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Correlation of electrolyte abnormalities with severity of illness in critically ill patients of NICU and PICU at CRGH and associated hospital of RD Gardi Medical College Ujjain (MP)

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Abstract---Objective: To determine the type of electrolytes abnormalities observed among critically ill patients of NICU and PICU. Material and Methods: A Hospital based prospective and observational study conducted among 99 critically ill patients between 0 to 15 years age. Results: Out of total patients, 78 (78.8%) cases had abnormal electrolytes level, and 21 (21.2%) cases had normal electrolytes level. 10 (12.8%) cases had imbalance of single electrolyte, 17 (21.7%) cases had imbalance of two electrolytes, 16 (20.5%) cases had imbalance of three electrolytes, and 35 (44.8%) cases had imbalance of more than three electrolytes. This shows that majority of patients in PICU had multiple electrolyte (>3) abnormalities. In our study, maximum prevalence is of sodium abnormalities 63 (63.6%) followed by potassium abnormalities 50 (50.5%). Calcium, Phosphate and Chloride has same prevalence 40 (40.3%). Conclusion: Our study findings conclude that maximum prevalence 80.7% is of sodium abnormalities. Hyponatremia is most common electrolyte abnormalities present in 63.5% cases. Early recognition with a thorough understanding of common electrolyte abnormalities and their prompt management

definitely pose an implication on the final outcome of the patient. Aggressive & strict adherence to correction of in particular to sodium and potassium before weaning is necessary for successful weaning from ventilator.

Keywords---electrolyte abnormalities, NICU, PICU, CRGH.

Introduction

Electrolytes plays a vital role in maintaining homeostasis of the body. They perform various important functions of life such as maintaining electrical neutrality inside and outside of the cell, generation and conduction of action potentials in the nerves and muscles, acid-base balances etc. They also regulate the osmotic pressure of the cells.^[1] Major electrolytes are sodium, potassium, calcium, magnesium, phosphorus and chloride. A high or a low level of electrolytes disrupts the normal bodily functions and can significantly result in morbidity and mortality.^[2] Electrolyte abnormalities are common in children who need intensive care, and it may remain unrecognized and result in morbidity and mortality. Critically ill children in intensive care unit are more susceptible to develop electrolyte imbalance due to disease itself or medical management. Several factors, including the underlying diseases, inability to express thirst, and injudicious use of intravenous fluid put ICU patients at a risk for developing electrolyte imbalance related morbidity and mortality. They do not always manifest specific symptoms, but often share the clinical features of underlying illnesses necessitating high index of suspicion. Prolonged intensive care, mechanical ventilation, IV drugs etc., require for critically ill patient, therefore early detection and Introduction treatment through serial electrolyte monitoring may help in improving morbidity, mortality and decreasing length of stay in hospital.^[3] Since electrolyte imbalances are common in children with serious underlying medical conditions like, severe burns, sepsis, neurological diseases, renal diseases, cardiac diseases etc. Therefore, knowing the basic sign and symptoms of various electrolytes imbalances becomes extremely important for early detection of high-risk patients and timely management of the patient especially in settings like neonatal and pediatric ICU.^[4] There is a lot of published adult data addressing this problem in adults but neonatal and pediatric data has just begun to generate especially after the growing pediatric critical care medicine as a sub speciality, furthermore maximum studies on electrolyte imbalance among ICU patients, had compare one or two electrolytes but limited studies had compared multiple electrolytes and their correlation. So, present study was undertaken to identify the magnitude and various aspects of the different problems among critically ill patients of NICU and PICU at CRGH and associated hospital of R D Gardi medical college Ujjain (M.P.)

Study Design: Observational Study

Objective

To determine the type of electrolytes abnormalities observed among critically ill patients of NICU and PICU.

Material and Methods

Hospital based prospective and observational study is conducted from January 2021 to November 2021 in the department of Pediatrics C.R. Gardi hospital and associated hospital; R.D. Gardi medical college, Ujjain with a total duration of 11 months. Ethical clearance was taken from the institutional ethical committee. Total 99 critically ill patients were enrolled between 0 -15 years of age of this study. Children who are on medications causing electrolyte imbalance prior to admission, Children who had taken prior treatment for electrolyte disturbances and children with underlying electrolyte abnormalities like Barter syndrome, Gitelman syndrome and Renal Tubular Acidosis were excluded from the study. A thorough physical examination was performed including anthropometry, general examination, systemic examination and laboratory investigations, provisional diagnosis and the final outcome (Discharge/ Death / LAMA/referred) are recorded in a predesigned proforma. The study group is divided into five groups on the basis of age. Group A: 0-3 months, Group B: 3-12 months, Group C: 1-5 years, Group D: 5-10 years, Group E: 10-15 years.

