ORIGINAL RESEARCH PAPER

Clinical Research

KEY WORDS: Phosphate, clinical equivalence, serum, plasma.

# CLINICAL EQUIVALENCE OF HEPARINIZED ARTERIAL PLASMA TO VENOUS SERUM SAMPLES FOR PHOSPHATE MEASUREMENT IN CRITICAL PATIENTS AT MOI TEACHING AND REFERRAL HOSPITAL

**Dominic Alwala** P.O.BOX 3837 Eldoret Kenya

**ABSTRACT**

Electrolytes excluding phosphate are measured as part of tests done during blood gas analysis (BGA) using arterial blood in Intensive Care Unit (ICU) patients. Phosphate is measured from a venous serum sample since it cannot be measured during BGA. Plasma obtained from sodium-heparin anticoagulant is yet to be used as a sample of choice for measuring phosphate since it is not clear whether there is clinical equivalence between concentrations obtained from venous serum and arterial plasma. It is clinically important that those measurements should give equivalent results and confirm the closeness to the absolute value. This study assessed the equivalence of arterial and venous blood phosphate concentration. Mean difference between phosphate concentration in plasma and serum was 0.14(t=1.18) p=0.24. Phosphate correlation between plasma and serum was r=0.99 [P = 0.00 (< 0.05)]. The study indicated clinical equivalence between phosphate concentration in arterial blood plasma and venous blood serum.

## INTRODUCTION

Electrolyte imbalance in hospitalized patients can lead to serious and critical events which might adversely affect the outcome of the patient hence quick and accurate assessment of these disturbances demands immediate medical attention (Alanazi, et al., 2015). In Moi Teaching and Referral Hospital (MTRH), patient samples for magnesium and phosphate measurement are collected by venipuncture and transported to the central laboratory for analysis separately from samples collected for Blood Gas Analysis (BGA). The same patient will then undergo an arterial puncture to obtain blood for BGA, thus the patient undergoes trauma twice. Phosphate is among the electrolytes found within the body and is involved in numerous metabolic processes (Moe, 2008). Almost all metabolic processes are dependent upon or are mediated by electrolytes (Budak, et al., 2012). Variation in electrolyte concentrations may be due to a variety of disorders and such disorders must be identified in time to ensure adequate and timely treatment as electrolyte abnormalities can represent significant risks to life (Budak, et al., 2012). Although frequent blood draws can destroy veins, cause pain, and lead to anemia, ICU patients typically have routine daily blood tests to help detect problems early (Eachempati, 2014). Under such circumstances it is important to obtain data quickly so as to optimize the therapeutic response interval and allow prompt treatment. In order to decrease the number of phlebotomies in the ICU, and thereby minimize the general discomfort and trauma patients undergo during such activities, it is preferable to measure blood electrolytes on the one single sample collected for blood gases rather than performing additional venipunctures to collect venous blood in order to check serum levels of phosphate as has been routinely done.

## MATERIALS AND METHODS

This was a cross-sectional study in which 153 paired samples were obtained by arterial puncture and venipuncture on patients in ICU for obtaining arterial blood and venous blood. Arterial blood was collected from the radial artery using heparinized syringes containing sodium heparin anticoagulant and centrifuged to obtain plasma while venous blood was collected from the antecubital vein using non-heparinized syringes and centrifuged to obtain serum. Plasma and serum obtained were transferred into a clean analyzer sample cup for magnesium measurement in the automated analyzer COBAS INTEGRA®400 plus (Roche diagnostics Germany) located in the biochemistry Laboratory of MTRH. Phosphate measurement employs a timed-rate method to determine the concentration of phosphate in serum and plasma. In the reaction, inorganic phosphorus reacts with ammonium molybdate in an acidic solution to form a colored phosphomolybdate complex. The system monitors the change in absorbance at 365 nm at a fixed time interval. This change in absorbance is directly proportional to the concentration of phosphate in the sample. Ethical approval for the study was sought from MTRH and Moi University Institutional Research and Ethics Committee (IREC) and approval number was 0002004.

