

Clinical Profile and Outcome of Children with Serum Electrolyte Abnormalities in Pediatric Intensive Care Unit.

1) V.Adithya Kiran 2) Dr.Richa Chaudhary

Designation of each author-

- 1) Junior Resident, Department Of Paediatrics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences (DMIMS), Sawangi (Meghe), Wardha, India
adithya6994@gmail.com, 9652979830
- 2) Associate Professor, Department Of Paediatrics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences (DMIMS), Sawangi (Meghe), Wardha, India
Indiaricha6101@gmail.com, 8390873476

Corresponding author's name and address:

V.ADITHYA KIRAN

Yashoda boys' Hostel, Room S2, Sawangi, Wardha 442001

Corresponding author's email id: adithya6994@gmail.com

Contact no. of the corresponding author: 9652979830

Type of Article- **Study Protocol**

Conflict of Interest: **None**

Funding: Nil

Abstract:

Background: In critically ill pediatric patients electrolyte abnormalities are amongst the most common problems increasing morbidity and mortality in these children. They are particularly at risk of developing electrolyte abnormalities due to their critical health status, administration of fluid and electrolytes, various medications and also due to certain interventions like positive pressure ventilation. The timely and appropriate management of various electrolyte abnormalities form a vital part in the management of critically ill patients particularly pediatric age group. This study has been undertaken to find out the prevalence of electrolyte abnormalities in PICU and to determine the association of electrolyte abnormalities with the overall outcome of the critically ill children.

Objectives: To study the Clinical profile and outcome of patients with serum electrolyte abnormalities admitted in PICU.

Methodology: This is a hospital based prospective observational study which will be conducted in Acharya Vinoba Bhave Rural Hospital (AVBRH) over a period of 18 months. All the children admitted in PICU during the study period meeting the inclusion criteria will be included in the study. The venous sample obtained will be sent for electrolyte assessment and other relevant investigations. Patient history, examination, serum electrolyte values, PICU course, treatment given, final outcome will be documented in the pre-designed proforma. The data thus obtained will be analyzed at a single point of time.

Results: We expect the overall morbidity and mortality to be more in patients with electrolyte abnormalities as compared with those without electrolyte abnormalities.

Conclusion: Routine monitoring of serum electrolyte levels and looking for abnormal levels in goal directed therapy may improve clinical outcome.

Keywords: Serum electrolytes, outcome, PICU

INTRODUCTION

Electrolyte disturbances are very common in Intensive care units (ICU) and often remain unrecognized which may lead to poor overall outcome of these patients. The timely and appropriate management of various electrolyte abnormalities form a vital part in the management of critically ill patients particularly in pediatric age group. The simple interventions like paying attention to the patient's drugs, intravenous fluids and nutrition can prevent electrolyte disturbances most of the times.

Normal Serum sodium value is between 135-145 meq/l. Dysnatremia in form of either hypo or hypernatremia is one of the most common problem in critically ill pediatric patients. It has been observed that the most common electrolyte abnormality in critically ill children is hyponatremia (serum sodium level < 135 meq/l). (1) Children in PICU mostly need fluid therapy and administration of hypotonic fluid may led to development of acute hyponatremia posing immediate danger to Central Nervous System and incidence of hyponatremia in PICU may be as high as 30%. (2)

Hypernatremia (>145 meq/l) is seen less frequently as compared to hyponatremia and is mostly iatrogenic with incidence of around 6% but with increased risk of mortality in those who are critically ill (3,4). Severe hypernatremia (>155 meq/l) is often associated with significant neurological damage in critically ill PICU patients. Dysnatremia on admission or during ICU stay has been identified as an independent risk factor for poor outcome. (3,5)

Serum concentration of potassium normally ranges between 3.5-5 meq/l. Hypokalemia is defined as serum concentration below 3.5 meq/l and its prevalence is around 15% in PICU. (6,7) Hyperkalemia (serum potassium level > 5.5 meq/l) occurs in 3.3% of all hospitalized patients and is associated with high mortality rate. (7) Hypokalemia can result in severe complications in children like cardiac arrhythmias and respiratory failure. Other symptoms of hypokalemia include paralysis, weakness, constipation and rhabdomyolysis. (8) On the other hand severe muscle weakness, paralysis and more importantly cardiac conduction abnormalities are associated with hyperkalemia resulting in adverse outcome in PICU. (9)

