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ELECTROLYTE ABNORMALITIES IN CRITICALLY ILL CHILDREN

Pediatrics

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ABSTRACT

OBJECTIVES: To study the frequency of electrolyte and blood glucose imbalance at admission in children admitted to a Pediatric Intensive Care Unit (PICU).
METHOD: Prospective study comprising of critically ill children admitted in Pediatric ICU of a tertiary care centre of North Karnataka from November 2015 to April 2017.
RESULTS: One hundred and fifty three patients aged 1mo to 15y, were admitted to the PICU during the study period. The mean age was 4.8 y. The male: female ratio was 1.2:1.128 patients (83.7%) had electrolyte abnormality. Hypochloremia was the most common electrolyte abnormality, followed by hyponatremia, hyperglycemia. Most common system involved was CNS, followed by Respiratory illness. Out of the 153 patients, 96.1% were discharged, 3.3% were discharged against medical advice, 0.7% died.
CONCLUSION: *Serum electrolyte and blood glucose abnormalities are very common in critically ill patients and can lead to fatal consequences. In view of these facts, a routine estimation of serum electrolytes and blood glucose should be considered in all patients getting admitted to PICU.*

KEYWORDS

Picu, Electrolyte Abnormalities, Sodium, Potassium, Calcium, Chloride.

INTRODUCTION

Disturbances of fluid and electrolyte homeostasis are commonly encountered in paediatric ICU [1].They occur in many conditions, may remain unrecognized and result in morbidity and mortality irrespective of the primary condition. Early goal directed therapy and a thorough understanding of common electrolyte abnormalities is necessary to ensure their correction [2].

Many patients encounter secondary homeostatic imbalances that involve one or more of the following:-Sodium, Potassium, Calcium, Chloride, Blood glucose. Sodium and potassium are common electrolyte disorders and are associated with increased morbidity and mortality [3].

Sodium is the main cation of the ECF, and is the main determinant of extracellular osmolality [3]. Among all the electrolytes sodium is unique because water balance, not the sodium balance, which determines its concentration [4]. Serum sodium concentration normally ranges between 135-145 mEq/l.

Potassium is the principal intracellular cation. Serum potassium concentration ranges between 3.5-5 mEq/l [5]. Most of the body potassium is present in muscles [4].

Calcium is a divalent cation that plays an important role in maintaining membrane potential and in various intracellular enzyme processes. Since about 99% of the calcium is in the bones [6], serum calcium concentration gives us poor information regarding the total body calcium.

Chloride is the principal anion along with sodium in the extracellular fluid. Serum chloride concentration normally ranges between 96-106mEq/l [7].

Glucose variability has potential effects on hydration and nutritional status. It indirectly leads to increased oxidative stress leading to cellular damage and apoptosis, the increased production of reactive oxygen species, such as peroxynitrite and superoxide has been postulated to be the major underlying mechanism for glucose induced micro vascular damage [8].

MATERIALS AND METHODS

This prospective study was conducted from November 2015 to April 2017 and included critically ill children aged 1 month to 15 years admitted to a paediatric ICU of a tertiary care hospital. Ethical clearance was obtained from Institutional Ethical Committee. Informed consent was obtained from the parents of all the children enrolled in the study.

INCLUSION CRITERIA:

Based on consensus guidelines for PICUs in India, Indian society of critical care medicine (Pediatric section) and Indian academy of Paediatrics (intensive care chapter) [9].

All PICU admitted children between age group 1 month to 15 years.

EXCLUSION CRITERIA:

1. Patients known or diagnosed to have chronic renal or hepatic disease.
2. Patients known to have metabolic disorders like Diabetes mellitus, Adrenal diseases etc.
3. Any condition with known abnormality of Glucose or electrolytes.

At the time of admission the patient's clinical picture is recorded in proforma. Venous blood sampling is obtained from each patient enrolled in the study, blood containing bulbs are labelled and kept aside for serum separation and sent for estimation of Electrolytes, Glucose without delay. Reports are then collected and interpreted. Patient was followed up till discharge or death.

Other investigations were done as per the need of the patient. Outcome in terms of electrolyte disturbance, discharge status or death was recorded.

Serum electrolytes were estimated using direct reading ion selective electrodes [ELECTROLYTE ANALYZER (AVL 988-3)].

