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Comparison of electrolyte levels in serum and plasma

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Abstract

Introduction: Measurement of electrolytes plays a significant role in the management of critically ill patients. The accuracy of electrolyte measurement depends on a number of pre-analytical variables. Electrolytes are the positively and negatively charged ions that are essential for normal cellular functioning of the body. Most of the metabolic processes are mediated through electrolytes. Electrolyte abnormalities are seen in a number of conditions and can end up in life threatening conditions unless accurate results are given from the laboratory.

Aim: To check the effect of different storage temperature on estimation of electrolyte values using serum and plasma samples of venous blood.

Materials and Method: Analysis of electrolyte levels was conducted in venous blood samples collected from 30 patients stored under room temperature and at 2-4 ^{0}C. Serum and plasma electrolytes-sodium [Na], potassium [K], chloride [Cl] were analysed using electrolyte analyser at different time intervals and storage conditions. The samples at room temperature were analysed immediately after collection and at 6hours, 12hrs, 24 hrs, 36hrs and 48hrs.The samples kept at 2 - 4^{0}C were also analysed at 6hrs, 12hrs, 24 hrs, 36hrs and48hrs simultaneously.

Results: Serum K, Cl has no significant changes till 48 and 12hrs, both at 2-4^{0}C and at room temperature respectively. Serum Na at 2-4^{0}C is relatively stable for a longer time than its counterpart stored at room temperature (48hrs vs 36 hrs). Similarly, plasma samples also showed more stability at 2-4^{0}C than at room temperature.

Conclusion: Estimation of electrolytes as early as possible at proper storage conditions is the best solution to avoid analytical errors.

Keywords: Sodium, Potassium, Chloride, Electrolytes, Storage Temperature.

Introduction

Electrolytes are essential for vital functioning of the body. Electrolytes play an important role in controlling fluid levels, acid-base balance, nerve conduction, blood clotting and muscle contraction.(1) Variation in electrolytes results leads to serious disorder unless otherwise corrected. The electrolyte values changes under different storage condition. Proper knowledge on preanalytical variables helps to avoid error in the estimation of electrolytes. In the present study, we have analysed the influence of temperature on sodium, potassium and chloride, collected in serum tubes and lithium heparin tubes. Rapid and accurate assessment of electrolyte abnormalities helps the physician in starting timely therapeutic measures. Laboratory services are the backbone of the modern healthcare system. Effective laboratory service is the amalgamation of precision, accuracy, and speed of reports delivered to the patient. In spite of rapid advances in laboratory science, it is still susceptible to various manual and systemic errors.(2) The pre-analytic phase is an important component of total laboratory quality.(3) A large body of evidence collected in the last decade, demonstrates that the pre-analytical phase of the total testing process is much more vulnerable to errors than all other steps.(4,5) Most errors occur in the pre-analytical phase (46-68.2%) and the post analytical phase (18.5- 47%), but still a large fraction (4-32%) can be attributed to the intra analytical phase of the testing process.(6) Errors at any stage of the collection, testing and reporting process can potentially leads to misdiagnosis. Laboratory errors in the analytical phase have significantly decreased in recent times due to automation and technological advancements.(6) Conflicting results have been reported on studies based on storage at different temperatures made us to take this project which would be helpful in the current day critical care milieu.

Materials and Method

This study was conducted during the period of April 2016 to June 2016 in the Biochemistry Clinical laboratory at Vinayaka Mission's Kirupananda Variyar Medical college hospital, Salem, Tamil Nadu, India. Ethical Committee has approved the study protocol. After obtaining consent, samples for the study were collected from OPD patients coming to the laboratory. The samples were collected by trained phlebotomist. Hemolysed and lipaemic samples were excluded from the study.

