ORIGINALARTICLE

Evaluation of the Pattern of Electrolyte Disturbances in Patients Admitted in ICU

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Abstract:

Background: Electrolyte and acid base disturbances are major responsible factors for leading complications in intensive care unit (ICUs) in conditions like Diabetes Mellitus, acute or chronic renal failure, acute or chronic respiratory failure, sepsis and cardiovascular diseases etc. Thus, present study was planned to evaluate the pattern of electrolyte disturbances in ICU patients. *Material and Method:*The present study was conducted at University Medical College with tertiary Care Hospital. It was Retrospective Cross sectional study. Study protocol was approved by Institutional Ethics Committee. Study was conducted during period ofApril 2018 to August 2018. Total Seventy-eight (78) cases admitted in ICU department were included in present study with following inclusion and exclusion criteria.Patients admitted in ICU department with their history, physical and clinical examinations and age above 18 years of both genders with Conditions like Diabetes Mellitus, Renal failure (Except dialysis patient), Sepsis, Cardiovascular disease and Cerebrovascular diseases were included in the study. Patient admitted in ICU having other conditions like Neuromuscular disorders, Semi-comatose and comatose state, Unwilling for participation and Patients on potassium diuretics were excluded from the study.Data was obtained by laboratory measurement of Serum Electrolyte levels (sodium, potassium, chloride) by using Electrolyte analyzer and from ICU for measurement of ionized calcium by ABG (Arterial Blood Gas) analyzer. Period of ICU stay was analyzed by date of ICU admission to date of discharge from ICU. Electrolytes were analyzed by using Prolyte Electrolyte Analyzer with ion selective electrode (Diamond Diagnostic: Prolyte 1- Na+K+Cl-L+ and ABG analyzer- Na+K+iCa++).Commercially available Fluid pack was Used for electrolyte measurement. This facility was available at Central Clinical Laboratory and ICU of our hospital.Data were compiled and analyzed using SPSS Software with version 28.0 for statistical analysis such as Paired "t test" , ANOVA test used to compare mean difference electrolyte levels among disease group and Pearson's Correlation coefficient to find out the correlation between hospital stay with electrolyte level. *Results:*Sodium showed statistically significant (p value <0.001) difference between patients at admission and at discharge amongst other electrolyte values.Positive correlation was found in potassium values compared to other electrolytes in case of period of stay by using Pearson's correlation coefficient. *Conclusion:*From this present study we can conclude that average 6 to 7 days of ICU stay is essential for managing electrolyte disturbances such as sodium and chloride. But Potassium and Ionized calcium need more ICU stay to manage disturbances? *Implication:* The study outcome will help the clinicians to identify common pattern of electrolyte imbalance and such pattern of electrolyte will help to decide period stay of patient in ICU.

Key words: Electrolyte pattern, ICU, Period of stay, Ion selective electrode, Sodium, Potassium, Ionized calcium, Electrolyte disturbances.

Introduction: Fluid and electrolyte balance is one of the key mechanism in protecting cellular function, tissue perfusion and acid-base balance thus play important role in maintaining homeostasis of body. It is necessary to maintain fluid and electrolyte balance for the management of various clinical conditions, and is found to be deteriorated in many diseases [1]. Kidney plays a central role in regulation of electrolytes as well as acid base balance and responsible for retention and excretion