The data collected were analysed for the frequency of various electrolyte imbalances, system wise distribution of illnesses associated with electrolyte imbalances, correlation of outcome to the severity of dyselectrolytemia, and mortality in relation to electrolyte imbalances.

RESULTS

Our study showed that out of the 153 cases included in study maximum

of 55% were male and 45% were female with male to female ratio was 1.2:1. Maximum belonged to age group of >5 years with a mean age of 4.8years.

Of the 153 cases, 128 cases (83.7%) had electrolyte abnormality. 78 (51%) cases had Hypochloremia, followed by 48 (31.4%) cases with Hyponatremia, 39 (25.5%) cases with Hyperglycemia, 30 (19.6%) cases with Hypercalcemia, 29 (19%) cases with Hypocalcemia, 19(12.4%) cases with Hypokalemia, 12 (7.8%) cases each with Hypernatremia and Hyperchloremia, 10 (6.5%) cases with Hyperkalemia, 6 (3.9%) cases with Hypoglycemia.

50 cases (32.7%) had CNS disease, 34 cases (22.2%) had respiratory disease, 29 (19%) had GI problems, 28 (18.3%) suffered from infectious diseases, 9 (5.9%) had CVS involvement and 3 (2%) had hematogical system involvement.

147 (96.1%) cases were discharged, 5 (3.3%) cases were discharged against medical advice, and 1 (0.7%) case died

1 case which died had mixed electrolyte abnormality.

DISCUSSION

FREQUENCY OF ELECTROLYTE IMBALANCES:

Electrolyte abnormalities were observed in 83.7% of children getting admitted to PICU. Thus it's a fairly common occurrence in an intensive care unit set up.

A study done by Subbarao SD [2], Biju Thomas showed that of the 305 patients admitted in PICU, 99 (32.45%) patients had electrolyte abnormality.
CNS (32.7%) was the most common system in my study followed by 22.2% with Respiratory illness and 19% were due to Gastrointestinal disease,18.3 % due to infectious disease, 5.9% due to cardiovascular problems, 2% with haematological disorders.

Among, the various electrolyte abnormalities detected in patients getting admitted to PICU, **Hypochloremia** was the commonest (accounting for 51% of all PICU admissions).

Very little is known about the clinical effects of chloride in critically ill patients. A study conducted by Makiko et al [10] showed that out of 448 cases, 43 patients (8.8%) had hypochloremia and the serum levels of sodium were also lower in about 50% of the hypochloremic group. However, multiple regression analysis showed that chloride was not an independent factor of poorer outcome. Hypochloremic patients were more prevalent in medical admissions, with hypochloremia correlating significantly with higher APACHE II scores. This study indicates that hypochloremia has clinical importance as an indicator of prognosis in critically ill patients.

Hyponatremia was the second most common electrolyte abnormality found in my study (31.4%) of all PICU admissions. This correlates with observation made in a prospective study of 727 sick children admitted in PICU, done by S.Singhi et al., [11] at PGIMER, Chandigarh.

In my study among the patients with Hyponatremia, CNS disease (29.8%) was the commonest cause of hyponatremia, followed by infectious diseases (27.1%) and respiratory infections (25%).

This correlates with a study done by S.Singhi [11] at al where CNS 33% was commonest cause of hyponatremia.

In my study hyponatremia was 80% corrected at the end of 24 hours after using RL as the maintenance fluid. In a study by Corsino et al [12], it was found that blood sodium levels of patients receiving hypotonic fluids decreased by 3.22 mmol/L, hence, hypotonic fluids increase the incidence of hyponatremia whereas isotonic fluids do not cause hyponatremia and should be considered as standard maintenance fluid. Results are in consistent with my study.

Study by Jeremy et al [13] found that use of isotonic maintenance fluids is safe and may result in fewer cases of hyponatremia.

Hyperglycemia was the third most common electrolyte abnormality noted in my study which accounted for 25.5% of all PICU admissions. This was seen mainly in CNS disorders (46.2%), followed by GI diseases (23.1%), followed by infectious disease (10.3%) and respiratory diseases (10.3%).

A retrospective study by Srinivasan, et al [14] reported that hyperglycemia at 24 hours was present in 54% cases. This correlates with my study.

