Clinical Section / Short Communication

Gerontology

Gerontology 2014;60:420–423
DOI: 10.1159/000360134

Received: December 3, 2013
Accepted: January 29, 2014
Published online: May 20, 2014

Age-Related Variety in Electrolyte Levels and Prevalence of Dysnatremias and Dyskalemias in Patients Presenting to the Emergency Department

Gregor Lindner[a] Carmen A. Pfortmüller[a] Alexander B. Leichtle[b]
Georg M. Fiedler[b] Aristomenis K. Exadaktylos[a]

[a]Department of Emergency Medicine and [b]Center for Laboratory Medicine, Inselspital, University Hospital Bern, Bern, Switzerland

Key Words
Age · Gender · Hyponatremia · Hypernatremia · Hypokalemia · Hyperkalemia

Abstract
Background: It was found that age and female gender are predisposing factors for hyponatremia in patients taking thiazides. ***Objective:*** To investigate whether a relationship exists between age and gender and serum sodium and potassium as well as the prevalence rates in a large population of patients presenting to the emergency department of a university hospital. ***Methods:*** In this retrospective analysis we gathered data on age, gender and current diuretic medication of all patients admitted to the emergency department of a large university hospital with measurement of serum sodium and potassium between January 1, 2009 and December 31, 2010. Prevalence rates of and risk factors for electrolyte disorders were calculated on the basis of these data. ***Results:*** A total of 20,667 patients were included in the analysis. Serum sodium levels declined significantly with increasing age while serum potassium rose, independent of diuretic medication at presentation. The prevalence rates of hyponatremia and hyperkalemia increased from 2.3% for hyponatremia in patients aged 16–21 years to 16.9% in patients aged >80 years and from 0.8% for hyperkalemia to 10.4%. In the regression analysis, age >60 years was a predictor for the presence of hyponatremia and hyperkalemia as was current use of diuretic medication. Male gender was associated with a decreased prevalence of hyponatremia and hypokalemia, while it was a predictor of hyperkalemia. ***Conclusions:*** Sodium levels were lower with increasing age, independent of diuretic intake, while potassium levels were higher. We found dramatically increasing prevalences of hyponatremia and hyperkalemia with increasing age, while no such effect could be found for hypernatremia and hypokalemia.

Introduction

Disorders of serum sodium and potassium are common in outpatients and were found to be present in more than 10% of patients, respectively [1–3]. Many factors have been found to be associated with the development of dysnatremias and dyskalemias, with diuretic therapy being the most prominent [4, 5]. Hyponatremia is often a consequence of diuretic therapy, the syndrome of inadequate vasopressin secretion or a low effective circulating volume as in heart failure or cirrhosis of the liver, while hypernatremia is most often due to dehydration in ambulatory patients or inadequate fluid therapy in critically ill patients [6, 7]. Hypokalemia most often is a consequence of diuretic therapy while hyperkalemia often is

KARGER

E-Mail karger@karger.com
www.karger.com/ger

0304–324X/14/0605–0420$39.50/0

Gregor Lindner, MD
Department of Emergency Medicine
Inselspital, University Hospital Bern
Freiburgstrasse, CH–3010 Bern (Switzerland)
E-Mail lindner.gregor@gmail.com

due to various medications (ACE inhibitors/angiotensin receptor blockers, diuretics) and/or renal insufficiency [8, 9]. In one study, age was found to be an independent predictor for hypo- and hypernatremia [10], however it did not take into account the medications of patients predisposing to the development of dysnatremias. It was also found that age and female gender might predispose to the development of hypokalemia [11, 12]. In the present study we aimed at clarifying whether a relationship between patients' age and gender and the prevalence of disorders of serum sodium and potassium exists under consideration of their present diuretic medication.

Methods

This retrospective analysis included all patients presenting to the Department of Emergency Medicine of a large university hospital between January 1, 2009 and December 31, 2010, with measurements of serum sodium and potassium. We obtained demographic data from all patients, such as gender, age, along with data on the current medication with a focus on currently prescribed diuretic agents. The normal range for serum sodium was defined as 135–145 mmol/l and as 3.5–4.7 mmol/l for potassium in accordance with the ranges of our central laboratory.