of fluids and electrolytes. There are several other factors too involved in regulating fluid and electrolyte balance in the healthy individuals like interactions of hormone with anti-diuretic hormone and stress[1, 2, 3].Electrolyte and acid base disturbances are frequent and dangerous complications in the intensive care unit (ICU), andits prediction can be useful in preventionof these complications by attention to the use of intravenous fluid and nutrition [4].Electrolyte disturbances may be due to various diseases such as Diabetes Mellitus (DM)[5], chronic Kidney Disease (CKD)[3], acute or chronic respiratory failure[6], sepsis [7] and cardiovascular diseases (CVD)[8].Altered states of consciousness are commonly seen in these patients admitted in ICU along with electrolyte abnormalities [9]. Thus importance of regulating sodium and potassium levels is well recognized present study was planned to study the pattern of electrolytes in patients admitted in ICUs[10]. So keeping this in mind, the patients admitted to ICU, and their correlation between patient's periods of ICU stay with emphasison Diabetes Mellitus, Renal failure, Sepsis, Cardiovascular disease, Cerebrovascular diseases. The objectives were formulated for the study includes To Estimate serum electrolytes (Sodium, Potassium, Chloride & ionized Calcium) in study group.To correlate the levels of Electrolyte in different diseases to understand their role in causing the disturbances. To correlate the serum electrolyte levels with patient's period of stay in ICU.

Material and Method:

The present study was conducted at University Medical College with tertiary Care Hospital. It was Retrospective Cross sectional study. Study protocol was approved by Institutional Ethics Committee. Study was conducted during period of April 2018 to August 2018. Total Seventy-eight (78) cases admitted in ICU department were included in present study with following inclusion and exclusion criteria.Patients admitted in ICU department with their history, physical and clinical examinations and age above 18 years of both genders with Conditions like Diabetes Mellitus, Renal failure (Except dialysis patient), Sepsis, Cardiovascular disease and Cerebrovascular diseases were included in the study. Patient admitted in ICU having other conditions like

neuromuscular disorders, Semi-comatose and comatose state, Unwilling for participation and Patients on potassium diuretics were excluded from the study. Data was obtained by laboratory measurement of Serum Electrolyte levels (sodium, potassium, chloride)by using Electrolyte analyzer and from ICU for measurement of ionizedcalcium by ABG (Arterial Blood Gas) analyzer. Period of ICU stay was analyzed by date of ICU admission to date of discharge from ICU. Electrolytes were analyzed by using Prolyte Electrolyte Analyzer with ion selective electrode (Diamond Diagnostic: Prolyte 1- Na+K+Cl-L+ and ABG analyzer- Na+K+iCa++).Commercially available Fluid pack was used for electrolyte measurement. This facility was available at Central Clinical Laboratory and ICU of our hospital. Data were compiled and analyzed using SPSS software with version 28.0 for statistical analysis such as Paired "t test" , ANOVA test used to compare mean difference electrolyte levels among disease group and Pearson's Correlation coefficient to find out the correlation between hospital stay with electrolyte level.

Results:

Seventy eight (78) patients were includedin the present study with the average age group of 55 years.Seventy three (73) were found with sodium abnormalities, Seventy one (71) with potassium abnormalities, Twenty one (21) with chloride abnormalities and forty one (41) with ionized calcium abnormalities and their mean values were noted at the time of admission and at the time of discharge in ICU.

We compared mean electrolyte patients values on their admission and on their discharge by applying "t test" (values were compared with normal ranges of electrolyte mentioned in Table 1). Only sodium showed statistically significant (p <0.01) difference between on admission and on discharge values, and other parameters were found to be statistically not significant.We compared correlation between electrolytes at admission and at discharge in patients admitted in ICU by applying "Pearson correlation coefficient" and results showed statistically significant positive correlation (p<0.01) was observed in case of sodium and potassium with period of stay. Chloride and ionized calcium were found to be statistically not significant as shown in Table 2. Total

seventy eight (78)recruited patients were segregated according to present disease condition such as Diabetes mellitus, Chronic kidney disease, Endocrinedisorder, Cerebrovascular disease, Cardiovascular disease, Respiratory disease, others etc. In the present study forty four (44) males and Thirty four (34) females were included. Analysis of data was done by using ANOVA to compare mean electrolyte values with their diagnosis.

