Stability of Electrolyte Determinations on the Siemens Advia 1800 Analyzer

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Background: It is sometimes necessary for the laboratory to re-test samples for critical serum electrolyte levels. It is important to assure reproducibility of results when testing is performed on stored, refrigerated samples. We have tested the reproducibility of results for the critical electrolytes, Na, K, Cl and Ca, from ten randomly selected patients' sera over our maximum storage period of nine (9) days on the Siemens Advia 1800 analyzer. The ranges for each electrolyte were 131–150 meq/L (Na), 3.4–5.2 meq/L (K), 101–123 meq/L (Cl) and 7.3–9.9 mg/dL (Ca). **Methods:** We used ion-

selective electrodes for Na, K and Cl and the ortho-cresolphthalein dye method for Ca. **Results:** We find that the reproducibility of determinations for all of these electrolytes was excellent, i.e. the coefficients of variation for each electrolyte determination for each patient were low. **Conclusion:** The methods of measurement for these electrolytes on the Advia 1800 are reliable and reproducible. J. Clin. Lab. Anal. 26:372–375, 2012. Published 2012. This article is a U.S. Government work and is in the public domain the USA.

Key words: sodium; potassium; chloride; calcium; ion-selective electrode; coefficient of variation; repeat analysis; reproducibility

INTRODUCTION

Because requests for repeat determinations of electrolyte values on patients' sera are sometimes received on our Laboratory Medicine Service, we undertook to test the reliability of repeat measurements on our main Clinical Chemistry analyzer, the Advia 1800 (Siemens, Tarrytown, NY). On occasion, we have observed that serum electrolyte values are found to be higher on repeat analysis 1 or 2 days after the first values were reported. These findings usually occur after identification and correction of a malfunction on the analyzer. For example, recently, we observed an unusual number of serum sodium values for patients with no known history of hyponatremia that were abnormally low. Investigation by our clinical chemistry staff, in collaboration with the Siemens technical support specialist, revealed a leak in the buffer line supplying the sodium ion-selective electrode. After correction of this problem, repeat analysis of the samples with suspiciously low sodium values revealed correction of the low values to values within the reference range although two samples were found to have reproducibly low sodium levels, presumably indicative of true hyponatremia.

Repeat analysis of a significant number of the samples that were found to have “corrected” sodium values showed that the sodium values continued to rise on subsequent assays, many of them increasing by 3–4 meq/L one day after the corrected value was obtained. These results and others in previous situations suggested that sample factors such as evaporation effects and/or analyzer factors such as transient electrode instability after the buffer leak problem may have caused the continuing increase in electrolyte levels. A recent study of the causes of spurious electrolyte values has been performed (1).

Our laboratory policy is to store all serum samples at 4°C for no less than 1 week after they have been received in the laboratory. Although requests for re-testing are not frequent (approximately 1% of samples), failures

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Fig. 1. (A–D) Plots of the results of serial determinations on the same sample, for each of ten patients, for sodium, potassium, chloride, and calcium, respectively, using the Advia 1800 chemistry autoanalyzer. Above each set of plot results is the label for the analyte being tested.

to reproduce initially obtained values can lead to doubts on the differential diagnosis of patients' conditions and to repeat phlebotomy and re-testing of affected patients. For outpatients, this may necessitate recalling them to the hospital for re-testing. Since we observed continuing increases of electrolyte levels on repeat analysis of samples, we became concerned that repeat analysis of stored samples may render artifactually higher values that result from sample and/or analyzer problems.

To investigate whether electrolyte values are stable on the Advia 1800, therefore, we have undertaken to examine

the stabilities of the four most commonly ordered electrolyte determinations, that is, sodium, potassium, chloride, and calcium over a 9-day period, the maximal time for sample storage, over a range of concentrations.

METHODS

Ten serum samples were chosen for this study such that their electrolyte values were found to be below, within, and/or above the reference ranges. All determinations were performed on the Siemens Advia 1800 Chemistry

Fig. 1. Continued.

analyzer. Determinations for sodium, potassium, and chloride were carried out using the appropriate ion-selective electrodes (2). Calcium determinations were performed using the ortho-cresolphthalein dye method (2). All samples were stored in a sample refrigerator at 4°C except when assays were performed at room temperature. All assays were performed once per day for 9 consecutive days (maximal storage time), except for chloride which was performed for 8 consecutive days.

RESULTS

Figure 1 summarizes the results of the serial assays for these electrolytes.

As can be seen from this figure, the variation in all values is small. Table 1 summarizes the range of values for each of the four critical electrolytes.

As can be seen from this table, the values for sodium, potassium, and chloride span the entire reference range including values below and above this range. The calcium values are similarly distributed except that no values exceeded the upper limit of the reference range.

This table also confirms that the maximum coefficients of variation (CV) for the values for each of these critical electrolytes are low. The overall range for the three electrolytes, sodium, potassium, and chloride is 0.32 (chloride)–1.2 (potassium), the latter being the highest CV. These values are compatible with those from a

TABLE 1. Ranges of Values and of CVs for Each Analyte and the Reference Ranges^a

Analyte	Range observed	Reference range	Range for coefficient of variation (CV) (%)
Sodium	131–150 meq/l	135–145 meq/l	0.44–0.71
Potassium	3.4–5.2 meq/l	3.5–5.0 meq/l	0.85–1.2
Chloride	101–123 meq/l	100–110 meq/l	0.32–0.75
Calcium	7.3–9.9 mg/dl	8.4–10.2 mg/dl	1.23–3.57

^aData for all ten patients.

previous study for these three electrolytes performed on the Monarch IL analyzer that found the CV range to be 0.82–1.14% (3). The highest calcium CV is approximately 3.5%, which is higher than that for the maximum for the ion-selective electrode-determined electrolytes, but is also a low value. This higher value may reflect the fact that calcium determinations, which are colorimetric and not determined by ion-selective electrode methodology, are sensitive to temperature, and small temperature changes can cause small fluctuations in values.

For calcium, there is an upward shift in the value for patient 1 from 8 on day 1 to 9 mg/dl on day 3; this is followed by a downward shift to remaining values that do not exceed 8.3. The CV for this patient's serum is 3.5%, the highest CV value. In addition, initial serum calcium values increase slightly for the other samples on day 6 and decrease to the slightly lower values through day 9. The range of these increases is 1.2–3.1%, which would appear to be insignificant. We interpret the value of 9 mg/dl for patient to be a possible spurious value.

Overall, the low CV values for all of these electrolytes support the conclusion that determinations of all four electrolytes are precise and stable over and beyond the storage period. Thus, sample problems such as evapora-

tion effects and inherent analyzer problems, such as unstable ion-selective electrodes, do not occur. Temperature fluctuations may be responsible for the higher CV values for calcium.

CONCLUSION

We conclude that determination of these critical electrolytes in serum has high precision on the Advia 1800 and that repeat testing of critical patient samples renders reliable values over at least a 9-day period.

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