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## COMPARISON OF SERUM ELECTROLYTES MEASUREMENT USING ABG ANALYSER AND ELECTROLYTE ANALYSER IN PATIENTS ADMITTED IN ICU

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### Keywords:

Electrolytes, Hyperlipidemia / hyperprotenemia, Method difference

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**ABSTRACT:** Electrolytes are crucial for establishing and maintaining the electrical potential across cell membranes. Electrolyte abnormalities can precipitate life-threatening events. The incidence of electrolyte disorders is nearly 25% in ICU patients. Ion selective electrodes (ISEs) are so far commonly used method for electrolytes estimation in clinical laboratories. Studies using different devices have reported different results. Consequently, determining how well different methods align in their electrolyte readings is important. Comparisons of electrolyte results from arterial (ABG analyzer) and serum (electrolyte analyzer) samples, both utilizing the direct, non-diluting ISE method, have been the subject in this study. The objective to investigate whether the results of electrolytes measures on electrolyte analyser and ABG analyser are equal when used to assess electrolyte levels (sodium, potassium & chloride). The gap is usually small (1-4 mmol/L) but in critically ill patients or in sever hyperlipidemia / hyperprotenemia; the difference can be clinically significant. our study we concluded that if there is a large difference between the two methods in the same patient, one should check for hyperlipidemia, hyperproteinemia, as hemolyses before deciding which result is more reliable.

**INTRODUCTION:** Electrolytes like sodium (Na<sup>+</sup>), potassium (K<sup>+</sup>), calcium (Ca<sup>2+</sup>), and chloride (Cl<sup>-</sup>) are crucial for establishing and maintaining the electrical potential across cell membranes. This is fundamental for nerve impulse transmission, muscle contraction (including the heart), and various cellular processes<sup>1</sup>. Sodium is the primary electrolyte that determines extracellular fluid volume.

Along with potassium and chloride, electrolytes influence osmotic pressure, which governs water movement between fluid compartments in the body, ensuring proper hydration and blood volume<sup>2</sup>. Electrolyte abnormalities can precipitate life-threatening events. The incidence of electrolyte disorders is nearly 25% in ICU patients.

For critically ill patients in the emergency department, those receiving fluid therapy, and individuals admitted to intensive care units (ICU), electrolyte levels are consistently monitored<sup>3</sup>. Misleading sodium values could result in unsuitable fluid therapy, leading to a state of hypernatremia. Aberrant potassium concentrations are a pivotal reversible determinant of cardiac arrest. Hyperkalemia can instigate bradycardia and

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asystole, conversely, hypokalemia may provoke cardiac arrhythmias. It's also well-established that potassium levels can fluctuate significantly throughout the process of cardiac resuscitation<sup>4</sup>.

Ion selective electrodes (ISEs) are so far commonly used method for electrolytes estimation in clinical laboratories. There are two types of ISE measurements based on sample preparation. Direct ISE uses an undiluted sample to interact with ISE membrane, and the devices based on indirect ISE use preanalytical dilution. Direct ISE may use whole blood as in the case of an arterial blood gas (ABG) analyzer, or may use serum as in the case of bench top prolyte electrolyte analyzers.

Studies using different devices have reported different results. Consequently, determining how well different methods align in their electrolyte readings is important. Comparisons of electrolyte results from arterial (ABG analyzer) and serum (electrolyte analyzer) samples, both utilizing the direct, non-diluting ISE method, have been the subject in this study.

The present study was done with the objective to investigate whether the results of electrolytes measures on electrolyte analyser and ABG analyser are equal when used to assess electrolyte levels (sodium, potassium & chloride), at Ashwini rural medical college Kumbhari, Solapur.

**METHODOLOGY:** A retrospective comparison study was done for 40 patients. The observational study was conducted for a period of 6 months, in the Central Biochemistry Laboratory Ashwini rural medical college & hospital Solapur. Ethical clearance to conduct the study was obtained from the Institutional ethical committee. The patients whose serum samples and heparinised arterial samples were drawn at the same time and sent to the laboratory were chosen for study. The electrolytes were measured in heparinised arterial

samples in ABG analyser by GASTAT -720 and serum samples in DIAMOND diagnostic PROLYT Eelectrolyte analyser

**METHODS:** The principles of analyses in ABG analyser are as follows: The GASTAT 720 ABG (Arterial Blood Gas) analyzer utilizes specialized electrodes to measure the partial pressures of oxygen (pO<sub>2</sub>) and carbon dioxide (pCO<sub>2</sub>) in a blood sample, as well as the pH level. The analyzer draws a small blood sample, typically from an artery, through a capillary tube. Each electrode generates an electrical signal proportional to the concentration of the measured substance. The electrical signals are amplified and converted into digital data by the analyzer's microcomputer. Prolyte electrolyte analyser utilize ion-selective electrode (ISE) technology to measure electrolyte concentrations. ISEs work based on the principle that certain ions, when in contact with a specific membrane (the ion-selective membrane), will selectively bind to it, causing a change in electrical potential. This potential difference is then measured and correlated to the concentration of the target ion in the sample.

