Pediatrics 2018;5(3):1097-1103.
8. Reddy AP, Thapar CRK, Gupta RK. Electrolyte disturbances in critically ill children admitted to pediatric tertiary care centre. J Evol Med Dent Sci 2017;6(41):3269-3273.
9. Rukesh CC, Shalini B. Correlation between serum electrolytes and clinical outcome in children admitted to PICU. IOSR J Dent Med Sci 2017;16(11):24-27.
10. Sadeghi-Bojd S, Noori NM, Damani E, et al. Electrolyte disturbances in PICU: a cross sectional study. Nephro Urol 2019;11(2):e87925.
11. Singhi S, Jayashre M. Free water excess is not the main cause for hyponatremia in critically ill children receiving conventional maintenance fluids. Indian Pediatr 2009;46(7):577-583.
12. Suryasa, I. W., Rodríguez-Gámez, M., & Koldoris, T. (2021). Get vaccinated when it is your turn and follow the local guidelines. *International Journal of Health Sciences*, *5*(3), x-xv. https://doi.org/10.53730/ijhs.v5n3.2938