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Original Research Article

Significance of serum electrolyte imbalance and comparison between different testing methods in patients with altered sensorium presenting to tertiary care hospital

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ABSTRACT

Background: Electrolyte disorders are common in patients in the emergency department and intensive care unit, and have been associated with increased morbidity and mortality. In this respect sodium and potassium are the most important cations, whose improper adjustment may cause severe neuromuscular disorders. This study was designed to compare values obtained by laboratory and point-of-care testing and also to find most frequent electrolyte abnormalities.
Methods: Observational Study was done on 51 patients presenting to Tertiary care Hospital emergency department with altered sensorium between 1st January 2016 to 31st May 2017 fulfilling the inclusion criteria and willing for participation by giving written informed consent. Electrolytes were tested in patients with GCS 14 or less by both point of care system and in the laboratory.
Results: The distribution of mean sodium and potassium levels did not differ significantly between two techniques (P-value>0.05). The sodium and potassium levels by POC and laboratory techniques are significantly and positively correlated (P-value<0.001). The distribution of mean along with 95% CI of mean of amount of bias in the estimation of Sodium and Potassium levels by POC against Laboratory method is 3.50 [2.79-4.20] mEq/L and 0.83 [0.55-1.11] mEq/L respectively. The most common electrolyte abnormality was hyponatremia.
Conclusions: We concluded that it is advisable to do a point-of-care electrolyte in Emergency department and Intensive care unit. By use of point-of-care testing, we can identify electrolytes imbalance early in emergency department. Point-of-care electrolyte levels had a near comparable value with laboratory electrolyte levels.

Keywords: Electrolyte abnormality Hyponatremia, Hyperkalaemia, Point-of-care

INTRODUCTION

The definition of 'consciousness' may be the state of awareness of one's self and environment. The absence of awareness, even when one is stimulated, may therefore indicate diffuse or multifocal brain dysfunction, and may be defined as 'altered sensorium'.[1] Coma can be caused by either due to structural damage as a result of brain trauma, edema, inflammation, ischemia, or mass lesions or diffuse metabolic and toxic effects on brain neurons. Structural lesions can affect the arousal neuronal network of the brain stem and basal forebrain directly through local neuronal damage or indirectly by downward or lateral pressure or displacement that causes local ischemia. Metabolic and toxic encephalopathies diffusely affect all brain neurons, particularly the metabolically sensitive cortical and thalamic neurons.[2] The studies that are most useful in the diagnosis of decreased consciousness are chemical toxicologic analysis of blood and urine, cranial CT or MRI, EEG, and CSF examination. Arterial blood gas analysis is helpful in patients with lung disease and acid-base disorders. The metabolic aberrations commonly encountered in clinical practice are usually exposed by measurement of electrolytes, glucose, calcium, osmolarity, and renal (blood urea nitrogen) and hepatic function. Toxicologic analysis may be necessary in any case of acute coma where the diagnosis is not immediately clear.[3] A wide range and growing number of point-of-care (POC, 'near patient') tests which provide rapid 'on site' results are now available. These may have potential to improve outcomes in primary care by optimising prescribing decisions, reducing referrals, improving efficiency of care and decreasing costs. the most common tests currently used were: urine pregnancy, urine leucocytes or nitrite and blood glucose.[4] Electrolyte disorders are common in patients in the emergency department and intensive care unit and have been associated with increased morbidity and mortality. In this respect sodium and potassium are the most important cations, whose improper adjustment may cause severe disorders in neuromuscular, gastrointestinal, respiratory and cardiovascular systems. Aim was to study the importance of electrolyte imbalance in patient presenting with altered sensorium. Objectives of research were to study the abnormalities in serum electrolyte levels in patients presenting with altered sensorium, to evaluate any correlation of electrolyte imbalances with age, sex and underlying disease and to evaluate any disproportion in values of serum electrolyte done by point of care and laboratory method.

METHODS

The study was a cross sectional observational type. This study was conducted from 1st January, 2016 to 31st May, 2017) for 17 months. Study population was about 51 patients with altered sensorium. Considering the reported mean and SD of previous studies with patient load of our hospital, the sample size of 45 had been estimated to give power of 80% for the study at 5% level of significance to detect the difference in mean of more than 15%. The formula used for sample size estimation is given below:

$N = 2 (z\alpha + z\beta)2 / (\delta/\sigma) 2$

Where, N = Sample size (per group), $z\alpha$ = (1.96) for 95% confidence (i.e. $\alpha = 0.05$), $z\beta$ = Cut-off value for Power (1 - β), σ = Common Standard Deviation (SD) of both the values, δ = Mean difference to be detected.

