

TEKRARLANABİLİR VE ATILABİLİR İYON SELEKTİF ELEKTROTLARLA SERUM SODYUM VE POTASYUM SEVİYELERİNİN ÖLÇÜLMESİ: KARŞILAŞTIRMA ÇALIŞMASI

MEASUREMENTS OF SERUM SODIUM AND POTASSIUM LEVELS BY USING DISPOSABLE
AND REUSABLE ION SELECTIVE ELECTRODES: A COMPARISON STUDY

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Özet

Elektrolit ölçümleri, özellikle sodyum ve potasyum, birçok hastalığın tanı ve takibinde çok önemli bir yere sahiptir. Farklı elektrolit analizörlerinde sodyum ve potasyum ölçümlerini karşılaştırmak için düşük, normal ve yüksek sodyum ve potasyum düzeylerini içeren 50 hasta serumu 4 farklı analizörde çalışıldı. Beckman E2A, Beckman EL-ISE, Nova-SPI Blood Gas and Disposable ISE strip (Kyoto Daiichi Kagaku Comp.). Bu analizörler iyon selektif elektrotlar kullanarak sodyum ve potasyum düzeylerini ölçerler. Tekrar kullanılabilen iyon selektif elektrotlar ile bir kez kullanılabilen ISE stripleri arasındaki farkın olup olmadığını belirlemek için yaptığımız bu çalışmada hem sodyum hem de potasyum için herhangi iki analizör ölçümleri arasında çok önemli korelasyonlar mevcuttu. Bu sonuçlar iyon selektif metoda göre ölçüm yapan her bir analizörden tekrar edilebilir neticeler elde edilebileceğini göstermiştir.

Anahtar kelimeler: *İyon selektif elektrot, Sodyum, Potasyum.*

Summary

Electrolyte determinations, particularly sodium and potassium, are very important in diagnosis and management of a very wide range of diseases. In order to compare the measurements of sodium and potassium in different electrolyte analyzers, we measured sodium and potassium levels in 50 patients sera having low, normal and high sodium and potassium concentrations in four different electrolyte analyzers: Beckman E2A, Beckman EL-ISE, Nova SP1 Blood Gas and Disposable ISE strip (Kyoto Daiichi Kagaku Comp.). These analyzers determine sodium and potassium levels by ion selective electrodes. The analyses made, in order to determine the difference between the convenient ion selective electrodes and the disposable ones using ISE strips, showed that there were very significant correlations between any two analyzers both for sodium and potassium measurements suggesting that each analyzer having ion selective electrode methodology may give reproducible results regardless reusable and disposable one.

Key words: *Ion selective electrode, Sodium, Potassium.*

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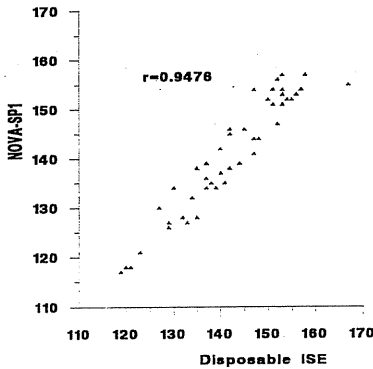
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Introduction

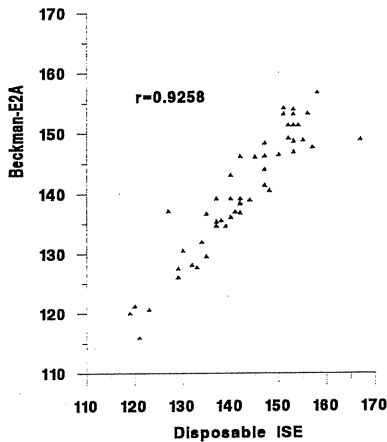
Electrolytes, especially Na^+ and K^+ ions, are of much importance in living subject. There are almost no metabolic processes which are not dependent upon or affected by Na^+ and K^+ . Their concentrations are altered in many diseases. Their determinations are very important in diagnosis and management of a very wide range of diseases (1,2,3). Thus, electrolyte determination should be done rapidly, practically, and reliably at any time. In the present study, we wanted to compare, if present, differences in the measurements of Na^+ and K^+ by ion-selective electrodes (ISE) in four different electrolyte analyzers: one is disposable and the others are convenient, and to compare the analyzers using commercial, ready-to-use reagents with ones using reagents that are prepared in our laboratory.