Diagnosis

Normal sodium value 135 - 145 mEq/l (reference nelson textbook of pediatrics).^[5]

- Hyponatremia >145 mEq/l
- Hypernatremia < 135mEq/l

Normal potassium value 3.5 - 5.5 mEq/l

- Hypokalemia < 3.5 mEq/l
- Hyperkalemia >5.5 mEq/l

Normal ionized calcium 1.12 millimole/l -1.23 mmol/l

- Hypocalcemia < 1.12 millimole/l
- Hypercalcemia >1.23 millimole /l

Normal Blood Urea = 5 to 18 mg/dl, Serum Creatinine = 0.17 to 0.71 mg/dl.

Statistical analysis

The collected data were analyzed with SPSS 21.0 version. To describe about the data, descriptive statistics, frequency analysis, percentage analysis were used for categorical variables and for continuous variables the mean and S.D were used. Qualitative data is expressed in percentage and statistical difference between the proportions is tested by chi square test or Fisher's exact test whereas quantitative data is assessed using ANOVA. In all the above statistical tools, the probability value of <0.05 was considered as significant level.

Observation and Results

Out of total 99 patients enrolled, n=10(10.1%) cases are in age groups of 0-3 months, n =13 (13.1%) cases are in age groups of 3-12 months, n=37(37.4%) cases are in age groups of 1-5years, n= 28(28.3%) cases are in age groups of 5-10 years and 11(11.1%) cases are in age groups of 10-15 years. Mean age of study group is 7.7 years. 59.6% cases are males and 40.4% cases are females. The ratio of male: female is 1.4:1.

Table 1: Distribution of study group according to different age groups and gender

AGE	GROUP	SEX			
		MALE	%	FEMALE	%
0-3 Months (n=10)	A	7	70.00	3	30.00
3-12 Months (n=13)	B	8	61.50	5	38.50
1-5 Years (n=37)	C	20	54.10	17	45.90
5-10 Years (n=28)	D	18	64.30	10	35.70
10-15 Years (n=11)	E	6	54.50	5	45.50

Graph: 1

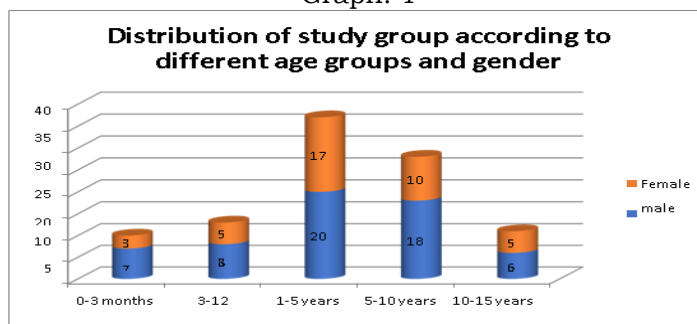


Table 2: Distribution of study group according to the different types of electrolytes abnormalities

Electrolytes	Frequency	Percentage	Abnormalities	Frequency & percentage
Sodium	63	80.7	Hyponatremia	n=40 (63.49)
			Hypernatremia	n=23 (36.5)
Potassium	50	64.1	Hypokalemia	n=44 (88)
			Hyperkalemia	n=6 (12)
Calcium	40	51.2	Hypocalcemia	n=38 (95)
			Hypercalcemia	n=2 (5)
Phosphate	40	51.2	Hypophosphatemia	n=33 (82.5)
			Hyperphosphatemia	n=7 (17.5)
Chloride	40	51.2	Hypochloremia	n=33 (82.5)
			Hyperchloremia	n=7 (17.5)
Magnesium	32	41	Hypomagnesemia	n=9 (28.12)
			Hypermagnesemia	n=23 (71.8)

Above table shows distribution of various electrolyte abnormalities, out of total n=78 (100%) cases, n=63(80.7%) cases have sodium abnormalities, n=50(64.1%) cases have potassium abnormalities, n=40(51.2%) cases have calcium abnormalities, n=40(51.2%) cases have phosphorous abnormalities, n=40(51.2%) cases have chloride abnormalities, n=32(41%) cases have magnesium abnormalities. This shows that abnormalities of sodium are most common electrolyte abnormalities followed by potassium abnormalities among critically ill patients, found in the present study.