Inclusion criteria includes patients aged 18 years or more and patients Glasgow coma scale 14 or less. Written informed consent given by patient/legally acceptable representative. Exclusion criteria includes patient with HEAD injury.

All patients presenting to tertiary care hospital emergency department with altered sensorium between 1st January 2016 to 31st May 2017 and fulfilling the inclusion criteria were included in the study. On presentation, the patient was thoroughly examined and a detailed history was obtained. Emergency treatment and investigation were done according to hospital's protocol. Patient's consciousness was assessed by Glasgow coma scale. Electrolytes were tested in patients with GCS 14 or less by both point of care system and laboratory. Point-of-care testing of electrolytes was done using ABG analyzer. Laboratory testing of electrolytes was done using central laboratory analyzer. Normal sodium level was taken as 135mEq/L-155mEq/L. Sodium level less than 135mEq/L was taken as hyponatremia and more than 155mEq/L was considered as hypernatremia. Normal potassium level was taken as 3.5mEq/L-5.5mEq/L. Potassium levels less than 3.5mEq/L was taken as hypokalemia and more than 5.5mEq/L was taken as hyperkalemia. Difference between levels of electrolytes estimated using two techniques was calculated. Abnormalities in the serum electrolyte were noted, and its relation with age, sex and underlying disease was studied. Time of the result was noted as printed on the result document. Difference of time between two techniques was calculated in minutes.

Statistical analysis

The data on categorical variables is shown as n (% of cases) and the data on continuous variables is presented as Mean and Standard deviation (SD). The statistical significance of inter-group difference of mean of continuous variables is tested using paired 't' test for normally distributed variables. The underlying normality assumption was tested before subjecting the study variables to 't' test. The entire data is entered and cleaned in Microsoft Excel before statistical analysis. The p-values less than 0.05 was considered to be statistically significant. All the hypotheses are formulated using two tailed alternatives against each null hypothesis (hypothesis of no difference). The entire data is statistically analyzed using Statistical Package for Social Sciences (SPSS).

RESULTS

The minimum -maximum age range of the entire group of cases studied was 23.0 years to 93.0 years. The mean ± standard deviation of age of the entire group of cases studied was 66.1±13.6years. Of 51 cases studied, 2 cases (3.9%) had their age below 40.0 years, 9 cases (17.6%) had their age between 40.0 -49.0 years, 34 cases (66.7%) had their age between 60.0-79.0 years and 6 cases (11.8%) had their age above 80.0 years. Of 51 cases studied, 26 cases (51.0%) were males and 25 cases (49.0%) were females. The male to female sex ratio in the entire study group was 1.04 : 1.00 (Table 1).

Table 1:Age distribution of all cases studied (n=51).

Age group (years)	No. of cases (%)
Below 40.0	2 (3.9%)
40.0-59.0	9 (17.6 %)
60.0-79.0	34 (66.7 %)
Above 80.0	6 (11.8%)

Out of 51 cases studied, 14 cases (27.4%) had normal sodium levels (135.0-155.0 mEq/L), 36 cases (70.6%) had hyponatremia (<135.0 mEq/L), and 1 case (2.0%) had hypernatremia (>155.0 mEq/L). 22 cases (43.2%) had normal potassium levels (3.5-5.5 mEq/L), 12 cases (23.5%) had hypokalemia (<3.5 mEq/L), and 17 cases (33.3%) had hyperkalemia (>5.5 mEq/L) (Table 2).

Table 2: The distribution of sodium and potassium levels among the cases studied (n=51).

Parameters		No. of cases (%)
Sodium	Normal	14 (27.4%)
	Hyponatremia	36(70.6 %)
	Hypernatremia	1 (2%)
Potassium	Normal	22 (43.2%)
	Hypokalemia	12 (23.5%)
	Hyperkalemia	17 (33.3%)

The time difference between point-of-care electrolyte result and laboratory electrolyte result was significant. The mean time difference was significantly higher compared to the ideal reference value (Zero) between two techniques (P-value<0.001). The mean of time difference observed was 250.98 minutes (Table 3).