Electrolyte abnormalities are associated with poor overall outcome in pediatric patients and these can be prevented by keeping a record of patient's intravenous fluids, drugs and procedures, monitoring the electrolytes regularly and planning appropriate and timely interventions. Various adult studies showed that electrolyte abnormalities in critically ill patients are associated with the poor overall outcome but the data is still less in pediatric age group and thus the present study has been undertaken to look into the various reasons for the

development of electrolyte disturbances in critically ill pediatric patients and to study the association of electrolyte abnormalities (both sodium and potassium) with morbidity and mortality in these children.

OBJECTIVES

1. To study the prevalence of electrolyte abnormalities in PICU.
2. To study the Clinical profile of patients with serum electrolyte abnormalities admitted in PICU.
3. To study the association of electrolyte abnormalities with morbidity and mortality in children admitted in PICU.

METHODS

Study design: Prospective observational study

Setting: This study will be conducted in PICU, Department of pediatrics, in Jawaharlal Nehru Medical College and AVBRH hospital, Sawangi, Wardha from October 2020 to November 2022

Participants:

Inclusion criteria:

All children above the age of 30 days who would be admitted to PICU

Exclusion criteria:

1. Refusal to give consent.
2. Children already on drugs having an effect on electrolyte metabolism.
3. Children with known renal diseases.

Variables: Serum electrolyte levels

Study size: Sample Size has been calculated as 272, by considering population size (N)-1000, hypothesized % frequency of outcome factor in the population (p): $45\% \pm 5$, confidence limits as % of 100 (absolute \pm %) (d): 5%, design effect (for cluster surveys-DEFF): 1, confidence limit (%) :95%.

Quantitative variables: All children admitted in PICU will be looked for abnormal electrolyte levels.

Statistical methods: Data once collected will be entered in Microsoft excel sheet. For analysis of the obtained data STATA software will be used. For representation of Quantitative variable mean and SD will be used while Qualitative data will be represented by frequency and percentage and Chi square test will be used for analysis. P value less than 0.05 will be considered significant.

EXPECTED RESULTS

We will enroll all the children admitted in the PICU who meet the inclusion criteria during the study period. Out of these children those whose parents will not give consent, children with known renal diseases, patients on certain drugs will be excluded. The final group of participants will be followed up during their entire PICU stay for the development of electrolyte abnormalities. Data obtained will be entered in the pre-designed proforma. The results obtained will be defined under demographic profile and main results. The

demographic profile will be defined under age, gender and main organ system involved. We will find out the age and sex wise distribution of various electrolyte abnormalities and also the distribution of various electrolyte abnormalities according to the main organ system involved. The main results will include various electrolyte abnormalities represented in percentage. The patients will be grouped according to serum sodium levels as having hyponatremia, hypernatremia and eunatremia. The various factors like intravenous fluids, drugs and interventions will be compared in the three groups to find out whether there is any significant association between these and dysnatremia. Similarly patients will be grouped as having hypokalemia, hyperkalemia or with normal serum potassium values and their association will also be studied with various risk factors associated with development of potassium abnormalities. We will further study the association of various electrolyte abnormalities with morbidity (as determined by number of days in ICU and requirement of various interventions) and mortality in critically ill patients and whether it is statistically significant (p value < 0.05). We expect the overall morbidity and mortality to be more in patients with electrolyte abnormalities as compared with those without electrolyte abnormalities.