All data are presented as means and standard deviation or median and first and third quartile, as appropriate. Uni- and multivariate regression analysis (age, sex, presence of diuretic therapy, electrolyte disorders as variables) were calculated using Statistica 10.0 software (StatSoft, Inc., Tulsa, Okla., USA).

The study was approved by the institutional review board of the University Hospital of Bern. Due to the retrospective design of the study the need for patients' informed consent was waived.

Results

During the study period a total of 20,667 patients presented to the Department of Emergency Medicine and received measurements of serum sodium and potassium levels. 11,986 patients (58%) presented due to medical reasons and 8,681 patients (42%) due to surgical referral reasons. The mean age of patients was 52 years (SD 20) and 57% of patients were male. A total of 2,371 patients (11%) were on diuretic medication at the time of referral to our emergency department. 1,764 patients (74%) had one, 527 (22%) had two, 74 (3%) had three, and 6 (1%) patients were on four different diuretic substances. Loop diuretics were the most common being taken by 1,366 patients (58%) followed by thiazide-type diuretics taken by 1,002 patients (42%) and aldosterone antagonists being present in 395 patients (17%). Mean serum sodium at presentation was 139.08 mmol/l (SD 3.75) and serum potassium was 3.94 mmol/l (SD 0.48). A clear age-dependent decline of serum sodium concentration could be seen in our patients from 140.1 mmol/l (SD 2.6) in patients in the age group 16–21 years compared to 138.2 mmol/l (SD 4.6) in patients >80 years, $p < 0.001$. With serum potassium levels, a steady age-dependent rise was found ranging from 3.8 mmol/l (SD 0.35) in patients between 16 and 21 years of age to 4.1 mmol/l (SD 0.59) in patients >80 years, $p < 0.001$. Overall, we saw a significant correlation between patient age and serum potassium ($R = 0.19$, $p < 0.05$) and a significant inverse correlation with serum sodium ($R = -0.17$, $p < 0.05$). Excluding patients taking diuretics, the correlation remained significant both for serum sodium ($R = -0.16$, $p < 0.05$) and potassium ($R = 0.19$, $p < 0.05$). Correlating to these findings, the prevalence rates of hyponatremia and hyperkalemia increased with age from 2.3% for hyponatremia in patients aged 16–21 years to 16.9% in patients >80 years and 0.8% for hyperkalemia to 10.4% (fig. 1). Table 1 gives an overview of the prevalence rates of dyskalemias and dysnatremias stratified for age groups.

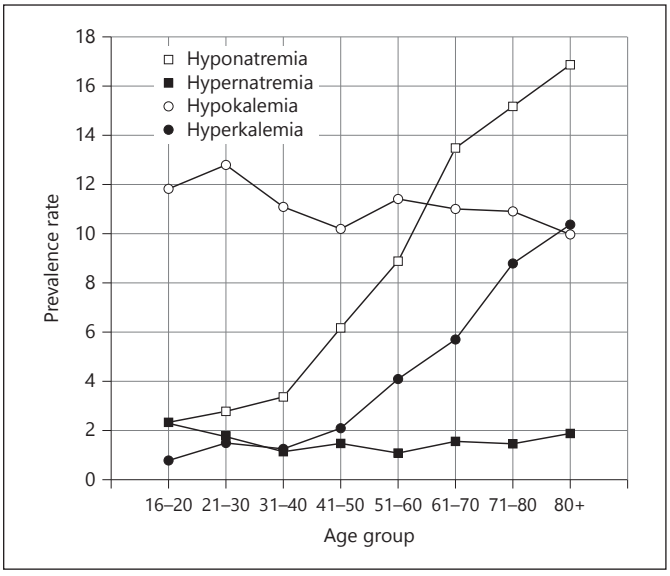

Fig. 1. Prevalence rates of dysnatremias and dyskalemias stratified for age group.