Table 3: The distribution of time difference between the results obtained by two techniques (n=51).

	Observed		Reference value	P value
	Mean	SD	Mean	
Time diff.	250.98	166.03	0.00	0.001***

P-value by one-sample 't' test. ***P-value<0.001

Table 4: The distribution of co-morbidities (n=51).

Co-morbidity	No. of cases	% of cases
Hypertension	36	70.6
Diabetes	23	45.1
Ischemic heart disease (IHD)	14	27.5
Chronic kidney disease (CKD)	10	19.6
COPD	3	5.9

Table 5: The comparison of mean sodium and potassium by point-of-care and laboratory techniques (n=51).

	Point of care (n = 51)		Laboratory (n = 51)		% Difference [POC-laboratory]		P-value
	Mean	SD	Mean	SD	Mean	95%CI	
Na (mEq/L	126.1	13.8	126.1	14.69	0.13%	-0.82-1.09%	0.997^{NS}
K (mEq/L	4.77	2.14	4.75	1.53	-1.01%	-9.11-7.09%	0.940^{NS}

P-values by paired t test. NS-Statistically non-significant

Out of 51 cases studied, 36 cases (70.6%) had hypertension, 23 cases (45.1%) had diabetes, 14 cases (27.5%) had ischemic heart disease (IHD), 10 cases (19.6%) had chronic kidney disease (CKD) and 3 cases (5.9%) had chronic obstructive pulmonary disease (COPD) (Table 4). The distribution of mean sodium levels did not differ significantly between two techniques (P-value>0.05).

Table 6: The correlation analysis between two techniques for sodium and potassium levels (n=51).

Parameter	Correlation between POC and laboratory technique	
	'r' value	P-value
Sodium	0.956	0.001***
Potassium	0.797	0.001***

***P-value<0.001 (Highly significant correlation)

Mean of sodium levels by point-of-care and laboratory technique was same (126.13mEq/L). The distribution of mean potassium levels did not differ significantly between two techniques (P-value>0.05). Mean of potassium levels by point-of-care and laboratory technique was 4.77 and 4.75, respectively (Table 5).

Correlation analysis was done by Pearson's method between two techniques. The sodium levels by POC and laboratory techniques are significantly and positively correlated (P-value<0.001). The potassium levels by POC and laboratory techniques are significantly and positively correlated (P-value<0.001) (Table 6).

Table 7: The Bland-Altman analysis showing the Bias in estimation (n=51).

	Point of care (N = 51)		Laboratory (N = 51)		Bias (POC-laboratory)		p-value
Parameters	Mean	SD	Mean	SD	Mean	95% CI	
Sodium (meq/L)	126.13	13.82	126.13	14.69	3.50	2.79 TO 4.20	0.997^{NS}
Potassium (meq/L)	4.77	2.14	4.75	1.53	0.83	0.55 TO 1.11	0.940^{NS}

Table 8: The linear regression analysis for the prediction of difference (bias) using average of both the methods by Bland-Altman analysis (n=51).

	DV: Difference in sodium levels			DV: Difference in potassium levels		
	Std. Beta	P-value	R^2 value	Std. Beta	P-value	R^2 value
Constant	-	0.697	1.02%	-	0.891	8.17%
Average	0.101	0.481		0.286	0.042	

DV = Dependent Variable, Difference (Bias) = POC-Laboratory

Agreement between two methods of clinical measurement can be quantified using the differences between observations made using the two methods on the same subjects. The Bland-Altman analysis5 suggest that there is a statistically significant agreement between point-of-care and laboratory method for the estimation of sodium and potassium levels. The distribution of mean along with 95% CI of mean of amount of bias in the estimation of Sodium and Potassium levels by POC against Laboratory method is 3.50 [2.79-4.20] mEq/L and 0.83 [0.55-1.11] mEq/L respectively (Table 7 and 8).