DISCUSSION

Electrolyte abnormalities when present are associated with poor overall outcome in pediatric patients and should be anticipated and prevented to ameliorate the overall outcome of critically ill pediatric patients. In our study we will find out the prevalence of various electrolyte abnormalities in PICU and also we will study the various factors associated with development of electrolyte abnormalities. The study will find out the percentage of children with and without electrolyte abnormalities and whether these are associated with increased morbidity and mortality in critically ill pediatric patients and is the difference statistically significant. In a similar study by Jayakumar B. et. al. 227 children were studied, out of which 85 children had sodium disturbances including both hyponatremia (80 children) and hypernatremia (5 children). Hyponatremia was more frequent in the PICU patients and was observed in 35.2% of the patients. The commonest cause for hyponatremia was cerebral salt wasting and Syndrome of Inappropriate ADH secretion (SIADH). They also observed that the morbidity (as determined by the PICU stay) was significantly higher in patients with hyponatremia. Also the risk of mortality increased by 3-3.5 times in patients with hyponatremia when compared to those with normal serum sodium. (10)

In a study by Panda et. al 729 children admitted in PICU were studied for electrolyte abnormalities and prevalence was 44.31%. Hyponatremia (27.43%) was the most common electrolyte abnormality. The mortality in children with electrolyte abnormality was found to be 28.8% which was significantly higher than mortality in those without electrolyte abnormality. They found that most children with hyponatremia had central nervous system involvement (48.5%) and those with hypernatremia had gastrointestinal involvement (65.4%) It was observed that Hypokalemia was most frequent in patients with gastrointestinal involvement (54.9%) and hyperkalemia was common in patients with renal involvement (34.8%) (P value < 0.001). (8)

RaoSubba et al studied 305 children admitted in PICU for electrolyte abnormalities and 99 (32.45%) developed electrolyte abnormalities. It was observed that 7.9% of the patients had multiple electrolyte abnormalities, 14.4% had hyperkalemia and 3.6% cases had hypokalemia. Hyponatremia was observed in 9.5% of the patients and 4.9% had hypernatremia. ECG changes were seen in 11 patients (potassium >6.5 meq/l). 29 patients had hyponatremia, Out of these 19 (65.5%) were euvolemic, 8 (27.6%) were hypovolemic and 2 (6.9%) were hypervolemic. It was observed that morbidity (prolonged hospital stay) and mortality was significantly ($p < 0.01$) higher in patients with electrolyte abnormalities as compared to those without these disturbances. (11) In a study by Haider M. et. al. out of 150 patients studied, electrolyte abnormalities were present in 86 children (57.3%). It was observed that mortality was significantly higher (53.5%) in patients with electrolyte abnormalities as compared with those without electrolyte abnormalities. Hypernatremia was found in 48 (32%), hyponatremia in 24 (16%), hyperkalemia in 21 (14%) and hypokalemia in 42 (28%) patients. (12)

Studies have shown that the electrolyte abnormalities are associated with increased mortality as observed by Bojd S. et. al. They studied hyponatremia and hypernatremia in PICU and found that hyponatremia (29.3% vs. 13.1%) and hypernatremia (18.3% vs. 15.9%) in children who had died were significantly higher than in alive children. ($P = 0.013$). The frequency of electrolyte abnormalities in children was not considerably different between diseases. (13)

In the present study we will find out the electrolyte disturbances in various diseases. In a study by Edagotti G. et. al. 248 children were studied for hyponatremia in PICU patients. Of the 248 patients 54 (21.77%) were hyponatremic and 26 (10.48%) were hypernatremic. They studied sodium disturbances in various diseases and it was observed that incidence of hyponatremia was highest in patients with meningitis (58.82%). (14)

The knowledge of various factors causing electrolyte abnormalities in PICU will help the person taking care of these patients to plan the appropriate treatment and prevent the development of these abnormalities. In a study by Sachdeva A on hospital acquired hyponatremia in PICU, 123 cases who developed hospital acquired hyponatremia (HAH) were studied and they found that the use of ADH stimulating drugs, post-surgical status and volume of fluid administered (ml/kg) were the risk factors for HAH. They also found that HAH was associated with prolonged PICU stay and mechanical Ventilation. (15) In a study by Ontenda et. al. on incidence and outcome of Dysnatremia in post-operative congenital Heart disease patients it was observed that the overall incidence of post-operative dysnatremia was 46.5%; 19.1% had hyponatremia, 25.6% had hypernatremia, and 1.8% had both hyponatremia and hypernatremia in the first 72 hours after surgery. The study concluded that Post-operative dysnatremia was associated with increased hospital stay and mortality. (16)

