e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2024; 16(1); 266-270

Original Research Article

A Hospital Based Assessment of the Electrolyte Levels in Serum and Plasma: A Comparative Study

Anupama Priyadarshini[1], Uma Shankar Kumar[2]

[1]Consultant, Department of Biochemistry, Bodhi Hospital, Patna,Bihar, India

[2]Consultant, Department of Anesthesiology, Bodhi Hospital, Patna, Bihar, India

Received: 10-11-2023 / Revised: 19-12-2023 / Accepted: 28-01-2024

Corresponding author: Dr. Uma Shankar Kumar

Conflict of interest: Nil

Abstract

Aim: The aim of the present study was to compare electrolyte levels in serum and plasma.

Material & methods: This study was conducted during the period of 12 months at Bodhi Hospital, Patna, Bihar, India 50 patients were included in the study. 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.

Results: According to the data, there are substantial differences in the average levels of certain electrolytes between serum and plasma. In the present study we found plasma and serum sodium levels did not vary till 48 hours at 2 to 4°C. At 2 to 4°C 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°C. 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.

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 ions that convey an electrical charge and thus are required for normal cell and organ function in the human body. They are involved in a variety of physiological processes, including fluid and electrolyte stability, blood pH regulation, and nerve impulse transmission. Electrolyte imbalances can cause a variety of clinical symptoms such as muscle spasms, weakness, and irregular heartbeats. As a result, accurate electrolyte measurement is critical in the detection and cure of a variety of medical conditions. [1] Numerous factors, including the serious nature of underlying diseases, incapacitation, inability to express thirst and inappropriate intravenous fluid administration, put ICU hospitalized patients at a high risk for developing sodium imbalance which may be associated with increased morbidity or mortality. [2,3,4] Similarly, potassium abnormalities have been recognized as a preventable cause of cardiac arrest. Serial measurements of arterial blood gases (ABG) and electrolytes are therefore essential for monitoring ICU patients. [5-7]

Fluctuation in potassium levels is also well-documented during the course of cardiac resuscitation. [8] Electrolyte abnormalities are one of the common reversible causes of morbidity. Inaccurate sodium results can lead to inappropriate fluid administration which can result in hypernatremia and abnormal levels of potassium can cause bradycardia, asystole and cardiac arrest. Accurate estimation of electrolytes has gained additional importance in diagnosis of etiology of various pathologies, because it is used to calculate anion gap. The turnaround time for electrolytes should be low, so that early management of electrolyte abnormalities can be done.

Although anemia in critically ill patients is multifactorial, phlebotomy accounts for greater blood loss than pathologic bleeding and is associated with a higher mortality rate in these patients. [9-11]

Serum and plasma are two biological fluids used to measure electrolytes. Serum is a clear, yellowish fluid that remains after blood coagulation and contains all of the components of blood except cells and clotting factors. Plasma, on the other hand, is the liquid component of blood that contains all of the blood's components, including cells and clotting

factors. However both serum and plasma can be used to measure electrolytes, there is some disagreement about which fluid is more accurate and reliable. [12] Hazards of frequent blood sampling for ABG, electrolyte and other laboratory investigations include increased infection rate, pain, stress response, patient's discomfort and anemia in newborns. In order to decrease the number of phlebotomies, it is preferable to check blood electrolytes on the one single sample collected for ABGs rather than performing additional venepunctures to collect venous blood in order to check serum levels of sodium and potassium.

The aim of the present study was to compare electrolyte levels in serum and plasma.

Material & Methods

This study was conducted during the period of 12 months at Bodhi Hospital, Patna, Bihar , India 50 patients were included in the study. 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.

Methodology

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 [13] to prevent ongoing metabolism of cellular constituents. [14] The samples were aliquotted separately for the analysis at room temperature and refrigerated at 2 to 40C. 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 trilevel 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, 36 hrs and 48hrs. The samples kept at 2 to 4°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: Baseline electrolyte levels of serum and plasma

	Serum		Plasma	
	Mean	**Standard Deviation**	**Mean**	**Standard Deviation**
Sodium (mEq/L)	138.2	3.37	137.6	3.24
Potassium(mEq/L)	4.46	0.47	4.16	0.45
Chloride(mEq/L)	104.6	3.17	105	3.27

According to the data, there are substantial differences in the average levels of certain electrolytes between serum and plasma.