Blood samples for electrolyte analysis were collected in serum and lithium heparin tubes simultaneously. The samples were centrifuged after 30 minutes of blood clotting for serum and immediately after phlebotomy for plasma(7) to prevent ongoing metabolism of cellular constituents.(8) The samples were aliquotted separately for the analysis at room temperature and refrigerated at 2 to 4^{0}C. Subsequently, serum and plasma samples were analysed for electrolyte

levels at various time intervals and conditions using Easy lyte plus machine, principle based on ion selective electrode method. Before sample analysis, we ran a tri-level quality-control using kit supplied by Easy QC [medica]. For quality assurance purposes, our laboratory participates in the External quality assessment scheme [EQAS] conducted by CMC Vellore. The control values were within range during the analysis period. The samples at room temperature were analysed immediately after collection and at 6hrs, 12hrs, 24 hrs, 36hrs and 48hrs. The samples kept at 2 to 4 ^{0}C were also analysed at 6hrs, 12hrs, 24 hrs, 36hrs and 48hrs simultaneously. Temperature maintenance was strictly followed. The zero hour sample was taken as the control value and compared with results from different time intervals.

Statistical analysis: The statistical analysis was done using SPSS version 16. All the data are expressed in mean and standard deviation. Paired t test was used to analyse difference in values from different time intervals. Test of probability less than 0.05 ($p<0.05$) was regarded significant.

Results

Table 1 shows the baseline electrolyte levels of plasma and serum sodium, potassium and chloride

Table 1: Baseline electrolyte levels of serum and plasma

	Serum		Plasma	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Sodium (mEq/L)	140.2	3.28	139.9	3.28
Potassium(mEq/L)	4.45	0.44	4.13	0.46
Chloride(mEq/L)	105.8	3.19	106	3.22

Table 2 shows serum sodium, potassium and chloride concentration at 2 to 4 ^{0}C over time intervals.

Table 2: Serum electrolytes levels at 2-4^{0}c over time intervals

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean/SD	140.2	3.23	140.2	3.27	140.4	3.36	140.5	3.56	140.6	3.71
	P value	1		0.32		0.12		0.11		0.08	
Potassium (mEq/L)	Mean/SD	4.46	0.44	4.44	0.44	4.43	0.45	4.44	0.44	4.48	0.47
	P value	0.33		0.18		0.13		0.69		0.10	
Chloride (mEq/L)	Mean/SD	106	3.2	106.2	3.47	106.7	3.22	106.5	2.79	106.7	3.54
	P value	0.23		0.23		0.002		0.03		0.002	

Table 3 shows serum sodium, potassium and chloride concentration at room temperature over time intervals.

Table 3: Serum electrolytes levels at room temperature over time intervals

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean±SD	140.3	3.18	140.4	3.28	140.2	3.26	140.4	3.42	141.4	3.41
	P value	0.60		0.29		0.58		0.08		< 0.001	
Potassium (mEq/L)	Mean/SD	4.45	0.44	4.45	0.44	4.45	0.45	4.45	0.44	4.47	0.45
	P value	0.66		0.57		0.71		0.85		0.16	
Chloride (mEq/L)	Mean/SD	105.8	3.21	105.7	3.33	106.6	2.92	106.8	3.05	106.6	3.57
	P value	0.32		0.66		0.0006		0.0003		0.006	

Table 4 shows plasma sodium, potassium and chloride concentration at 2 to 4^{0}C over time intervals.

Table 4: Plasma electrolytes levels at 2-4^{0}c over time intervals

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean/SD	139.9	3.41	140.2	3.18	140.3	3.23	140.2	3.12	140.5	3.09
	P value	1		0.08		0.07		0.12		0.05	
Potassium (mEq/L)	Mean/SD	4.16	0.46	4.13	0.46	4.17	0.44	4.19	0.46	4.22	0.48
	P value	0.24		0.41		0.29		0.08		0.002	
Chloride (mEq/L)	Mean/SD	106	3.17	106.2	3.29	107.1	3.57	106.7	3.15	107	3.30
	P value	1		0.05		0.0003		0.02		0.003	

Table 5 shows plasma sodium, potassium and chloride concentration at room temperature over time intervals.

