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Research Article

A Hospital-Based Study of Dyselectrolytemia In Geriatric Population - Prevalence, Etiology And Co-Morbidities

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ABSTRACT

Introduction Dyselectrolytemia is one of the major contributors to mortality in the elderly. The common electrolytes affected in the elderly are sodium, potassium and calcium with hyponatremia being the commonest electrolyte disturbance.
Objectives To study the prevalence of dyselectrolytemia, the various electrolytes affected, the antecedent causes and the associated co-morbidities in the elderly patients hospitalized in a tertiary setting of north India.
Methodology This observational descriptive study was conducted at the Himalayan Hospital, Swami Rama Nagar, Dehradun over a period of 12 months. Institutional ethical clearance was obtained and a structured format was used to obtain demographic, clinical and laboratory data from the patients after a written and informed consent. Serum electrolytes were estimated at the time of hospitalization and the cause of imbalance, if present, was investigated.
Results Of the 536 geriatric patients enrolled, dyselectrolytemia was found in 390 patients (72.7, mean age 69.6 years)of which 240 (61.5) were females. Hyponatremia (n=180; 46.1) was the commonest electrolyte abnormality followed by hypocalcemia (n=60; 15.3) and hypokalemia (n=49; 12.5). Two or more electrolytes were deranged in 309 (57.6) patients and 17 (4.3) patients with dyselectrolytemia succumbed. Diuretic use (n=72; 40) and infections (n=36,20) were the leading causes of hyponatremia.
Conclusion While multiple electrolytes maybe affected in an elderly individual, hyponatremia is the commonest electrolyte disorder with a female preponderance. Awareness of the electrolyte abnormalities is helpful in preventing adverse outcomes, although less and not directly attributable to dyselectrolytemia, in the elderly.

INTRODUCTION:

Ageing is associated with progressive decline in the cardio-and reno-vascular functional reserve compromising the ability of the elderly to maintain homeostasis, especially pertaining to fluid and electrolytes, Any trauma or illness related stress may produce major modifications in plasma electrolytes in the elderly in contrast to trivial responses in younger population. The dyselectrolytemias, thus produced, may result in increase in mortality and morbidity in elderly population. (1)

Indians practice self-medication and commonly seek treatment from unqualified practitioners further predisposing and contributing to dyselectrolytemia. Various drugs ,mainly diuretics, produce dyselectrolytemia in this population especially by causing renal impairment. (1)Delayed post-operative recovery and increased morbidity and mortality may result from salt and water overload. The prevalence of hyponatremia has been reported variably as 21 to 0.53 depending on the severity. Most of the cases are asymptomatic or mildly symptomatic if the hyponatremia is mild (serum sodium <136meq/dl).Severe hyponatremia (serum sodium <116) is symptomatic and occasionally fatal. Hypernatremia occurs in <1 in ambulatory hospitalized elderly patients and ageing has been suggested as an independent risk factor for sodium disorders in the elderly population. (2) Disorders of the other major electrolyte, potassium, are observed in 1-10 hospitalized geriatric patients. (3)

Not much data is available from the Indian subcontinent on electrolyte abnormalities in the geriatric age group. Hence, we planned this study to identify the various electrolyte abnormalities, their causes and the impact of dyselectrolytemia on short-term outcome of elderly patients admitted to a tertiary care centre of the north Indian state of Uttarakhand.

MATERIALS AND METHODS

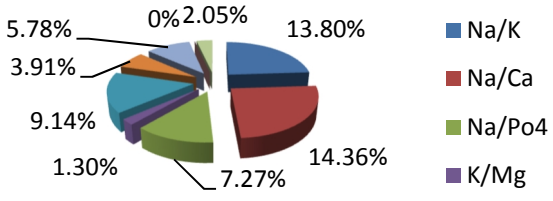
This prospective cross-sectional observational study included all elderly subjects (aged > 60 years) hospitalized to the medical wards over a period of 12 months after obtaining written informed consent and institutional ethical clearance. A structured format was used to obtain data on demography, economic dependence, co-morbidities, medical history and the indication of hospitalization. Electrolytes viz. sodium, potassium, calcium, magnesium and phosphorus were evaluated in all subjects. An attempt was also made to elicit the cause of the electrolyte imbalance by suitable investigations. The outcome measures studied were duration of hospitalization and short-term mortality. Suitable descriptive statistics were used to analyze the data generated.

RESULTS

The elderly constituted 35 of all hospitalizations to the medical wards in theyear. Of the 536 patients studied, 390 (72.7%) had dyselectrolytemia. Hyponatremia (n=180; 46.1%) was the commonest electrolyte abnormality followed by hypocalcemia (n=60; 15.3%) and hypokalemia (n=49; 12.5%). Almost two-third of all subjects with dyselectrolytemia were asymptomatic on this count. Diabetes mellitus and hypertension were the co-morbidities both predating dyselectrolytemias in nearly a third of cases each.

The mean age of those with dyselectrolytemia was 69.6 $\pm$ 6.9 years with female preponderance (n=240; 61.5%). The age distribution of various electrolyte disturbances is shown in table 1. Dyselectrolytemia involving two electrolytes was observed in 309 (79.2%) patients (see figure 1); more than 2 electrolytes were disturbed in 11 (2.8%) patients.