DISCUSSION

In the present study, we observed that electrolyte imbalance was more common in elderly age group. Majority of altered sensorium patients with electrolyte imbalance was in age group of 60.0 -79.0 years. Mean of age was 66.12 with minimum age of 23 years and maximum age of 93 years (Table 1). Study by Qazi Najeeb et al6 had mean age of 41.75, and 67% of study population were less than 45 years of age. Study by Mauro Giordano et al7 had mean age of 52.3. In the present study, we observed that there was no difference in distribution on basis of sex. Out of 51 cases studied, 26 cases (51.0%) were males and 25 cases (49.0%) were females.

In the present study, we observed that out of 51 cases studied, 14 cases (27.4%) had normal sodium levels (135.0-155.0 mEq/L), 36 cases (70.6%) had hyponatremia (<135.0 mEq/L), and 1 case (2.0%) had hypernatremia (>155.0 mEq/L). 22 cases (43.2%) had normal potassium levels (3.5-5.5 mEq/L), 12 cases (23.5%) had hypokalemia (<3.5 mEq/L), and 17 cases (33.3%) had hyperkalemia (>5.5 mEq/L). Study by Giordano M et al had 44% cases of hyponatremia, 4.4% cases of hypernatremia, 39% cases of hypokalemia and 13% cases of hyperkalemia.[7] Study by Najeeb Q et al had 49% cases of hyponatremia, 7% cases of hypernatremia, 36% cases of hypokalemia and 16% cases of hyperkalemia.[6] Study by Singi S and Dhavan A found that the most frequent abnormality was hyponatremia (25%) followed by hypokalemia (12%) (Table 2).[6,8] In the present study, we observed that time difference between point-of-care electrolyte result and laboratory electrolyte result was significant. The mean time difference was significantly higher compared to the ideal reference value (Zero) between two techniques (P-value<0.001). The mean of time difference observed was 250.98 minutes. Other studies had not included time difference, so reference value calculated ideally as Zero. (Table 3).

In the present study, we observed that out of 51 cases studied, 36 cases (70.6%) had hypertension, 23 cases (45.1%) had diabetes, 14 cases (27.5%) had ischemic heart disease (IHD), 10 cases (19.6%) had chronic kidney disease (CKD) and 3 cases (5.9%) had chronic obstructive pulmonary disease (COPD) (Table 4).

In the present study, we observed that the distribution of mean sodium levels did not differ significantly between point-of-care and laboratory technique (P-value>0.05). Mean of sodium levels by point-of-care and laboratory technique was same (126.13mEq/L) (Table 5). Correlation analysis was done by Pearson's method between two techniques. The sodium levels by point-of-care and laboratory techniques are significantly and positively correlated (P-value<0.001) (Table 6). Study by Servent AJ et al had mean difference of 1.3mEq/L for sodium between two techniques.[9] Study by Chacko B et al had mean difference of 4.0mEq/L for sodium between two techniques.[10] In the present study, we observed that the distribution of mean potassium levels did not differ significantly between point-of-care and laboratory technique (P-value>0.05). Mean of potassium levels by point-of-care and laboratory technique was 4.77 and 4.75, respectively (Table 5). Correlation analysis was done by Pearson's method between two techniques. The potassium levels by point-of-care and laboratory techniques are significantly and positively correlated (P-value<0.001) (Table 6). Study by Servent AJ et al had mean difference of 0.2mEq/L for potassium between two techniques.[9] Study by Chacko B et al had mean difference of 0.3mEq/L for sodium between two techniques.[10] Morimatsu H et al concluded that results with two different measurement technologies differed significantly for plasma sodium.[11] Jain A et al found no significant difference between the potassium values measured by the point-of-care testing and the central laboratory auto-analyzer.[12] However, the difference between the measured sodium was found to be significant. Agreement between two methods of clinical measurement can be quantified using the differences between observations made using the two methods on the same subjects. The Bland-Altman analysis was done with our observations. We concluded that there is a statistically significant agreement between point-of-care and laboratory method for the estimation of sodium and potassium levels (Table 7 and 8). Study by Servent AJ et al concluded that for all electrolytes, the mean difference between assays remained below the respective CLIA criteria, defining interchangeability.[9]

CONCLUSION

Based on present study, we concluded that it is advisable to do point-of-care electrolyte estimation. By use of point-of-care testing, we can identify electrolytes imbalance early. Point-of-care electrolyte level had near comparable value with laboratory electrolyte level. As there is no significant difference between results of two techniques, point-of-care result can be used to guide the treatment.

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