Materials and Methods

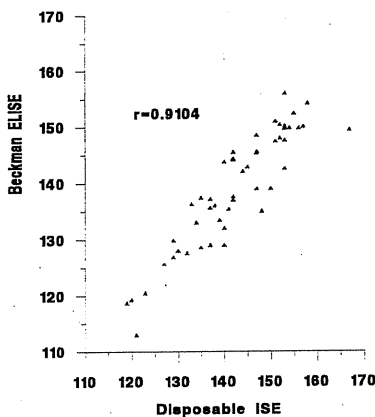
In this study, 50 serum samples obtained from different patients having low, normal and high Na^+ and K^+ concentrations were studied. Serum Na^+ and K^+ levels were measured by ISE method in four different electrolyte analyzers found in our laboratory: Beckman E 2A (B-E2A), Beckman EL-ISE (B-ELISE), Nova-SPI Blood Gas (N-SP1) and Disposable ISE-strips (D-ISE) (Kyoto Daiichi Kagaku Cong). Commercial and disposable ISE-Strips in D-ISE and the ready-to-use original reagents in NSP 1 analyzer were used. The reagents (diluent, reference, high and low calibrators) of B-E2A and B-ELISE were prepared in our laboratory and were used for testing. All 50 serum samples were simultaneously analyzed in the analyzers with the same calibration. Results were expressed as



1a



1 b



1c

Fig 1. Comparisons Between

- D-ISE-N-SP1
- D-ISE-B-E2A
- D-ISE-B-ELISE sodium measurements in 50 serum samples.

mean values \pm SD. For statistical evaluation, Student's t test and linear regression analysis were used. Significance defined as $p < 0.05$.

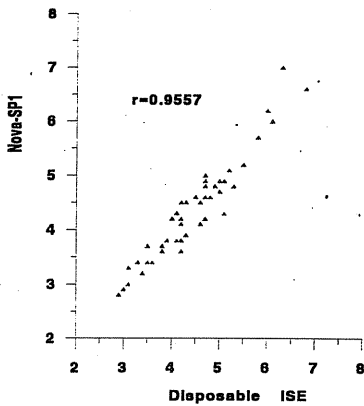
Results and Conclusion

Table I shows the mean values of serum Na^+ and K^+ levels measured in four different analyzers. As shown from the Table I, there were no statistically significant differences between the disposable and convenient ion-selective electrodes ($p > 0.05$). The same insignificance was also present between commercial and self-prepared reagent sets in terms of Na^+ and K^+ measurements ($p > 0.05$). Tables II and III show the correlations of Na^+ and K^+ measurements between the instruments. These results showed that there were very significant correlations between any two analyzers both for Na^+ and K^+ measurements ($p < 0.001$ in all figures 1a,b,c and 2a,b,c). On the other hand, 20 serial determinations with self-prepared reagents showed low intraassay coefficient of variation (CV % = 1,5 for K^+ and CV % = 4.5 for Na^+). Na^+ and K^+ are generally quantitated simultaneously either by flame emission spectrophotometry, atomic absorption spectrophotometry or electrochemically with an ISE. The former two methods were widely used until the advent of ISE some time around 1975, as a new method for measurements of Na^+ , K^+ and Cl^- (4). An ISE is an electrode having a membrane that is responsive to specific ion in the solution, to measure the ion concentrations or the activity by utilizing electromotive force (2). ISE methods use glass ion-exchange membranes for Na^+ and valinomycin neutral carrier membrane for K^+ measurements made on clinical samples. Direct method measures the ion activity in an undiluted sample and indirect method measures the ion activity in a prediluted sample (1,2).

