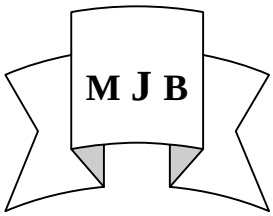
Serum Potassium, Magnesium, Sodium and Chloride Levels in Elderly Population

Lamia M. Al-Naama Jamal A. Abdl Barry
@ Sarkis S. Strak
Department of Biochemistry and @Medicine, College of Medicine, University of Basrah, Basrah - IRAQ.



Abstract

A total of 110 elderly patients aged 72 ± 6.5 years (62 males and 48 females) were prospectively studied. Measurements of serum potassium, magnesium, sodium and chloride were done and the effects of biological factors (age, sex, weight) and a large set of pathological conditions were examined. For comparison; another 100 subjects (63 males and 37 females) whom were found free of any disease and / or alcoholic and smoking habits considered as a control group. Their age range was 68 ± 8 years.

Results showed a significant decreased ($P< 0.05$) in the concentration of serum potassium level in hypertensive and in patients with renal failure. While a significant increased ($P < 0.05$) was correlated with myocardial infarction. No significant alteration in the concentration of plasma potassium was found in other pathologic populations.

Serum magnesium level was significantly lowered ($P<0.05$) in diabetic patients, however, its value was unchanged among other pathological conditions.

Low serum sodium value was observed in association with renal failure. Other pathological conditions had no effects on serum sodium level.

Decreased concentration of serum chloride was observed mainly in renal failure. No significant changes in serum chloride levels was found in relation to other pathological conditions.

Therefore our data suggest that, the decrease of potassium, magnesium sodium and chloride levels in the aged population is either merely related to an age- associated pathology or may be a normal physiological event occurring during the process of aging.

الخلاصة

شملت الدراسة الحالية ١١٠ من المرضى كبار السن (٦٢ رجل و ٤٨امرأة) معد اعمارهم ٧٢+ ٥،٦ سنة . لقد تم فحص تأثير عدد من الحلات المرضية وكذلك عدد من العوامل البايولوجية (العمر ، الجنس ، الوزن) على مستويات البوتاسيوم ، المغنيشيوم ، الصوديوم والكلوريد) في مستوى البوتاسيوم في لدم للمرضى P< اشارت الدراسة الى وجود انخفاظ احصائي معنوى (٠،٠٥و
الذين يعانون من الضغط وعجز الكلى . بينما ارتفع مستوى البوتاسيوم بشكل احصائي معنوي
(P<0.05)
عند الاشخاص الذين يعانون من امراض القلب . ولم يسجل أي تغير بمستوى البوتاسيوم في الحالات المرضية الاخرى .
(P<0.05) ان مستوى المغنيسيوم قد انخفض بشكل احصائي منعوى
في مرضى السكرى ولم يلاحظ ايس تغير احصائي بمستوى المنغنسيوم في الحالات المرضية الاخرى . كذلك لوحظ انخفاض بمستوى الصوديوم في بلازما الدم وكان متزامن مع المرض الذين يعانون عجز الكلى بينما لم تؤثر الحالات المرضية الاخرى على مستويات الصوديوم .
ان مستوى كلوريد الدم قد انخفض بشكل احصائي مهم في مرضى عجز الكلى في كبار السن ولم يتغير مستوى الكلوريد في الحالات المرضية الاخرى فقد اشارت الدراسة الحالية الى وجود انخفاض بمستوى البوتاسيوم المغنيسيوزم الصوديوم والكوريد عند المرضى من كبار السن وان سبب الانخفاض قد يعود لتقدم العمر المتزامن مع الحالات المرضية او ربما يعود الى الحالة الطبيعية التي يمر بها الشخص نتيجة تقدم العمر بة .

Introduction

Aging consists of the progressive changes that take place in a cell, an organ or total organism with passage of time. It is a process that goes an over the entire adult life- span of any living thing [1]. The study of aging process, is devoted to understanding and control of all factors contributing to the finitude of individual life.

Electrolytes are anions or cations depending on whether they move in an electrical field toward the anode or toward the cathode, that is, whether they have a positive or negative charge. The major electrolytes included are sodium (Na), potassium (K) , calcium (Ca), magnesium (Mg), chloride (Cl), bicarbonate (HCO3), phosphate (HPO4), sulphate (SO4) , and lactate as well as few other organic anions and trace elements [1].

The most predominantly intracellular ions are potassium and magnesium, of which the intracellular concentrations are closely correlated [1,2]. Many workers reported about the associations between serum potassium and magnesium concentrations. Hypokalemia and hypomagnesemia have been linked with life threatening cardiac arrhythmia [2,4,5]. In routine screening of hospitalized hypokalemic patients, hypomagnesemia was 6.91% [6]. Whang et al, [7] suggested that the percentage was far exceeded , raising up to 42% of hypokalemic patients.