Table 2: Serum electrolytes levels at 2-4°C over time intervals

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean/SD	140.4	3.26	140.4	3.28	140.5	3.37	140.7	3.54	140.8	3.74
	P value	1		0.36		0.15		0.12		0.07	
Potassium (mEq/L)	Mean/SD	4.48	0.42	4.46	0.40	4.45	0.41	4.48	0.43	4.49	0.46
	P value	0.39		0.17		0.14		0.68		0.12	
Chloride (mEq/L)	Mean/SD	106	3.4	106.3	3.44	106.6	3.24	106.6	2.78	106.8	3.56
	P value	0.25		0.28		0.003		0.04		0.007	

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

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean±SD	140.5	3.16	140.3	3.24	140.2	3.22	140.5	3.46	141.2	3.44
	P value	0.68		0.25		0.52		0.07		< 0.001	
Potassium (mEq/L)	Mean/SD	4.46	0.42	4.44	0.43	4.46	0.42	4.47	0.45	4.48	0.44
	P value	0.62		0.52		0.75		0.80		0.17	
Chloride (mEq/L)	Mean/SD	105.7	3.22	105.8	3.34	106.4	2.88	106.6	3.07	106.7	3.58
	P value	0.36		0.68		0.0007		0.0004		0.007	

Table 4: Plasma electrolytes levels at 2-4°C over time intervals

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean/SD	139.8	3.42	140.2	3.17	140.4	3.24	140.1	3.14	140.7	3.07
	P value	1		0.09		0.07		0.19		0.07	
Potassium (mEq/L)	Mean/SD	4.17	0.43	4.14	0.46	4.18	0.42	4.18	0.43	4.23	0.47
	P value	0.28		0.43		0.26		0.07		0.002	
Chloride (mEq/L)	Mean/SD	106	3.17	106.4	3.26	107.2	3.56	106.6	3.16	107	3.32
	P value	1		0.06		0.0007		0.02		0.005	

In the present study we found plasma and serum sodium levels did not vary till 48 hours at 2 to 4°C. At 2 to 4°C 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°C. (Table 2-4)

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

		6hr		12hr		24hr		36hr		48hr	
Sodium (mEq/L)	Mean/SD	140.2	3.04	140.3	3.05	140.4	3.12	140.7	3.11	141	3.52
	P value	1		0.23		0.32		0.003		0.002	
Potassium (mEq/L)	Mean/SD	4.15	0.43	4.15	0.41	4.16	0.42	4.17	0.44	4.18	0.46
	P value	0.36		0.58		0.03		0.01		0.007	
Chloride (mEq/L)	Mean/SD	104.6	3.65	105.7	4.02	105.7	4.07	105.7	3.62	106.4	3.86
	P value	0.07		0.01		0.007		0.03		0.0001	

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

Electrolytes are ions that convey an electrical charge and thus are required for normal cell and organ function in the human body. They are involved in a variety of physiological processes, including fluid and electrolyte stability, blood pH regulation, and nerve impulse transmission. Electrolyte imbalances can cause a variety of clinical symptoms such as muscle spasms, weakness, and irregular heartbeats. As a result, accurate electrolyte measurement is critical in the detection and cure of a variety of medical conditions. [15] Serum and plasma are two biological fluids used to measure electrolytes. Serum is a clear, yellowish fluid that remains after blood coagulation and contains all of the components of blood except cells and clotting factors. Plasma, on the other hand, is the liquid component of blood that contains all of the blood's components, including cells and clotting factors. However both serum and plasma can be used to measure electrolytes, there is some disagreement about which fluid is more accurate and reliable. [16]

According to the data, there are substantial differences in the average levels of certain electrolytes between serum and plasma. In the present study we found plasma and serum sodium levels did not vary till 48 hours at 2 to 4°C. At 2 to 4°C 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°C. Electrolyte abnormalities can precipitate life-threatening events. [17] Electrolyte abnormalities are one of the common reversible causes of morbidity and mortality in patients admitted in intensive care unit. [18] 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. [19] Laboratory tests are used by clinicians for diagnosis, monitoring, and prognosis in patients with different diseases. [20]

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. 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. [21] Similarly Heins et al [22] who performed stability studies on 22 serum analytes found out sodium and potassium were stable for 4 days in serum at 90C. However study by Tanner et al [23] 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. Similarly, a study was conducted by Martastahl et al [24] in which they have used whole blood for analysis.

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°C.