Table: 3 Distribution of study group according to diseases involved and electrolyte abnormalities, showing correlation

Disease involved	Electrolyte abnormalities				Total	Chi square	P- value
	Present	%	Absent	%			
Respiratory (n=32)	28	87.50	4	12.50	32	11.23	0.01
Neurological (n=27)	23	85.19	4	14.81	27		
Cardiovascular (n=13)	10	76.92	3	23.08	13		
Renal (n=10)	7	70.00	3	30.00	10		
Gastrointestinal (n=8)	4	50.00	4	50.00	8		
Others (n=9)	6	66.67	3	33.33	9		
Total	78		21		99		

Above table shows that there are electrolyte abnormalities in all the diseases e.g., respiratory, neurological, cardiovascular, renal and others having critical illness, but the percentage of electrolyte abnormalities was found maximally in respiratory diseases n=28 (87.5%), followed by neurological diseases n=23 (85.19), followed by cardiovascular diseases n=10(76.92%) and renal diseases n=7(70%) in descending order in the present study. This data is statistically highly significant (Chi-square -11.23; P value-0.01).

Graph: 2

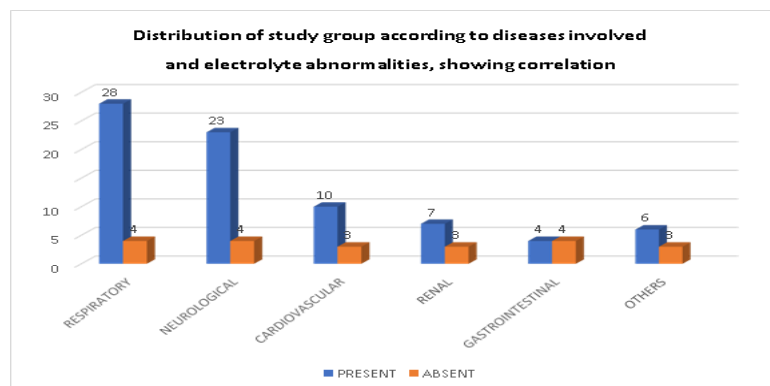
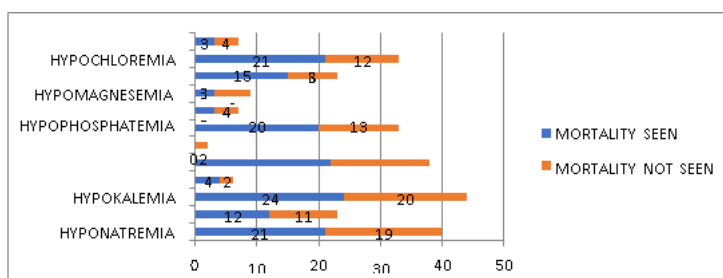


Table: 4 Distribution of study group according to electrolyte abnormalities and outcome

Electrolytes	Abnormalities	Outcome		P value
		Death n(%)	Discharge n(%)	
Sodium	Hyponatremia (n=40)	21 (52.5)	19 (47.5)	0.014
	Hypernatremia (n=23)	12 (52.1)	11 (47.8)	
Potassium	Hypokalemia (n=44)	24 (54.5)	20 (45.4)	0.01
	Hyperkalemia (n=6)	4 (66.6)	2 (33.3)	
Calcium	Hypocalcemia (n=38)	22 (57.8)	16 (42.1)	0.021
	Hypercalcemia (n=2)	0 (0.0)	2 (100.0)	
Phosphate	Hypophosphatemia (n=33)	20 (66.6)	13 (39.3)	0.019
	Hyperphosphatemia (n=7)	3 (42.8)	4 (57.1)	
Chloride	Hypochloremia (n=33)	21 (63.6)	12 (36.3)	0.05
	Hyperchloremia (n=7)	3 (42.8)	4 (57.1)	
Magnesium	Hypomagnesemia (n=9)	3 (33.3)	6 (66.6)	0.03
	Hypermagnesemia (n=23)	15 (65.2)	8 (53.3)	