Table 5: Plasma electrolytes levels at room temperature over time intervals

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean/SD	140.1	3.03	140.2	3.04	140.2	3.10	140.6	3.10	141	3.54
	P value	1		0.29		0.35		0.002		0.001	
Potasium (mEq/L)	Mean/SD	4.15	0.45	4.15	0.46	4.18	0.44	4.19	0.45	4.19	0.45
	P value	0.32		0.52		0.02		0.01		0.007	
Chloride (mEq/L)	Mean/SD	104.9	3.68	105.6	4.01	105.8	4.06	105.6	3.64	106.3	3.88
	P value	0.05		0.01		0.008		0.03		0.0001	

Results obtained for samples immediately after centrifugation are compared with results at different time intervals and their p value were shown in table 2,3,4 and 5. In the present study we found plasma and serum sodium levels did not vary till 48 hours at 2 to 4^0C. At 2 to 4^0C serum K levels did not differ from the baseline value up to 48 hrs, whereas changes were noticed in plasma K after 36 hours. Serum and plasma chloride were stable only up to 12 hours at 2 to 4^0C.

At room temperature, sodium levels did not show any change up to 24 hours in plasma and up to 36 hours in serum. Plasma K was stable up to 12 hours but serum K was stable up to 48 hours. Plasma chloride was stable up to 6 hours but serum chloride was stable upto 12hours.

Discussion

Electrolyte abnormalities can precipitate life-threatening events.[9] Electrolyte abnormalities are one of the common reversible causes of morbidity and mortality in patients admitted in intensive care unit[10] Patients in the intensive care unit are susceptible to develop electrolyte imbalance and it is important to obtain data quickly and correctly to allow prompt therapeutic measures.[11] Laboratory tests are used by clinicians for diagnosis, monitoring, and prognosis in patients with different diseases[12] According to statistics, around 60-70% of the decisions about admissions, discharges and medications are based upon laboratory results.[6] Laboratory testing is an error prone, complex procedure which involves pre-analytical, analytical and post-analytical phases. Of these, the pre-analytical phase is an important component of laboratory medicine, it includes specimen collection, storage time and temperature.[13] This is followed by performing the test as early as possible, since it plays a vital role in accuracy of the result. Pre-analytical errors are largely attributable to human mistakes and the majority of these errors are preventable.[14] Hazards of frequent blood sampling for electrolytes and other laboratory investigations leads to increased infection rate, pain, stress and discomfort to the patient.[15] This study has demonstrated a significant difference in electrolyte values obtained from serum tube and lithium heparin when samples stored at room temperature and at 2 to 4^0C.

In the present study, we found that at room temperature serum sodium levels did not vary till 36 hours and whereas 2 to 4 ^{0}C, variation was not seen till 48 hours. No changes were observed till 48 hours when we compared potassium levels measured using serum samples stored at 2 to 4^0C and at room temperature. Similarly, there were no difference in chloride levels in serum samples up to 12 hours stored at room temperature and at 2 to 4^0C.

Plasma sodium levels did not change till 48hours in samples at 2 to 4^0C whereas changes were seen from 24hours in samples at room temperature. Plasma potassium levels significantly varied from 12 hours at room temperature in contrast to 36 hours at 2 to 4^0C. Plasma chloride levels remained the same as the base line value till 12 hours at 2 to 4^0C, whereas at room temperature changes were noted from 6 hours.

Similar studies have shown varied results. Bobby et al., who investigated the stability of 24 analytes after prolonged contact of plasma and serum with blood cells and after immediate separation of plasma and serum at room temperature and analysed in 0, 2, 4, 8, 16, 24, 32, 40, 48 and 56 hours after collection, found out sodium, potassium and chloride remain stable up to 56 hours.[8] Similarly Heins et al., who performed stability studies on 22 serum analytes found out sodium and potassium were stable for 4 days in serum at 9^0C.[16]

However study by Tanner et al., on 30 adult healthy volunteers on 35 analytes showed that stability of potassium is altered within 24 hours but sodium remains stable up to 24 hours.[17]

Similarly, a study was conducted by Martastahl et al in which they have used whole blood for analysis.[18] Despatch of accurate results by strictly minimizing the pre-analytical errors, repeated venepunctures can be avoided. To conclude, this study may contribute in guiding acceptable delay time and preferable storage conditions.

Limitation

Analysis of electrolytes on a larger number of samples would be of further help.

Conclusions

We suggest that the samples for measurement of serum or plasma electrolytes should be analysed as soon as they are received in the laboratory to ensure valid results. In the event of any delay, samples should be properly covered and stored at 2-4^0C.

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