The status of magnesium and potassium in elderly subjects with and without dementia of the Alzheimer type was studied [8], and it was reported that, plasma magnesium significantly lowered in elderly people, with no difference between congnitively normal and demented subjects.

As part of a broad study on the biology of aging [9] , we wanted to document the cumulative effects of both age and pathology on the concentrations of potassium, magnesium, sodium and chloride in plasma of an elderly population, taking account medical history and biological data.

Materials and methods

Serum potassium, magnesium, sodium and chloride were performed on 110 unselected elderly patients (62 males and 48 females). The age range was 72 $\pm$ 6.5 years; 67 % of them were over 65 years of age.

Most of the patients were hospitalized in Saddam Teaching and Basrah General Hospitals for a variety of diseases requiring constant medical assistance and therefore could not be regarded as representative of normal, healthy elderly populations.

The following information was recorded: age, sex, weight, smoking, drug intake and history of cardiovascular diseases (ischamic heart failure, hypertension and cardiac failure), bone and joint diseases, chronic renal failure, and diabetes mellitus (type 2) .

Another 100 subjects (63 males and 37 females) attending the out patients clinic for variuos complains had underwent throught physical and clinical examiation. They were found free of any of the above diseases and / or alcoholic and smoking habits and, therefore, considered as a control group. Their age range was 68 $\pm$ 8 years.

Venous blood samples were drawn under standardized conditions (8 - 9:30 a.m.) and immediately centrifuged. The serum samples were stored frozen (20 ^{o}c) until assayed. Flame photometeric method (Instrumentation laboratory) was used for sodium and potassium determinations [10], while for chloride determination, the colorimetric titration method [11] by chloride-meter, (Corning EEL). Serum magnesium was determined using kits from BioMerieux, France (Ref. No. 6378).

Normal and pathological commercial control sera were included in each series of analysis. The interassay coefficient of variations were 1.4 % and 1.9% for potassium 1.3 % and 1.7% for magnesium, 1.4 % and 1.9 for sodium and 2.4 % and 2.9% for chloride , respectively.

Results are expressed as mean $\pm$ SD. Differences in the mean between various diseases and control groups were assessed using the student's ' t ' test and one way analysis of

variance (ANOVA). The statistical significance of the relation between the different diseased conditions and concentrations of potassium, magnesium, sodium and chloride were assessed by using Fisher exact test. P values of > 0.05 were considered not significant.

Results

Effect of age, sex, and weight :

As shown in table-1, out of the 110 elderly patients studied; 26 (23.6 %) of them had abnormal values for plasma potassium, either low (12.7 %) or high (10.9 %). Sex and weight did not influence serum potassium level, however, a relation between age and incidence of high values for serum potassium was observed (P< 0.05).

About 18.2 % of the population studied (20 out of 110) had abnormal values for serum magnesium , either low (14.1 %) or high (4.1 %) . No significant effects of age, sex and weight on the serum magnesium level was observed.

The abnormality in serum sodium level was 16.5 % (18 out of 110), which was either low 11.1% or high 5.4%. No significant effects of age or weight on the concentration of serum sodium was found, however, this study pointed out that, in females the concentrations of sodium were lower than in males (P< 0.05).

Out of the 110 population studied ; 12 elderly patients (10.8%) had abnormal values for serum chloride, either low (5.6 %) or high (5.2 %). Again, no significant effect of age , sex and weight was observe on the serum chloride level.

Effect of diseased conditon:

The effect of diseased conditions upon the mean levels and the distributions of serum potassium, sodium, magnesium and chloride are presented in Table 2 .

Serum potassium level was significantly decreased (P< 0.001) in patients with hypertension and renal failure. While its value was significantly increased in patients with ischamic heart disease (P< 0.001). No significant alteration in the concentration of serum potassium was found among other conditions .

The mean concentration of serum magnesium was significantly lower (P< 0.05) in patients with diabetes, however, its value was unchanged among other conditions.

Subjects with normal renal function who were taking thiazeds were more frequently hyponatraemic, on the other hand low serum sodium value was observed in association with renal failure (P< 0.05). Other diseased conditions had no effects on the serum sodium level.

Decreased concentration of serum chloride was observed mainly in renal failure (P < 0.05) and in patients taking thiazeds. No significant changes in the concentration of serum chloride were found in other diseased conditions.

Discussion

The most common feature of any biological measurement in an elderly population as compared to a younger control group is the wider spread of values, while their mean level remains essentially unchanged. In comparison to the reference values for potassium , magnesium, sodium and chloride defined in young healthy population, (range 3.5 – 5.2 m Eq/L, 1.7 – 2.6 mg/dl, 136-145 m Eq/L and 98-107 m Eq/L respectively) [(1)]. In the present study, our elderly population had a marked shift to wards low values for those biochemical parameters.