In the multivariate regression analysis, age >60 years (OR 2.5, 95% CI 1.9–3.0, $p < 0.001$) and current diuretic therapy (OR 1.9, 95% CI 1.7–2.2, $p < 0.001$) were risk factors for the presence of hyponatremia, while male gender was slightly protective (OR 0.88, 95% CI 0.8–1, $p = 0.005$). For hypernatremia, neither age nor sex or diuretic therapy was a predictor. Age >60 years (OR 3.3, 95% CI 2.8–

Table 1. Prevalence rates of dysnatremias and dyskalemias, serum sodium, potassium (both in mmol/l) and creatinine (in μmol/l) levels according to age group of patients

	Age group, years							
	16–20	21–30	31–40	41–50	51–60	61–70	71–80	>80
Patients	1,302	2,847	2,562	3,039	2,964	3,094	2,630	2,229
Male, %	52	52	57	61	64	61	57	47
Diuretics, %	0.3	0.6	1.5	3.9	9.3	16.4	25.8	32.8
Male, %	50	31	72	60	64	63	54	41
Creatinine, ±SD	69.6±37.3	69.4±26.3	71±36.1	73.7±43.3	80±73.4	88.3±72.7	103.6±40.3	105.9±80.8
Na^+ level, ±SD	140.1±2.6	139.9±2.75	139.7±2.9	139.3±3.4	139±3.9	138.5±4.3	138.3±4.2	138.2±4.6
Hyponatremia, %	2.3	2.8	3.4	6.2	8.9	13.5	15.2	16.9
Male, %	47	52	59	57	67	58	49	34
Hypernatremia, %	2.3	1.8	1.2	1.5	1.1	1.6	1.5	1.9
Male, %	80	67	65	64	42	56	56	50
K^+ level, ±SD	3.8±0.35	3.8±0.37	3.86±0.39	3.89±0.4	3.94±0.47	3.98±0.52	4.04±0.55	4.1±0.59
Hypokalemia, %	11.8	12.8	11.1	10.2	11.4	11	10.9	10
Male, %	46	42	51	50	54	45	45	26
Hyperkalemia, %	0.8	1.5	1.3	2.1	4.1	5.7	8.8	10.4
Male, %	60	64	67	65	70	74	65	58

3.8, $p < 0.001$), male gender (OR 1.6, 95% CI 1.4–1.8, $p < 0.001$) and diuretic medication (OR 2.2, 95% CI 1.9–2.5, $p < 0.001$) were predictors of hyperkalemia. On the other hand, current diuretic therapy was a risk factor for hypokalemia (OR 1.6, 95% CI 1.5–1.9, $p < 0.001$), while age >60 years (OR 0.8, 95% CI 0.7–0.9, $p < 0.001$) and male gender (OR 0.6, 95% CI 0.5–0.7, $p < 0.001$) were protective.

Discussion

In the present study, we found a significant increase of the prevalence of hyponatremia and hyperkalemia with increasing age while prevalence rates for hypernatremia remained stable with age and even slightly decreased for hypokalemia. The serum sodium concentration of patients significantly correlated inversely with the age of patients while the serum potassium concentration positively correlated. This finding was also seen when excluding patients currently taking diuretic medication. In the regression analysis, age >60 years was a predictor for the presence of hyponatremia and hyperkalemia as was current use of diuretic medication. Male gender was associated with a decreased prevalence of hyponatremia and hypokalemia while it was a predictor of hyperkalemia.