Electrolyte abnormalities in ICU patients could be the result of the primary disease process; but they can arise due to various complications (17-20), multiple organ system involvement or various interventions such as intravenous fluid administration and medications. Because of the frail state of many of the PICU patients, electrolyte imbalances may have abstruse effect on patient outcome, and in their extreme forms may have critical outcome and this study will help in identifying the factors responsible for development of sodium abnormalities in

critically ill children and will help in formation of strategies for the prevention of the same. Few of the related studies on Pediatric health issues were reviewed (21-25). The limitation of the present study is that this will be conducted in a tertiary care Centre. Thus, the results cannot be applied to the general population or other peripheral Centrehospitals, further large studies are needed for the same.

CONCLUSION

Electrolyte abnormalities often develop or are frequently exacerbated during ICU stay and are associated with prolonged stay and mortality. Thus, regular monitoring of electrolytes and timely correction of those abnormalities are essential to reduce morbidity and mortality in a critically ill child. The present study will help in identifying the factors responsible for development of electrolyte abnormalities in PICU.

REFERENCES

- [1]. Greenbaum LA. Pathophysiology of body fluids and fluid therapy. In: Kliegman RM, Stanton BF, St Geme III JW, Schor NF, editors. *Nelson's Textbook of Pediatrics*. 20th ed. Canada: Elsevier; 2016:350-363
- [2]. Hauser GJ, Kulick AF. Electrolyte disorders in the PICU. In: Wheeler DS et al, eds. *Pediatric critical care medicine*. London: Springer-Verlag; 2014;13:147-61.
- [3]. Barron R, Freebairn R. Electrolyte disorders in the critically ill. *Anaesth Intensive Care Med*. 2010;11(12):523-8.
- [4]. SubbaRao SD, Thomas B. Electrolyte Abnormalities in Children Admitted to Pediatric Intensive Care Unit. *Indian Pediatr*. 2000;37:1348- 53
- [5]. Gibbs R, Macnaughton P. Electrolyte and metabolic disturbances in critically ill patients. *AnaesthIntens Care Med*. 2007;8(12):529-33.
- [6]. Hoskote SS, Joshi SR, Ghosh AK. Disorders of potassium homeostasis: pathophysiology and management. *JAPI*. 2008;56:685-93.
- [7]. Singhi S, Marudkar A. Hypokalemia in a pediatric intensive care unit. *Indian Pediatr*. 1996;33:9.
- [8]. Panda I, Save S. Study of association of mortality with electrolyte abnormalities in children admitted in pediatric intensive care unit. *IntJContempPediatr*. 2018;5(3):1097-1103
- [9]. Viera AJ, Wouk N. Potassium disorders: hypokalemia and hyperkalemia. *American family physician*. 2015 Sep 15;92(6):487-95
- [10]. Jayakumar. B, Sambasivam E. Clinical profile, etiology, management and outcome of serum sodium disturbances in children admitted in PICU. *Int J Res Med Sci*. 2017 Jun;5(6):2546-2551
- [11]. SubbaRao SD, Thomas B. Electrolyte Abnormalities in Children Admitted to Pediatric Intensive Care Unit. *Indian Pediatr*. 2000;37:1348- 53.
- [12]. Haider M, Hameed A, Fatima S, Afroze M, Noor N, Arshad U et. al. Frequency of Electrolyte Disorders and Its Effect On Mortality Among Children Admitted In Pediatric Intensive Care Unit. *JBUMDC* 2020;10(2):115-119
- [13]. Bojd S.S, Noori N.M, Damani E, Teimouri A. Electrolyte Disturbances in PICU: A Cross Sectional Study. *Nephro-Urol Mon*. 2019 May; 11(2):e87925. doi: 10.5812/numonthly.87925
- [14]. Edagotti.G, Murali K.M, Mulaka S, Chowdary J.S. a study on hyponatremia in children admitted in our pediatric intensive care unit. *Indian journal of Applied Research*. 2017;7:62-64
- [15]. Sachdev A, Pandharikar N, Gupta D, Gupta N, Gupta S, Venkatraman ST. Hospital-acquired Hyponatremia in Pediatric Intensive Care Unit. *Indian J Crit Care Med*. 2017;21(9):599-603. doi:10.4103/ijccm.IJCCM_131_17
- [16]. Ontaneda M.A, Lasa J, Arikian A .A, Coss-Bu J, Price J, Shekerdemian L. Dysnatremia in the Pediatric Cardiac Critical Care Unit: incidence and Outcomes in Post-operative Congenital Heart Disease Patients. *Pediatrics*. 2018;141:324. DOI:10.1542/peds.141.1