Our data are in agreement with most of published studies on serum sodium, potassium, magnesium and chloride[(12)]. However we did observe age related increase in potassium for ages above 79 years. Baglin et al,[(13)] suggested that , 12.2 percent of subjects aged 70 years or more had hypokalemia (below 3.5 m Eq/L). Bahemuka and Hodkinson[(14)] and Judge [(15)], observed variations in sodium and potassium concentrations with age and sex in 118 subjects ranging in age from 20 to 65 years and in 128 subjects ranging in age

from 20 to 70 years. Bahemuka and Hodkinson [14] found nighther age nor sex difference in the potassium concentration, while Judge [15] observed significantly higher values in females than in males at all ages ($P < 0.05$). However in this prospective study sex difference was not observed.

The variations with age of the sodium concentrations were distinct. This study pointout that, the concentration of sodium in females whose age more than 70 years were significantly lower than males. The mechanism underlying this sex difference is poorly understood. In contrast Joji and Masako[16] observed a steady increase in serum sodium level in aged group more than 75 years, though the difference in males was slight. When males and females were compared as a whole in the sodium concentrations no significant difference was found.

No relation was found between values for serum magnesium with age, sex and body weight . In contrast Touitou et al [12] , found a relation between low values for serum magnesium and body weight and suggested that, such decrease could not be attributed to pathology or treatment with diuretics and antihypertensive drugs.

In all elderly subjects studied insignificant changes in the concentration of serum chloride was found due to either age, sex or body weight. At this stage it is not possible to give explanation for our observation and further studies are needed to identify it.

Our findings showed a relationship between the decreased levels of potassium, magnesium and sodium in the serum . Seventy five percent of these low values could be readily explained by their known association with a particular disease (hypertenstion, cardiovascular disease, renal failure and diabetes mellitus type 2). Touitou et al [12] reported low values of serum potassium found in hypertensive elderly subjects, and the higher values was associated with ischamic heart disease. Other workers, also, observed the association of hypokalemia, hyponatremia and hypomagnesemia. Whang etal [7] suggested that the hypomagnesemia which occurred in 42 % of patients with hypokalemia and in 27 % of patients with hyponatremia, should alert the physicion to request serum magnesium more frequently. It has been shown that detection of either hypokalemia and hyponatremia which are routinely available determination, can predict low serum magnesium, because of frequent association of hypomagnesemia with those electrolytes perturbations[2,7]. Magnesium depeletion in human is characterized by hypomagnesemia and hypokalemia. Patients in whom hypomagnesemia can be anticipated include alcoholic patients, patients receiving diuretics, patients with acute myocardial infarction with or without arrhythmias, patients incurring extrarenal losses of fluid and electrolytes, patients treated with aminoglycosides, patients receiving cisplatin and patients with digiatalis intoxication[7]. Hypomagnesemia in those patients was commonly associated with hypokalemia[6,7] .

Magensium depeletion and hypomagnesemia were commonly associated with diabetes mellitus and its complications [12,17]. Previous studies showed that hypomagnesemia acts as a risk factor in diabetic retinopathy [18]. Our study showed that, the mean concentration of plama magnesium was significantly decreased ($P< 0.01$) in diabetic patients. A possible explanation for such observation might be due to either increased uriuary loss of magnesium or due to the osmotic action of glycosuria and hyperglycaemia which may affect net tubular reabsorption of magnesium in renal man [19].

This study also pointed out that, plasma sodium level was abnomally low in subjects with renal failure. Previous reports [13] studying electrolyte abnormalities in elderly people showed that among 337 subjects not taking drugs (like diuretics, angiotensin-converting enzyme inhibitors, anti-inflammatory agents) which were likely to create problems; 3.6 percent had

hyponatremia. However, subjects with normal renal function who were taking angiotensin- converting enzyme inhibitors or non- steroidal anti-inflammatory agents showed no more electrolytic abnormalities than those who were not taken them, and conversely, subjects on thiazedes were more frequently hyponatremic (11.8 %) and hypokalemic (16.2 %) [13].

Serum chloride level significantly decreased in patients with renal failure or those taking thiazeds. A possible cause was propably due to renal losses of chloride. Diminished tubular reabosrption of chloride might be caused by inappropriate choice, dose, or use drugs by primary or secondary deficiency of aldosterone or by severe polyuria [1, 20].

In conclusion the present study pointed out that, the high percentage of abnormal potassium, magnesium, sodium and chloride values in elderly population can readily explained by the association with specific disease and is not related mainly to biological parmeters such as age, sex or weight. The usual known refrence limits for the above parameters, therefore, can be applied also to the aged population.

Acknowledgments

The authors wish to thanks Mr. Hssam Ooda, for his help in collection blood samples.