Our present findings support data from studies on thiazide-induced electrolyte disorders where higher age and female sex were found to be a risk factor for the development of hyponatremia [13–15]. However, interestingly, we also found an age-related decline in serum sodium concentration and a rise in serum potassium concentration that was also present after exclusion of patients taking diuretics. To our knowledge this finding has until now never been described and its causes are unclear. One can speculate that other than diuretics, declining renal function or an altered physiologic threshold in the elderly may play a role in the age-related changing electrolyte levels. Whichever way, it may explain at least to some degree the higher susceptibility of the elderly to the development of electrolyte disorders after starting new medications (diuretics, ACE inhibitors, etc.). Another interesting finding was that we could not see a significant increase in the prevalence of hypernatremia with age (as was described previously), although this specific electrolyte disorder is usually considered to be almost exclusively found in the elderly, critically ill and nursing home residents [10, 16, 17].

Our study is limited by its retrospective design and the lack of data on the current medications of patients other than diuretics. Additionally, it should be noted that other factors than diuretics might contribute to the development of dysnatremias and dyskalemias which are not considered in the current analysis. Also, we do not have detailed data on the morbidities of patients.

In conclusion, serum sodium levels were lower with the increasing age of patients, independent of diuretic in-

take, while serum potassium levels were higher. We found dramatically increasing prevalence rates of hyponatremia and hyperkalemia with the increasing age of patients, while no such effect could be found for hypernatremia and hypokalemia.

Disclosure Statement

The authors have no conflicts of interest to disclose.

References

1 Arampatzis S, Frauchiger B, Fiedler GM, et al: Characteristics, symptoms, and outcome of severe dysnatremias present on hospital admission. Am J Med 2012;125:1125.e1–e7.
2 Marti G, Schwarz C, Leichtle AB, et al: Etiology and symptoms of severe hypokalemia in emergency department patients. Eur J Emerg Med 2014;21:46–51.
3 Pfortmuller CA, Leichtle AB, Fiedler GM, Exadaktylos AK, Lindner G: Hyperkalemia in the emergency department: etiology, symptoms and outcome of a life-threatening electrolyte disorder. Eur J Intern Med 2013;24:e59–e60.
4 Arampatzis S, Funk GC, Leichtle AB, et al: Impact of diuretic therapy-associated electrolyte disorders present on admission to the emergency department: a cross-sectional analysis. BMC Med 2013;11:83.
5 Mannesse CK, Jansen PA, Van Marum RJ, et al: Characteristics, prevalence, risk factors, and underlying mechanism of hyponatremia in elderly patients treated with antidepressants: a cross-sectional study. Maturitas 2013;76:357–363.
6 Lindner G, Funk GC: Hypernatremia in critically ill patients. J Crit Care 2013;28:216.e11–e20.
7 Lindner G, Schwarz C: An update on the current management of hyponatremia. Minerva Med 2012;103:279–291.
8 Rose DB, Post TW: Clinical Physiology of Acid-Base and Electrolyte Disorders. New York, McGraw-Hill, 2001.
9 Halperin ML, Kamel KS: Potassium. Lancet 1998;352:135–140.
10 Hawkins RC: Age and gender as risk factors for hyponatremia and hypernatremia. Clin Chim 2003;337:169–172.
11 Hawkins RC: Gender and age as risk factors for hypokalemia and hyperkalemia in a multiethnic Asian population. Clin Chim Acta 2003;331:171–172.
12 Kleinfeld M, Borra S, Gavani S, Corcoran A: Hypokalemia: are elderly females more vulnerable? J Natl Med Assoc 1993;85:861–864.
13 Rodenburg EM, Hoorn EJ, Ruiter R, et al: Thiazide-associated hyponatremia: a population-based study. Am J Kidney Dis 2013;62:67–72.
14 Jolobe OM: Diuretic-induced hyponatraemia in elderly hypertensive women. J Hum Hypertens 2003;17:151.
15 Sharabi Y, Illan R, Kamari Y, et al: Diuretic-induced hyponatraemia in elderly hypertensive women. J Hum Hypertens 2002;16:631–635.
16 Adrogue HJ, Madias NE: Hypernatremia. N Engl J Med 2000;342:1493–1499.
17 Himmelstein DU, Jones AA, Woolhandler S: Hypernatremic dehydration in nursing home patients: an indicator of neglect. J Am Geriatr Soc 1983;31:466–471.