Study by Jain H, Arya S et al [15], showed that the prevalence of hyperglycemia was 58% and was associated with higher mortality rate and longer duration of PICU stay.

In a study byVinayak KP, Swati BC [16] regarding hyperglycemia in critically ill children all patients received Dextrose containing I V fluids. This corresponds with my study.

Hypercalcemia was detected in 19.6% children admitted in our PICU and was fourth in order of frequency in my study.

Study by Ruiz MP et al [17] showed that out of the 360 children admitted in PICU the incidence of Hypercalcemia was 5.8%.

Hypercalcemia was mainly associated with CNS diseases (46.7%), followed by 23.3% ingastrointestinal diseases in my study.

In my study RL and DNS were used mainly in cases with Hypercalcemia and there was 100% correction in electrolyte abnormality with these two fluids.

A study by David G [18]concluded that hydration with normal saline is must in every patient with acute, severe hypercalcemia to correct ECF deficit. This correlates with my study.

Hypocalcemia was seen in 19% children admitted to PICU in my study. 31% each association was seen with Infectious disease and respiratory diseases, followed by 27.6% in CNS diseases.

In a prospective study by Singhi S [11], Singh J it was seen that out of 100 children admitted in PICU, the incidence of hypocalcemia was 22.4%. This correlates with my study.

Hypokalemia was seen in 7.8% children admitted in PICU. Gastrointestinal system, infectious diseases, respiratory infectious accounted for 26.3% each of all cases with hypokalemia, followed by 21.1% in CNS disorders.

In my study there was 50% correction in hypokalemia after using RL and Isolyte P (0.2% NS) as maintenance fluids, followed by 40% with 0.45% DNS, 20% with DNS.

Study by Singhi. S and Murudkar.A [19], concluded that use of higher potassium content of maintenance IV fluids corrected mild to moderate hypokalemia. This correlates with my study.

Hypernatremia was detected in 7.8% of the children getting admitted to PICU in my study. Hypernatremia was seen most commonly in CNS and gastrointestinal diseases (25% each), followed by 16.7% each in cardiovascular disease and infectious disease, 8.3% each in hematologic and respiratory illness. This correlates with study by Subba Rao et al [2] where CNS disease had 26.7% association with hypokalemia.

Hyperchloremia was seen in 7.8% of children admitted to PICU. It was mainly associated with CNS and gastrointestinal disorders which accounted for 33.3% each, followed by infectious diseases (16.7%), 8.3% each with cardiovascular and respiratory illness. It was seen that use of maintenance fluids like 0.45%DNS and Isolyte P led to the correction in hyperchloremia by 66.7% and 50% respectively.

A study by Broccard SP, Bhargava M [20] concluded that lactated ringer lactate solution prevents hyperchloremia in critically ill neurologic patients. This differs from my study.

Hyperkalemia was seen in 6.5 % of patients admitted to PICU in my study. CNS disease accounted for 40% of cases of hyperkalemia in my study followed by 30% by respiratory illness, 20% by gastrointestinal diseases, 10% by cardiovascular diseases.

Similar study by S. Singhi et al [11], hyperkalemia accounted for 5.4% cases admitted in PICU. This correlates with my study.

Hypoglycemia was seen in 3.9% children admitted in PICU.

The study by Vriesendorp et al [21], out of the 2272 patients included in the study, 156 (6.9%) patients experienced at least on episode of hypoglycemia.

46.2% cases were associated with CNS disorders followed by 33.3% due to infectious diseases, 16.7% cases due to respiratory illness.

In my study it was found that hypoglycemia was 100% corrected at the end of 24 hours after using DNS and Isolyte P as intravenous maintenance fluids, followed by 0.45%DNS (50%) correction in electrolyte abnormality.

LIMITATIONS

CONCLUSION

Fluid and electrolyte abnormalities in critically ill patients can lead to fatal consequences. More caution to electrolyte disturbances should be exercised in intensive care because it is often impossible to adequately assess symptoms and signs of critically ill patients. To provide optimal management, clinicians should be knowledgeable about fluid and electrolyte homeostasis and the underlying pathophysiology of the respective disorders. In addition, intensivists should pay attention to the administered fluid and medications potentially associated with fluid and electrolyte disturbances.