Above shows distribution of electrolyte abnormalities and outcome of the patients which shows that maximum mortality is due to hyperkalemia n=4 (66.6%) cases (p-value-0.01) followed by hypophosphatemia n=20 (60.6%) cases (p-value-0.019) and hypochloremia n=21(63.6%) cases (p-value-0.005). Death due to electrolytes abnormalities were not singular. There were multiple electrolytes abnormalities in a patient. A patient can have hyponatremia as well as hypokalemia along with hypocalcemia and hypophosphatemia. The correlation between electrolyte abnormalities and outcome of patients regarding every electrolyte abnormalitis is statistically highly significant. (p value- 0.005)

Graph: 3



Discussion

Total 99 critically ill patients are enrolled between 0 -15 years of age. Males are in majority 59.6%. Maximum patients 37.4% are in the age groups of 1-5 years. Mean age of patients in the present study is 7.7 years. 78.8% patients have electrolyte abnormalities. Maximum electrolyte abnormalities 38.4% are present in age groups of 1-5 years. Maximum patients 44.8% had abnormalities of more than three electrolytes. Maximum prevalence 80.7% is of sodium abnormalities.

Hyponatremia is most common electrolyte abnormalities present in 63.5% cases. Hypokalemia is 2nd commonest electrolyte abnormalities 88% cases.

In the our study, the study population was classified into five subgroups A, B, C, D, E., out of which, n=10 (10.1%) cases belong to age group of 0-3 months, n =13 (13.1%) cases were in age group from 3-12 months, n=37 (37.4%) cases were in age group of 1-5 years, n= 28 (28.3%) cases were in age groups of 5-10 years and 11 (11.1%) cases were in age groups of 10-15 years. Similar study done by Dr. C. Rukesh Chary et. al ^[6] had enrolled total n=132 patients out of which, 40 (30.30%) patients were of 1 month to 1 year and 40 (30.30%) patients in age group 1 year to 5 years, 21 (15%) patients were between 5 to 10 years, whereas 31 (23%) patients were more than 10 years.

Present study shows that, the study groups which had maximum no. of male patients was in the age group of 0-3 months i.e., n=7 (70%), followed by age group of 5-10 years i.e., n=18 (64.3%). Contrary to present study, no other study has correlated gender with different age groups. In the present study, out of total 99 patients enrolled, n=78 (78.8%) cases had abnormal electrolytes level, and n=21 (21.2%) cases had normal electrolytes level, this shows that electrolyte imbalance was more common in critically ill patients in the present study. In accordance with the present study, the study done by Faizia Naseem et. al ^[7] had enrolled n=101 patients out of which n=85 (84.15%) patients had electrolyte imbalance and remaining n=16 (15.84%) patients had normal serum electrolytes, showing more electrolyte abnormalities in critically ill patients than the present study. In the present study, out of total n=78 (100%) having electrolyte abnormalities, maximum number of patients belonged to age group 1-5 years n=30 (38.4%) followed by 5-10 years n=19 (24.3%). In accordance with the present study, a study done by Mrutyunjay Routray et. al ^[8] maximum number of patients having electrolyte abnormalities belong to age groups between 1-5 years (67.06%) followed by 5-10 years (37.76%)

In the present study, maximum prevalence is of sodium abnormalities n=63 (63.6%) followed by potassium abnormalities n=50(50.5%). Calcium, Phosphate and Chloride has same prevalence n=40 (40.3%). Similar study conducted by Faizia Naseem et. al ^[7] showed maximum prevalence is of sodium n=52 (61.1%) followed by calcium n=49 (57.6%) followed by potassium n=42 (49.4%), phosphate n=40 (47%) and magnesium n=24 (28.2%) which is lower than the present study except for calcium which is higher than the present study.

In the present study, out of total n=40(63.4%) hyponatremic patients, maximum number of patients, who succumbed to death had respiratory diseases, n=11(34.3%) and followed by cardiovascular diseases, n=4 (30.7%) and neurological diseases n=6(22.2). Contrary to the present study, study done by Girma Elala et. al ^[9] showed the most common cause of death in hyponatremic patient was heart failure (cardiovascular). In the present study, out of total n=44(88%) hypokalemic patients, maximum number of patients, who succumbed to death had cardiovascular diseases, n=4(30.7%) followed by respiratory diseases, n=9 (28.1%) and neurological diseases n=7(25.9%) and renal diseases n=2 (20%). Contrary to the present study, a study conducted by Isha Panda and S

Save et. al [10] showed more than 50% patients with hypokalemia had gastrointestinal involvement whereas hyperkalemia had renal involvement.