## RESULTS

Arterial and venous blood samples were obtained whose plasma and serum were analyzed for phosphate concentrations. Phosphate concentrations obtained from plasma and serum were analyzed statistically to obtain mean, SD, mean differences and correlations.

Mean difference between phosphate concentration in arterial blood plasma and venous blood serum was 1.71±1.02mmol/L and mean phosphate concentration in serum was 1.85±1.09mmol/L. The mean difference between plasma and serum was 0.14mmol/L (t=1.18, p=0.24).

**Table 1. Mean difference between phosphate concentration in arterial and venous blood**

| N | Arterial Blood Mean±SD | Venous Blood Mean±SD | Mean Difference | t-value | p-value |
|---|---|---|---|---|---|
| 153 | 1.71±1.02 | 1.85±1.09 | 0.14 | 1.18 | 0.24 |

N (sample size) =153. Plasma and serum samples were obtained from 153 patients to measure phosphate levels. Each sample was measured once.

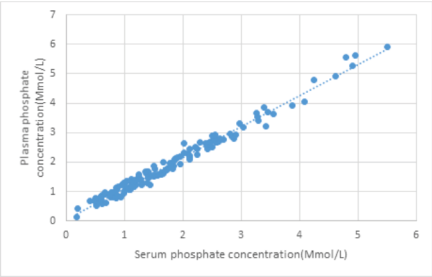
From these results, the p-value is not significant therefore null hypothesis is accepted. This means there is no difference in phosphate concentration between arterial blood plasma and venous blood serum in patients admitted to the ICU at MTRH. Donnelly (Donelly, et al., 2009) used lithium heparin plasma and serum and compared the values of 27 biochemical analyses. For 16 of the 27 tests, statistical differences were observed between the mean results obtained from the analysis of heparinized plasma and those obtained from the analysis of serum (Student t-test; P < .001). However, none of these differences were medically significant. Doumas (Doumas, et al., 1989)measured 25 analytes in plasma and serum from the same blood specimen, for 22 of the analytes, values for plasma were practically the same as those for serum. Carey (Carey, et al., 2016) found a mean difference of 0.003 (p=0.47) between simultaneously drawn serum and plasma phosphorus in 101 dialysis patients. The above studies are reflective of the results obtained in the current study indicating that arterial blood plasma can be used in place of venous blood serum without getting a difference in values.

### Correlation between phosphate concentration in arterial and venous blood

The correlation between phosphate concentration in arterial blood plasma and venous blood serum from 153 patients was

done using Pearson correlation and r value obtained was 0.99 [P = 0.00 (< 0.05)].

**Figure 1. Correlation between phosphate concentration in arterial and venous blood.**




The p-value obtained is significant therefore null hypothesis is rejected and alternative hypothesis accepted. This means there is a correlation between phosphate concentration in arterial blood plasma and phosphate concentration in venous blood serum. O'Keane (O'Keane M & Cunningham S, 2006) evaluated serum, plasma lithium heparin and serum gel separator for analysis of biochemical analytes. All analytes, except potassium, demonstrated equivalence. Carey (Carey, et al., 2016) did a study to find the relationship between simultaneously drawn serum and plasma phosphorus in 101 dialysis patients and found r = 1.00. Tze-Kiong (Tze-Kiong Er, et al., 2006) analyzed aliquots of serum andheparinized plasma samples for sodium (Na), potassium (K), chloride (Cl) among other biochemical analytes and percent differences between serum versus heparinized plasma samples for all analytes ranged from 0.0% to 10.8%. The above studies demonstrated equivalence between serum and plasma concentration of analytes. Results obtained in the current study demonstrated equivalence in phosphate concentration between serum and plasma samples suggesting that no alteration in concentration occurs in phosphate concentration between the two sample matrices.

## CONCLUSION

1. Phosphate concentration in arterial blood plasma and venous blood serum is not significantly different.
2. There is correlation between phosphate concentration in arterial blood plasma and venous blood serum.