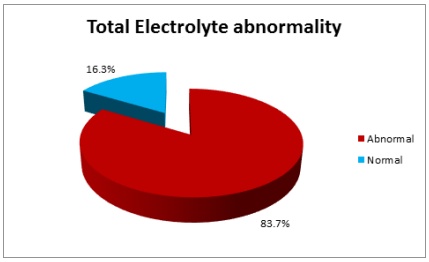
In view of these facts, a routine estimation of serum electrolytes should be considered in all patients getting admitted to PICU.

Thus this study brings out the salient aspects of electrolyte abnormalities in severely ill children, and focuses on the importance and need to recognize the abnormalities and acts as good predictor of mortality in PICU.

Table I: percentage of electrolyte abnormality in PICU

Total Electrolyte abnormality	N	%
Abnormal	128	83.7
Normal	25	16.3
Total	153	100.0

Graph I: Pie diagram showing percentage of electrolyte abnormality in PICU

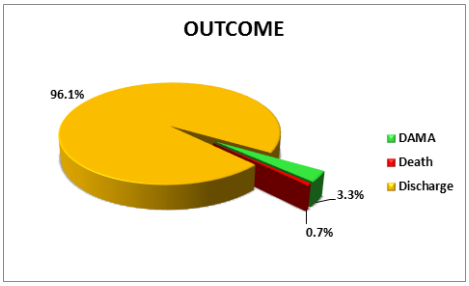


Shows 128 cases (83.7%) had electrolyte abnormality.

Table II: Distribution of cases by Outcome

OUTCOME	N	%
DAMA	5	3.3
Death	1	0.7
Discharge	147	96.1
Total	153	100.0

Graph II: Distribution of cases by Outcome



*DAMA- Discharge against medical advice

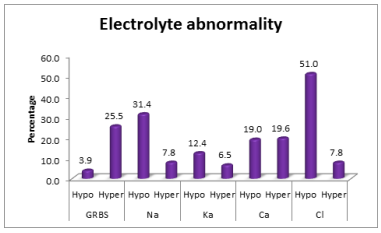
Shows 147 (96.1%) cases were discharged, 5 (3.3%) cases were discharged against medical advice, and 1 (0.7%) case died

1 case which died had mixed electrolyte abnormality.

Table III: Distribution of cases based on electrolyte imbalance.

Electrolyte abnormality		N	%
Blood glucose	Hypoglycemia	6	3.9
	Hyperglycemia	39	25.5
Na^+	Hyponatremia	48	31.4
	Hypernatremia	12	7.8
K^+	Hypokalemia	19	12.4
	Hyperkalemia	10	6.5
Ca^{2+}	Hypocalcemia	29	19.0
	Hypercalcemia	30	19.6
Cl^-	Hypochloremia	78	51.0
	Hyperchloremia	12	7.8

Graph III: Distribution of cases based on electrolyte imbalance

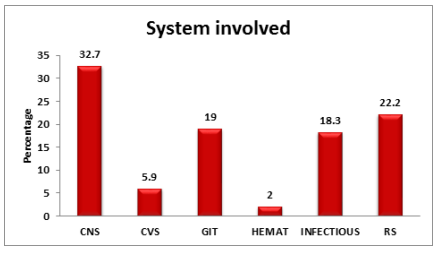


Shows 78 (51%) cases had Hypochloremia, followed by 48 (31.4%) cases with Hyponatremia, 39 (25.5%) cases with Hyperglycemia, 30 (19.6%) cases with Hypercalcemia, 29 (19%) cases with Hypocalcemia, 19(12.4%) cases with Hypokalemia, 12 (7.8%) cases each with Hypernatremia and Hyperchloremia, 10 (6.5%) cases with Hyperkalemia, 6 (3.9%) cases with Hypoglycemia.

Table IV: Distribution of cases by System involved

System involved	N	%
CNS	50	32.7
CVS	9	5.9
GIT	29	19
HEMAT	3	2
INFECTIOUS DISEASE	28	18.3
RS	34	22.2
Total	153	100

Graph IV: Distribution of cases by System involved



Shows 50 cases (32.7%) had CNS disease, 34 cases (22.2%) had respiratory disease, 29 (19%) had GI problems, 28 (18.3%) suffered from infectious diseases, 9 (5.9%) had CVS involvement and 3 (2%) had hematogical system involvement.