References

1. Madias NE, Adrogué HJ. PMID: 10793167. N Engl J Med. 2000 May 4;342(18):1581-9.
2. Arieff AI: Acid-base, electrolyte, and metabolic abnormalities. In Critical Care Medicine: Principles of Diagnosis and Management in the Adult 2nd edition. Edited by: Parrillo JE, Dellinger RP. St. Louis: Mosby ; 2002; 1169- 1203
3. Palevsky PM, Bhagrath R, Greenberg A. Hypernatremia in hospitalized patients. Ann Intern Med 1996; 124 (2): 197- 203.
4. Anderson RJ, Chung HM, Kluge R, Schrier RW. Hyponatremia: a prospective analysis of its epidemiology and the pathogenetic role of vasopressin. Ann Intern Med 1985; 102 (2): 164- 8.
5. Dong SH, Liu HM, Song GW, Rong ZP, Wu YP. Arterialized capillary blood gases and acid-base studies in normal individuals from 29 days to 24 years of age. Am J Dis Child 1985; 139 (10): 1019- 22.
6. Adrogué HJ, Rashad MN, Gorin AB, Yacoub J, Madias NE. Assessing acid-base status in circulatory failure. Differences between arterial and central venous blood. N Engl J Med 1989; 320 (20): 1312- 6.
7. Roberts D, Ostryzniuk P, Loewen E, Shanks A, Wasyluk T, Pronger L, et al. Control of blood gas measurements in intensive-care units. Lancet 1991; 337 (8757): 1580- 2.
8. Johnston HLM, Murphy R. Agreement between an arterial blood gas analyser and avenous blood analyser in the measurement of potassium inpatients in cardiac arrest. Int J Emerg Med. 2005;22:269-71.
9. Raghavan M, Marik PE. Anemia, allogenic blood transfusion, and immunomodulation in the critically ill. Chest 2005; 127 (1): 295- 307.
10. Von Ahsen N, Müller C, Serke S, Frei U, Eckardt KU. Important role of nondiagnostic blood loss and blunted erythropoietic response in the anemia of medical intensive care patients. Crit Care Med 1999; 27 (12): 2630- 9.
11. Carson JL, Duff A, Poses RM, Berlin JA, Spence RK, Trout R, et al. Effect of anaemia and cardiovascular disease on surgical mortality and morbidity. Lancet 1996; 348 (90 34): 1055-60.
12. FJ Gennari. N Engl J Med. 1998 Dec 31;339 (27):451-8.
13. Christiane Oddoze, Elise Lombard, Henri Portugal, Stability study of 81 analytes in human whole blood, in serum and in plasma, Clinical Biochemistry, 2012,45,464– 469.
14. Bobby L. Boyyanton, Jr., and Kenneth E. Blick, Stability studies of Twenty-Four Analytes in Human Plasma and Serum, Clinical Chemistry, 2002,48(12),2242-2247.
15. Madias NE, Adrogué HJ. PMID: 10793167. N Engl J Med. 2000 May 4;342(18):1581-9.
16. FJ Gennari. N Engl J Med. 1998 Dec 31;339 (27):451-8.
17. Binila Chacko, John V Peter, Shalom Patole, Jude J Fleming and Ratnasamy Selvakumar. Electrolytes assessed by point-of-care testing – Are the values comparable with results obtained from the central laboratory? Indian J Crit Care Med, 2011,15(1),24–29.
18. Shalini Gupta, Ashwani K Gupta, Kamaljit Singh, Minni Verma, Are sodium and potassium results on arterial blood gas analyzer equivalent to those on electrolyte analyzer?, Indian J Crit Care Med 2016,20(4),233-237.
19. Yasemin U Budak, Kagan Huysal, Murat Polat. Use of a blood gas analyzer and a laboratory autoanalyzerin routine practice to measure electrolytes in intensive care unit patients. BMC Anaesthesiology, 2012,12(17), 1-7.
20. A Marjani, Effect of Storage Time and Temperature on Some Serum Analytes, The internet Journal of Laboratory Medicine, 2006 ,2(2),1-6.
21. Bobby L. Boyyanton, Jr., and Kenneth E. Blick, Stability studies of Twenty-Four Analytes in Human Plasma and Serum, Clinical Chemistry, 2002,48(12),2242-2247.
22. Michael Heins, Wolfgang Heil and Wolfgang With old, Storage of Serum or Whole Blood Samples? Effects of Time and Temperature on 22 Serum Analytes, Eur J Clin Chem Clin Biochem, 1995,33,231-238.
23. Melissa Tanner, Neil Kent, Brian Smith, Stephen Fletcher and Michelle Lewer, Stability of common biochemical analytes in serum gel tubes subjected to various storage temperatures and times pre-centrifugation, Annals of Clinical Biochemistry, 2008,45,375-379.
24. Marta Stahl and Ivan Brandslund, Controlled Storage Conditions Prolong Stability of biochemical Components in Whole blood, Clin Chem Lab Med, 2005,43(2),210-215.