Conclusion

Our study findings conclude that maximum prevalence 80.7% is of sodium abnormalities. Hyponatremia is most common electrolyte abnormalities present in 63.5% cases. The most common cause of death in hyponatremic patients was found respiratory diseases and among hyponatremic patients most common cause of death was neurological diseases. Early recognition with a thorough understanding of common electrolyte abnormalities and their prompt management definitely pose an implication on the final outcome of the patient. Aggressive and strict adherence to correction of in particular to sodium and potassium before weaning is necessary for successful weaning from ventilator.

Limitations

Main limitation of the present study is that study is carried out during period of Covid-19 lockdown, so maximum cases was not able to reach hospital on time. Another limitation of present study was small sample size which makes data statistically non-significant. Present study did not aim at defining the various factors which could have contributed to higher morbidity and mortality. Several factors, which would have caused hyponatremia, could not be deciphered like SIADH. Moreover, respiratory diseases which led to maximum mortality could have been due to Covid-19 infection, which could not be proved in all respiratory cases.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee of RD Gardi Medical College, Ujjain (MP)

References

1. Agarwal N, Rao Y, Saxena R, Acharya R. Profile of serum electrolytes in critically ill children: A prospective study. *Indian J Child Health*. 2018; 5 (2):128-132.
2. Balci AK, Koksall O, Kose A, Armagan E, Ozdemir F, Inal T, et al. General characteristics of patients with electrolyte imbalance admitted to emergency department. *World J Emerg Med*. 2011;4(2):113-116
3. Bockenkamp B, Vyas H. Understanding and managing acute fluid and electrolyte disturbances. *Current Paediatrics* 2003; 13: 520–528.

4. C.Rukesh Chary, B. Shalini. Correlation Between Serum Electrolytes And Clinical Outcome in Children Admitted To PICU. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 2017; 16(11): 24-27.
5. Girma Elala, Damte Shimelis. Patterns of electrolyte abnormalities in children 0-15 years of age admitted to Pediatric Emergency. *IOSR-JDMS*, 2018;17(2): PP 12-16.
6. Isha Panda, Sushma Save. Study of association of mortality with electrolyte abnormalities in children admitted in pediatric intensive care unit. *Int J ContempPediatr*. 2018 May;5(3):1097-1103.
7. Khilnani P. Electrolyte abnormalities in critically ill children. *Crit Care Med*. 1992 Feb;20(2):241-50. doi: 10.1097/00003246-199202000-00013. PMID: 1737458.
8. Mrutyunjay Routray, Kishore SV, Jyotiranjana Champatiray, Saroj Kumar Satpathy. Demographic variation of electrolyte imbalance in a tertiary care pediatric intensive care unit. *Int J Contemp Pediatr*. 2020 Feb;7(2):224-229
9. Naseem F, Saleem A, Mahar IA, Arif F. Electrolyte imbalance in critically ill paediatric patients. *Pak J Med Sci*. 2019;35(4):1093-1098.
10. Ratnawati, I. G. A. A., Suandayani, N. K. T., & Sutapa, G. N. (2019). The linearity of x-ray devices radiation output and its relationship with patient thickness. *International Journal of Physical Sciences and Engineering*, 3(3), 1–6. <https://doi.org/10.29332/ijpse.v3n3.351>
11. Rustagi, M., & Anudhakar, A. (2022). Evaluation of serum thyroid hormone profile and its correlation with the clinical outcome in critically ill children. *International Journal of Health Sciences*, 6(S3), 3484–3496. <https://doi.org/10.53730/ijhs.v6nS3.6516>
12. Shiber JR, Mattu A. Serum phosphate abnormalities in the emergency department. *J Emerg Med* 2002; 23: 395–400.
13. Suryasa, I. W., Rodríguez-Gómez, M., & Koldoris, T. (2022). Post-pandemic health and its sustainability: Educational situation. *International Journal of Health Sciences*, 6(1), i-v. <https://doi.org/10.53730/ijhs.v6n1.5949>