REFERENCES:

1. Lee JW. Fluid and electrolyte disturbances in critically ill patients. Electrolyte Blood press 2010; 8:72-81.
2. Subba Rao SD, Thomas B .Electrolyte abnormalities in children admitted to pediatric intensive care unit. Indian Paediatrics 2000; 37:1348-53.
3. Linda F. Fried MD, Paul M. Palevsky MD: Hyponatremia and hypernatremia. Medical Clinics of North America - Volume 81, Issue 3 (May 1997) - Copyright © 1997 W. B. Saunders Company.
4. Larry A. Greenbaum. Electrolyte and acid-base disorders. In:Kleigman, Behrman, Jenson, Stanton editors. Nelson textbook of pediatrics, 18th ed.Elsevier;1; 52; 375
5. Srivastava RN Arvind B. Fluid, Electrolyte and Acid – base disorders.In: Priyanka Khandelwal, Arvind Bagga. Pediatric nephrology. 6thed India.2016;100-115.

6. Paul VK, Bagga A. Fluid and Electrolytes. In: Kamaran Afzal. Ghai Essential of Pediatrics.8th ed. India, Delhi.2013; 70-87.
7. Morrison G. Serum Chloride. In: Walker HK, Hall WD, Hurst JW, editors. Clinical Methods: The History, Physical, and Laboratory Examinations. 3rd edition. Boston: Butterworths; 1990. Chapter 197.
8. Bhutia, Tsultem D. Abnormaltites in glucose homeostasis in critically ill children. 2013;14:e16-e25
9. Adelman RD, Soihaug MJ. "Pathophysiology of body fluids and fluid therapy". Nelson Textbook of Pediatrics, 19th Edition, Vol. 1 Eds Behrman RE, Kilegman RM, Jenson HB. Philadelphia. W.B. Saunders, 2000; 189-196
10. Tani, Makiko & Morimatsu, Hiroshi & Takatsu, Fumiaki & Morita, Kiyoshi. (2012). The Incidence and Prognostic Value of Hypochloremia in Critically Ill Patients. TheScientificWorldJournal. 2012. 474185. 10.1100/2012/474185.
11. Singhi S, Prasad SVSS, Chugh KS. "Hyponatremia in sick children: a marker of serious illness". Indian Pediatrics. 1994; 31:19 - 25.
12. Rey, Corsino & Los-Arcos, Marta & Hernández, Arturo & Sánchez, Amelia & Diaz, Juan & López-Herce, Jesús. (2011). Hypotonic versus isotonic maintenance fluids in critically ill children: A multicenter prospective randomized study. Acta paediatrica (Oslo, Norway: 1992). 100. 1138-43.
13. Jeremy N Friedman; Canadian Paediatric Society Acute Care Committee Paediatr Child Health 2013;18(2):102-104
14. Srinivasan V, Spinella PC, Drott HR, Roth CL, Helfaer MA, Nadkarni V. Association of timing, duration, and intensity of hyperglycemia with intensive care unit mortality in critically ill children. Pediatr Crit Care Med. 2004; 5(4):329–36.
15. Jain H, Arya S, Mandloi R.The prevalence of hyperglycemia in critically ill children admitted in PICU. Int J Pediatr Res.2016; 3(6):467-471.
16. Sivanandan, Sindhu & Sinha, Aditi & Jain, Vandana & Lodha, Rakesh. (2010). Management of Diabetic Ketoacidosis. Indian journal of pediatrics. 78. 576-84. 10.1007/s12098-010-0294-8.
17. Zofkova L. Hypercalcaemia pathophysiological aspects. Physiol Res. 2015; 65:1–10.
18. Goltzman D. Hypercalcemia. In: De Groot LJ, Chrousos G, Dungan K, et al., editors. Endotext . South Dartmouth (MA): MDText.com, Inc.; 2000-226.
19. S. Singhi and A. Marudkar, hypokalemia in pediatric intensive care unit November 17, 1994; Accepted: April 17, 1995.
20. Sacha PB, Maneesh B, Alexander Z. The use of modified lactated ringer solution prevents hyperchloremia in critically ill neurological patients. American jornal of respiratory and critical care medicine 2013; 187:A 1598.
21. Vriesendorp TM, van Santen S, DeVries JH, et al: Predisposing factors for hypoglycemia in the intensive care unit. Critical care medicine.2006; 34;96-101