- [17]. Parameshwar Reddy, V., R.J. Meshram, and S.S. Chaudhari. "Fluid Balance in Critically Ill Children Admitted in Picu." *International Journal of Pharmaceutical Research* 11, no. 3 (2019): 1449–53. <https://doi.org/10.31838/ijpr/2019.11.03.160>.
- [18]. Varma, A., R.J. Meshram, N. Darvhekar, Z. Patel, S.G. Damke, and A. Taksande. "Study of Clinical Profile of Neonatal Seizures in a Nicu of Rural Central India." *International Journal of Research in Pharmaceutical Sciences* 11, no. 4 (2020): 5603–7. <https://doi.org/10.26452/ijrps.v11i4.3198>.
- [19]. Varma, A., V. Sharma, S. Damke, R.J. Meshram, A. Kher, and J. Vagha. "Clinical Presentation of Cyanotic Congenital Heart Diseases in the Pediatric Population." *Journal of Datta Meghe Institute of Medical Sciences University* 15, no. 1 (2020): 7–11. https://doi.org/10.4103/jdmimsu.jdmimsu_74_18.
- [20]. Jagzape, A., T. Jagzape, and V. Deshpande. "Simple Visual Reaction Time in Sickle Cell Disease Patients of Pediatric Age Group." *National Journal of Physiology, Pharmacy and Pharmacology* 7, no. 12 (2017): 1368–70. <https://doi.org/10.5455/njppp.2017.7.0832731082017>.
- [21]. Yadav, P., S. Dhaka, R. Chaudhary, S. Damke, and S. Lohiya. "A Rare Case Report of Guillain-Barré Syndrome Presenting as Unilateral Facial Palsy with Isolated Acute Bulbar Palsy." *Journal of Pediatric Neurosciences* 15, no. 2 (2020): 157–59. https://doi.org/10.4103/jpn.JPN_129_19.
- [22]. Girish, M., A. Rawekar, S. Jose, U. Chaudhari, and G. Nanoti. "Utility of Low Fidelity Manikins for Learning High Quality Chest Compressions." *Indian Journal of Pediatrics* 85, no. 3 (2018): 184–88. <https://doi.org/10.1007/s12098-017-2473-3>.
- [23]. Gupta, V., and A. Bhake. "Molecular Diagnosis of Tubercular Lymphadenopathy from Fine-Needle Aspirates in Pediatric Patients." *Acta Cytologica* 61, no. 3 (2017): 173–78. <https://doi.org/10.1159/000475832>.
- [24]. Jagzape, A., T. Jagzape, and V. Deshpande. "Simple Visual Reaction Time in Sickle Cell Disease Patients of Pediatric Age Group." *National Journal of Physiology, Pharmacy and Pharmacology* 7, no. 12 (2017): 1368–70. <https://doi.org/10.5455/njppp.2017.7.0832731082017>.
- [25]. Jameel, P.Z., S. Lohiya, A. Dongre, S. Damke, and B.B. Lakhkar. "Concurrent Diabetic Ketoacidosis and Pancreatitis in Paediatric Acute Lymphoblastic Leukemia Receiving L-Asparaginase." *BMC Pediatrics* 20, no. 1 (2020). <https://doi.org/10.1186/s12887-020-02136-3>.