## REFERENCES

1. Alanazi, Obaidi, Enezi, AlMutairi, Aljerian, Alsultan, . . . Qureshi. (2015). Correlation between the Measurements of Serum and Arterial Blood Gas (ABG) Electrolytes in Patients Admitted to the Intensive Care Unit at King Abdul-Aziz Medical City, Riyadh, Saudi Arabia. American Journal of Clinical Medicine Research., 3(3), 55-59.
2. Budak, Huysal, Polat, Budak Y U, Huysal K, & Polat M. (2012). Use of a blood gas analyzer and a laboratory autoanalyzer in routine practice to measure electrolytes in intensive care unit patients. BMC Anesthesiology., 12-17. Retrieved from http://doi.org/10.1186/1471-2253-12-17
3. Donelly, James G. Donelly, Steven J. Soldin, Daniel A. Nealon, Jocelyn M. Hicks, & Soldin. (2009). Is Heparinized Plasma Suitable for Use in Routine Biochemistry? Pediatric Pathology & Laboratory Medicine , 15:4, 555-559.
4. Doumas, B T Doumas, L L Hause, D M Simuncak, D Breitenfeld, Hause, et al. (1989). Differences between values for plasma and serum in tests performed in the Ektachem 700 XR Analyzer, and evaluation of "plasma separator tubes (PST)". Clinical Chemistry , 35(1), 151-153.
5. Eachempati. (2014). Monitoring and Testing the Critical Care Patient [Electronic Version]. Approach to the Critically Ill Patient. Retrieved from http://www.msdmanuals.com/professional/critical-care-medicine/approach-to-the-critically-ill-patient/monitoring-and-testing-the-critical-care-patient
6. Gupta, Gupta S, Gupta AK, Singh K, Verma M, & A K. (2016). Are sodium and potassium results on arterial blood gas analyzer equivalent to those on electrolyte analyzer? Indian Journal of Critical Care Medicine : Peer-Reviewed, Official Publication of Indian Society of Critical Care Medicine, 233-237. Retrieved from http://doi.org/10.4103/0972-5229.180044
7. Jain, Subhan, Joshi, Jain A, Subhan I, & Joshi M. (2009). Comparison of the point-of-care blood gas analyzer versus the laboratory auto-analyzer for the measurement of electrolytes. International Journal of Emergency Medicine, 2(2), 117-120. Retrieved from http://doi.org/10.1007/s12245-009-0091-1
8. Moe. (2008). Disorders Involving Calcium, Phosphorus, and Magnesium. Primary Care, 215. Retrieved from http://doi.org/10.1016/j.pop.2008.01.007
9. O'Keane M, & Cunningham S. (2006). Evaluation of three different specimen types (serum, plasma lithium heparin and serum gel separator) for analysis of certain analytes: clinical significance of differences in results and efficiency in use. Clinical Chemistry and Laboratory Medicine (CCLM) , 44(5), 662-668.
10. Tze-Kiong Er, Li-Yu Tsai, Yuh-Jyh Jong, Bai-Hsiun Chen, Tze-Kiong Er, & Li-Yu Tsai. (2006). Selected Analyte Values in Serum Versus Heparinized Plasma Using the SYNCHRON LX PRO Assay Methods/Instrument. Laboratory Medicine , Volume 37 (Issue 12), 731-732.
11. Yu, Kastenmüller, He Y, Belcredi P, Möller, Prehn C, & Wang-Sattler. (2011). Differences between Human Plasma and Serum Metabolite Profiles. PLoS ONE, 6(7), e21230. Retrieved from http://doi.org/10.1371/ journal. pone.0021230
12. Zhang, Lin, Zhao, Zhang JB, Lin J, & Zhao XD. (2015). Analysis of Bias in Measurements of Potassium, Sodium and Hemoglobin by an Emergency Department-Based Blood Gas Analyzer Relative to Hospital Laboratory Autoanalyzer Results. PLoS ONE, 10(4), e0122383. Retrieved from http://doi.org/10.1371/journal.pone.0122383