**Statistical Analysis:** The data were collected and arranged in tables using Microsoft Excel version 2010. The Mean, standard deviation and P value was calculated. P value < 0.05 was considered statistically significant.

## RESULTS:

**TABLE 1: DIFFERENCE BETWEEN ABG ANALYSER AND ELECTROLYTE ANALYSER**

ABG analyser	Electrolyte analyser
Whole blood analysed	Serum sample analysed
Arterial sample used	Venous sample used
Heparinized sample used	Serum sample used without anticoagulant
No effect of protein level	Affected by protein level
TAT is short – within 5 min	TAT is long – within 30 min

**TABLE 2: COMPARISON OF RESULT ABG AND SERUM ELECTROLYTE**

Electrolytes	No. of sample	ABG value	Serum value	Mean difference	SDI	P value
Sodium	40	139.4	135.28	4.12	8.48	p<0.05
Potassium	40	4.98	4.45	0.53	1.1	p<0.05
Chloride	40	108	103.4	4.6	8.37	p<0.05

p<0.001 - Highly significant p<0.01 - More significant p<0.05- Significant p>0.05- Not significant.

The study compared sodium levels in serum and ABG samples, revealing a statistically significant

(p < 0.05) discrepancy. The mean sodium level in serum was 135.28 mmol/L, compared to 139.4

mmol/L in ABG. This resulted in a maximum difference of 4.12 mmol/L, with a negative bias observed in the arterial samples. Despite this difference, 40 samples fell within the acceptable variation range of 4 mmol/L, as per CLIA guidelines. A significant discrepancy was observed in potassium measurements, with serum samples showing a mean of 4.45 mmol/L and ABG samples averaging 4.98 mmol/L ( $P < 0.05$ ). This suggests a positive bias of 0.53 mmol/L in serum potassium readings compared to ABG. However, it's worth noting that the variation in 40 samples fell within the acceptable 0.5 mmol/L range stipulated by CLIA guidelines.

The mean Chloride in serum sample was 103.4 mmol/L as compared to 108 mmol/L in ABG sample ( $P < 0.05$ ) **Table 2**. A significant difference also found when the mean ( $\pm$ SD) of potassium levels compared between ABG and electrolyte analyser ( $p < 0.05$ ). The mean difference among the results was 4.6 mmol/L showing a positive bias in serum sample. There were 40 samples with variation up to 4 mmol/L which is acceptable limit for  $K^+$  as per Clinical Laboratories Improvement Amendment (CLIA) guidelines.

**DISCUSSION:** Electrolyte abnormalities, such as imbalances in sodium, potassium and chloride are frequently observed in ICU settings and can cause serious complications, including cardiac arrhythmias, respiratory failure, and neurological dysfunction. Many of these issues are reversible with timely intervention, highlighting the importance of regular monitoring<sup>5</sup>.

To ensure the reliability of our laboratory's electrolyte measurements, our central lab, which employs an electrolyte analyser actively participates in CMC Vellore external quality assessment (EQA) program. This EQA program allowed for confirmation of accurate electrolyte measurements throughout the study. While we utilized internal quality controls for the ABG analyser, which is also used in our lab, was not evaluated by an external EQA program. We used internal trivalent controls for the ABG analyser instead. The difference may be at the principle on which the instrument works and the sample type. Electrolyte analyser uses indirect ion- selective electrode (ISE) method.

In addition, the sample serum / plasma is diluted before measurement. Results can be influenced by the proportion of water in plasma affected by high lipids as proteins pseudohyponatremia effect is more likely with indirect ISE<sup>6,9</sup>.

Blood gas analyser uses direct ISE method the sample here is not diluted. Less affected by abnormal protein of lipid concentration. So, Sodium, Potassium, chloride tend to be more accurate in such cases. Sodium and potassium values from a blood gas analyser may be slightly lowers especially compared to indirect ISE because latter reports the concentration in plasma water + solids while direct ISE measures just the plasma water. The gap is usually small (1-4 mmol/L) but in critically ill patients or in sever hyperlipidemia / hyperprotenemia; the difference can be clinically significant<sup>7</sup>.

Blood gas analysers are preferred for quick point of care electrolyte checks especially in ICU/ OT. Electrolyte analysers are the lab standard for routine reporting; but results may need correlation if abnormal plasma solids are suspected. Further turnaround time is slower in electrolyte analyser (Lab based) whereas it is very fast in blood gas analyser which is point of care<sup>8,10</sup>.

**CONCLUSION:** So based on our overall observations of our study we concluded that if there is a large difference between the two methods in the same patient, one should check for hyperlipidemia, hyperproteinemia, as hemolyses before deciding which result is more reliable.

**Ethics Approval and Consent to Participate:** This study was approved by the Institutional Ethical Committee.

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**CONFLICT OF INTEREST:** The authors have no conflicts of interest.

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