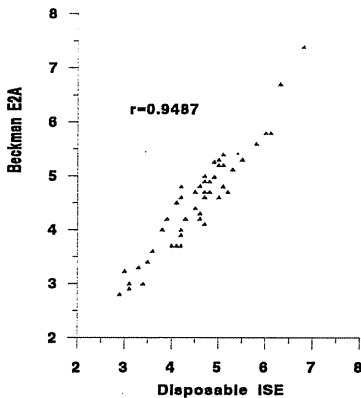
Table I. Mean Values of Na^+ and K^+ Measurements In Four Different Analyzers

	Na^+ (mg/dl) (n=50)	K^+ (mg/dl) (n=50)	P
D-ISE	142.38 \pm 10.84	4.5 \pm 0.86	>0.05
N-SP1	140.9 \pm 11.3	4.4 \pm 0.9	>0.05
B-E2A	140.19 \pm 10.12	4.4 \pm 0.93	>0.05
B-ELISE	139.01 \pm 10.31	2.47 \pm 0.94	>0.05

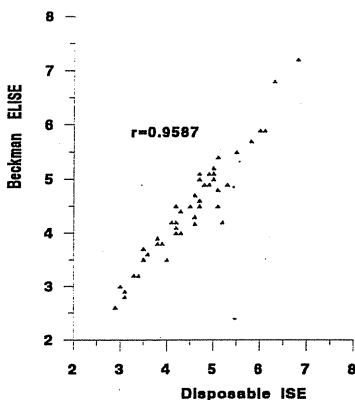
In our study, the sample was introduced to the analyzer directly and diluted by the analyzer but D-ISE uses an undiluted sample. These data showed that there were excellent correlations between D-ISE and convenient ones, and self-prepared reagent sets and commercial ones with respect to Na^+ and K^+



2a



2b



2c

Fig 2. Comparisons between

- a) D-ISE-N-SP1
- b) D-ISE-B-E2A
- c) D-ISE-B-ELISE potassium measurements in 50 serum samples.

Table II. Correlation Coefficients of Na⁺ Measurements In Four Different Analyzers

	r	y=a+bx
D-ISE—N-SP1	0,9476	y=13.95+0,91 x
D-ISE—B-E2A	0,9258	y= 3.34+0.99 x
D-ISE—B-ELISE	0.9104	y= 9.24+0.95 x
N-SP1—B-E2A	0.9705	y=-10.59+1.08 x
N-SP1—B-ELISE	0.9087	y= 2.80+0.95 x
B-E2A—B-ELISE	0.9298	y=13.26+0.91 x

measurements. Since cost of any analyte is very important, preparation of the reagents lowers the cost dramatically. Andersen et al measured Na⁺ and K⁺ concentrations in 100 patients' sera with microlyte (ISE method) and LL 343 flame photometer and found no significant difference between Na⁺ levels, as measured with the two instruments (r=0,97) and K⁺ levels (r=0,98) (5). In another study, Adam and colleagues detected very good correlations with results by flame photometry and coulometry. Correlation coefficients were 0,98 for Cl, 0,96 for Na⁺ and 0,99 for K⁺ (6). Adam et al used the Seralyzer dry reagent strip test for potassium and compared to ISE (Beckman ASTRA) and flame photometer (IL 643) procedures. They determined excellent correlations between three methods and r=0,98 for ionophoric vs ISE and r=0,98 for ionophoric vs flame methods (7). Those studies cited above were consistent with our results. In conclusion, we found the D-ISE strip for Na⁺ and K⁺ measurements to be accurate, rapid and less sample-consuming and can be used when a result is urgently requested.

Table III. Correlation Coefficients of K⁺ Measurements In Four Different Analyzers

	r	y=a+bx
D-ISE—N-SP1	0.9557	y=0.44+0.92 x
D-ISE—B-E2A	0.9487	y=0.59+0.87x
D-ISE—B-ELISE	0.9587	y=0.61+0.87x
N-SP1—BE2A	0.9330	y=0.42+0.89 x
N-SP1—B-ELISE	0.9506	y=0.42+0.89 x
B-E2A—B-ELISE	0.9596	y=0.12+0.96 x

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