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Table (1) Distribution and mean levels of serum potassium (mEq/L), magnesium (mmol/L)sodium (mEq/L) and chloride (mEq/L) in 110 patients according to age, sex and weight.

	No. of Patients	Serum potassium				Serum Magnesium				Serum Na				Serum Cl			
		Percentage of patients having K			Conc. Mean ± SD	Percentage of patients having Mg			Conc. Mean ± SD	Percentage of patients having Na			Conc. Mean ± SD	Percentage of patients having Cl			Conc. Mean ± SD
		< 3.5	3.5 - 5	> 5		< 0.7	0.7-1.07	> 1.07		< 136	136 – 145	> 145		< 98	98 - 108	> 108	
Age : Years																	
≤ 64	36	6.2	88.6	5.2	4.3 ± 0.2	4.3	35.1	1.7	0.8 ± 0.08	7.1	87.6	5.3	141 ± 1.8	6.3	88.3	5.4	105 ± 2.0
65 - 79	52	18.4	77.2	4.4	4.4 ± 0.3	8.05	31.9	1.2	0.8 ± 0.12	14.6	79.2	6.2	140 ± 2	5.4	89.8	4.8	104 ± 1.8
80 ≥	22	12.6	64.6	22.8 *	4.4 ± 0.4	4.9	33.3	2.2	0.8 ± 0.08	11.8	83.5	4.7	141 ± 2.1	5.2	89.2	5.6	106 ± 1.9
All subjects	110	12.7	76.8	10.9	4.3 ± 0.4	5.8	33.6	1.7	0.8 ± 0.12	11.1	83.5	5.4	141 ± 2	5.6	89.2	5.2	105 ± 2.0
Sex:																	
Men	62	3.6	89	7.4	4.5 ± 0.4	0.95	38.4	1.7	0.9 ± 0.08	8.3	87.5	4.2	140 ± 3	3.3	94.1	2.6	103 ± 3.3
Women	48	2.8	76.4	10.8	4.6 ± 0.3	1.4	36.17	3.5	0.9 ± 0.08	22.4 *	71.3	6.1	136 ± 3	4.3	92.5	3.2	101 ± 2.8
Weight : kg																	
40 – 59	28	2.4	91.4	6.2	4.3 ± 0.3	1.4	37.8	1.9	0.7 ± 0.08	4.6	92.5	2.9	141 ± 2.9	3.4	94	2.6	99 ± 2.8
60 – 79	65	2.9	93.3	3.8	4.3 ± 0.3	1.6	37.4	2.2	0.8 ± 0.12	3.7	93.7	2.6	142 ± 3.1	3.2	93.9	2.9	101 ± 3
80 ≥	17	3.9	94	2.1	4.3 ± 0.2	1.2	39.0	0.95	0.8 ± 0.12	4.2	92.9	2.9	140 ± 1.9	4.2	92.4	3.4	101 ± 2.9

* $P < 0.05$

Table (2) Effects of diseased conditions on mean concentrations of serum Potassium, Magnesium, Sodium and Chloride
in Elderly Subjects .

Diseased Conditions	No. of patients	Potassium mEq/L	Magnesium mmol/L	Sodium mEq/L	Chloride mEq/L
None	100	4.6 ± 0.3	0.86 ± 0.12	138 ± 3	104 ± 2.8
Smokers					
No	78	4.4 ± 0.3	0.82 ± 0.08	137 ± 2.9	103 ± 3.5
Yes	32	4.2 ± 0.2	0.78 ± 0.12	139 ± 3.2	104 ± 3.6
Heart Disease					
No	44	4.2 ± 0.4	0.78 ± 0.08	138 ± 2.1	100 ± 2.8
Yes	66	5.6 ± 0.5 *	0.74 ± 0.12	139 ± 3	101 ± 2.2
Bone and joint					
No	72	4.3 ± 0.3	0.74 ± 0.12	141 ± 3.2	102 ± 3.1
Yes	38	4.1 ± 0.4	0.78 ± 0.12	140 ± 2.9	101 ± 2.9
Renal failure					
No	61	4.6 ± 0.4	0.86 ± 0.12	140 ± 3.2	102 ± 2.6
Yes	49	3.2 ± 0.2 *	0.82 ± 0.08	129 ± 3.1 *	91 ± 2.1 *
Diabetes Mellitus					
No	65	4.5 ± 0.5	0.86 ± 0.08	138 ± 1.9	103 ± 3.1
Yes	45	4.1 ± 0.3	0.82 ± 0.08 *	135 ± 2.1	100 ± 2.6
Hypertension					
No	34	4.7 ± 0.3	0.86 ± 0.12	139 ± 2.9	101 ± 2.7
Yes	76	3.2 ± 0.4 *	0.78 ± 0.082	141 ± 2.2	104 ± 2.2

values represented as mean ± SD
*P < 0.001