Table 1: Comparison of between the values of electrolytes at the time of admission and at discharge among patients admitted in ICU

Serum Electrolytes	Normal Range	Patients Status	Mean	p value
Sodium (n=73)	130-145 mEq/L	At admission	130.15 ± 10.90	<0.001*
		At discharge	134.56 ± 5.97	
Potassium (n=71)	3.5-5.5 mEq/L	At admission	4.1134 ± 0.93	0.4
		At discharge	4.2069 ± 0.83	
Chloride (n=21)	98-107mEq/L	At admission	101.381 ± 9.04	0.079
		At discharge	105.00 ± 5.75	
Ionized Calcium (n=41)	1.12-1.32 mmol/L	At admission	1.30293 ± 1.06	0.2
		At discharge	1.1188 ± 0.15	

In the present study forty four (44) males and Thirty four (34) females were included. Analysis of data was done by using ANOVA to compare mean electrolyte values with their diagnosis.We compared electrolytes results amongst different disease conditions by using "ANOVA test "and we observed that there were no statistically significantly mean differences of electrolytes among different diseases(Table 3).There were no statistically significantly correlation was observed between electrolytes and length of ICU stay.We also used Pearson's correlation coefficient to find out the correlation between patients' hospital stay (in days,) with their difference in electrolytes levels. We observed

during data collection, on an average patient's period of stay in ICU were 6 to 7 days with exception of 2/3 patients who stayed long for almost 21 to 24 days.

Table 2: Correlation of respective electrolytes between at the time of admission and discharge among patients admitted in ICU

Period of stay		
Serum Electrolytes	Correlation coefficient	p value
Sodium (n=73)	0.514	0.001*
Potassium (n=71)	0.402	0.001*
Chloride (n=21)	0.331	0.143
Ionized Calcium (n=41)	0.069	0.666

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Present study was divided as per inclusion criteria in different disease condition with respect to their ICU stay but results showed average ICU stay were 6 to 7 days with exception of CKD. Two to three patients of CKD (except dialysis patient) were stayed more than 7 days.

In this study we have considered difference in electrolyte levels (value at admission and on discharge) and number of days of stayThus, Table 4 represents the correlation between observed difference between (Na, K, Cl&iCa) both values (at admission and at discharge) with length of stay.Positive correlation was observed for potassium (K) with patient's period of stay (in days). Thus, Sodium (Na), chloride(Cl), ionized calcium (I Ca) were showed negative correlation with patients period of ICU stay (in days).

Discussion:

Fluid and electrolyte disturbances are the most common

Table 3: Comparison of electrolytes among the different patient disease groups

Serum Electrolyte	Groups	Sum of Squares	Mean Square	F	P
Na	Between Groups	246.13	49.23	0.5	0.74
	Within Groups	6061.54	90.47		
	Total	6307.67			
K	Between Groups	3.84	0.76	0.8	0.53
	Within Groups	60.72	0.93		
	Total	64.56			
Cl	Between Groups	646.55	129.3	2.0	0.13
	Within Groups	960.39	64.02		
	Total	1606.95			
i_Ca	Between Groups	1.90	0.47	0.4	0.80
	Within Groups	42.96	1.19		
	Total	44.86			

Table 4: Correlation of electrolytes with period of ICU stay of patients

Period of ICU stay		
Serum Electrolytes	Correlation coefficient (r)	p value
Sodium(n=73)	-0.177	0.135
Potassium(n=71)	0.127	0.293
Chloride(n=21)	-0.403	0.070
Ionized Calcium(n=41)	-0.030	0.850

Problems encountered in Intensive care units (ICU's). Clinically important electrolytes occur in body are sodium (Na), potassium (K), chloride (Cl), and ionized calcium (iCa)These electrolytes controlled by hormones in the body. A deviation in serum electrolytes level leads to adverse effect on the body system and may be causing array of serious problems like seizures and cardiac arrest. [9]The main responsible organ for electrolyte regulation is the kidney but other mechanisms are also involved in this process are hormonal activities of ADH, Aldosterone and parathyroid hormone. Thus disorders related to this system may deteriorate electrolyte balance thus results emergencies[1]Body Electrolytes are play a key role in various metabolic and homeostatic functions thus its disorders are commonly observed in ICU patients and thus shows its association with increased morbidity and mortality. [10]In our study we compared electrolyte values in patient at admission and at discharge and found significant ($p<0.01$) rise at discharge compared to an admission which could be after correction. As per Table hypernatremia could be overcome by increasing patient's period of stay with respective corrections. Our results are similar to SohaAbdElhady[11]and GiorginaPiccoli[2]. Unlike sodium (Na), potassium and chloride showed non-significant rise in their levels at time of discharge compared to an admission.Potassium values were found very close or normal at discharge compared to an admission. But as per Tsering Dhondup Qi Qi an, CKD patients can develop hypokalemia which could be due to GI potassium loss[3].Hypocalcaemia observed in the present study at discharge compared with at admission. Hypocalcaemia is one of the abnormalities of electrolytes in ICU which is associated with increased mortality in ICU. Hypocalcaemia could be caused due to trauma, renal disese, sepsis, pancreatitis, transfusion, post para thyroidectomy etc. which may lead to tetany and seizures [12].Electrolyte values were checked at the time of admission and at the time of discharge and sodium showed significant difference or rise by "t test" and our results are similar to Trivedi[12]. We monitored electrolyte pattern in various disease conditions like DM, CKD, CVD, CVS, RD and compared that with electrolyte levels by using ANNOVA test. Thus DM [5],

CKD[2, 3], CVS[4], Respiratory diseases[6] could be the important disease conditions where electrolyte disturbances take place.We have observed correlation of different disease condition with ICU stay of patient and we found average 6 to 7 days ICU stay in all condition except 2 to 3 patient of CKD patient needs more stay, that could be due to insufficient correction and could be overcome by using novel treatment like for managing CKD patient to improve patient speedy outcomes.[2,4]

We used Pearson's correlation coefficient to find out correlation between patient's hospital stay with electrolyte levels and there is positive correlation found in case of Potassium and negative correlation with sodium, chloride and ionized calcium. By the study we observed if we increase more participants it may shows positive correlation with disease condition (0.33 to 0.5) and sodium chloride and ionized calcium levels may come to normal if we increase the stay of diseased patient in ICU.

Conclusion:

Disturbances in fluid and electrolyte level may lead to fatal consequences in critically ill patients. Thus precautionary measures should be practiced regularly for patient electrolyte levels in intensive careunit.Thus timely recognition, high index of suspicion and thorough understanding of abnormalities are needed to ensure their correction and reduce morbidity and mortality. Thus serum electrolytes level should be monitored routinely in these patients and an attempt should be made to correct them at the earliest to avoid poor outcome and to reduce morbidity and mortality One of the key points we

observed in patients admitted in ICU with various diseases was electrolyte disturbances. Therefore, we should be cautious for electrolyte imbalance in those ICU patients. From this present study we can conclude average 6 to 7 days ICU stay for all disease conditions is essential for managing electrolyte disturbances such as potassium and sodium. Chloride and Ionized calcium need more ICU stay to manage disturbances.Our results may not reflect actual prevalence of electrolyte disturbances but definitely acknowledge fluid electrolyte balance dynamics because of high incidence rate. Patient with diabetes may associated with electrolyte disturbances and on complex drug administration. Thus prevention of electrolyte disturbances in patient with Diabetes and renal impairment can mostly require discontinuation of these medications as well as strict control of glycaemia. Newer more randomized controlled trials are essential to clarify prognosis of these diseases, which could help for study outcome.

Implication:

Electrolyte abnormalities are measured as one of the biochemical investigation to determine its clinical correlation with various conditions. The study outcome will help the clinicians to identify common pattern of electrolyte imbalance and these electrolyte pattern will help to decide period of stay of patient at our study settings. This will help for understanding the role of serum electrolyte with illness and its progress.

Conflict of Interest - Nil

Sources of Support- Nil

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