Fig- 1: Mixed electrolyte disturbances in the study group (n=309)



Patients with hyponatremia were hypervolemia (n=117; 65%), euvolemic (n=20; 11.1%), and hypovolemic (n=43; 23.8%); the corresponding figures for hypernatremia (n=10) were 50,% 20% and 30% respectively. The causes of electrolyte imbalances in our study group are shown in table 2. Chronic kidney disease was the cause of hypocalcemia and hyperphosphatemia in 43.3% and 73.5% patients with these disorders. The major factor implicated in the pathogenesis of sodium and potassium related dyselectrolytemias was iatrogenic. The drugs most commonly implicated in dyselectrolytemia were diuretics viz. thiazides and loop diuretics, ACE inhibitors, angiotensin receptor blockers and calcium supplements; alcohol and drugs (proton pump inhibitors and aminoglycosides) were responsible for hypomagnesaemia in one patient each. Qualified as

well as unqualified practitioners prescribed the drugs; moreover, the propensity of prescription of diuretics, calcium supplements and proton pump inhibitors was similar.

Table 1: Morbidities associated with dyselectrolytemia in the elderly

	Diabetes mellitus	Hypertension	CAD	COPD	Tuberculosis	Stroke	Osteoarthritis	Total
Hyponatremia (n=180)	90 (50)	58 (32.2)	6 (3.3)	15 (8.3)	6 (3.3)	2 (1.1)	3 (1.6)	180 (46.1)
Hypernatremia (n=10)	2 (20)	4 (40)	1 (10)	2 (20)	-	1 (10)	1 (10)	10 (2.5)
Hypokalemia (n=49)	20 (40.8)	15 (30.6)	4 (8.2)	2 (4.1)	2 (4.1)	4 (8.2)	2 (4.1)	49 (12.5)
Hyperkalemia (n=36)	19 (52.8)	11 (30.6)	2 (5.5)	3 (8.3)	-	-	1 (2.8)	36 (9.2)
Hypocalcemia (n=60)	34 (56.7)	11 (18.3)	7 (11.6)	1 (1.7)	1 (1.77)	1 (1.7)	5 (8.3)	60 (15.3)
Hypercalcemia (n=6)	3 (50)	2 (33.3)	1 (16.6)	-	-	-	-	6 (1.5)
Hypophosphatemia (n=10)	3 (30)	3 (30)	1 (10)	-	1 (10)	-	2 (20)	10 (2.5)
Hyperphosphatemia (n=34	11 (32.3)	7 (20.5)	6 (17.6)	5 (14.7)	1 (2.9)	-	4 (11.7)	34(8.7)
Hypomagnesemia (n=5)	1 (20)	2 (40)	1 (20)	1 (20)	-	-	-	5 (1.3)
Total=536	145 (37.2)	117 (30)	43 (11)	31 (9.4)	13 (3.3)	9 (2.3)	34 (8.7)	390 (72.7)

ECG was normal in nearly 50% of all cases with hyperkalemia. Tall T waves were noted in nearly 1/3rd cases. ECG was normal in almost 2/3rd of cases with hypokalemia; the commonest ECG abnormality was low amplitude of T waves. Prolongation of QT interval was seen in 94.8% of all patients with hypocalcemia.

Table 2: Age wise distribution of dyselectrolytemia

Dyselectrolytemia	61-70 years		71-80 years		81-90years		> 90years	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
Hyponatremia (n=180)	54 (30)	76 (42)	16 (8.8)	24 (13.33)	2 (1.1)	4 (2.2)	0	4 (2.2)
Hypernatremia (n=10)	1 (10)	2 (20)	3 (30)	3 (30)	0	0	0	0
Hypokalemia (n=49)	5 (10.2)	16 (32.6)	4 (8.1)	20 (40.8)	1 (2)	3 (6.1)	0	0
Hyperkalemia (n=36)	9 (25)	13 (36.1)	5 (13.8)	4 (11.1)	3 (8.3)	2 (5.5)	0	0
Hypocalcemia (n=60)	23 (38.3)	19 (31.6)	5 (8.3)	10 (16.6)	1 (1.6)	1 (1.6)	1 (1.6)	0
Hypercalcemia (n=6)	2 (33.3)	2 (33.3)	2 (33.3)	0	0	0	0	0
Hypophosphatemia (n=10)	3 (30)	3 (30)	3 (30)	1 (10)	0	0	0	0
Hyperphosphatemia (n=34)	5 (14.7)	17 (50)	4 (11.7)	4 (11.7)	2 (5.8)	0	0	2 (5.8)
Hypomagnesemia (n=5)	3 (60)	1 (20)	1 (20)	0	0	0	0	0
Total (n=390)	105 (26.9)	149 (38.2)	43 (11)	75 (19.2)	9 (2.3)	10 (2.5)	01 (0.02)	06 (1.5)

Table 3: Outcome of elderly with dyselectrolytemia

Dyselectrolytemia	**Deaths No. (%)**	**Improved No. (%)**	**Total No. (%)**
Hyponatremia (n=180)	7 (3.8)	173 (96.1)	180 (46.1)
Hypernatremia (n=10)	1 (10)	9 (90)	10 (2.5)
Hypokalemia (n=49)	-	49 (100)	49 (12.5)
Hyperkalemia (n=36)	2 (5.5)	34 (94.4)	36 (9.2)
Hypocalcemia (n=60)	4 (6.6)	56 (93.3)	60 (15.3)
Hypercalcemia (n=6)	-	6 (100)	6 (1.5)
Hypophosphatemia (n=10)	-	10 (100)	10 (2.5)
Hyperphosphatemia (n=34)	3 (8.8)	31 (91.1)	34 (8.7)
Hypomagnesemia (n=5)	-	5 (100)	5 (1.3)
Total (n=390)	17 (4.3)	373 (95.6)	390 (100)

Table 4: Causes of electrolyte imbalance in elderly

Hyponatremia	**Hypernatremia**	**Hypokalemia**	**Hyperkalemia**	**Hypoclacemia**	**Hyperclacemia**	**Hypophosphatemia**	**Hyperphosphatemia**	**Hypomagnesemia**
180 (46.1)	**10 (2.5)**	**49 (12.5)**	**36 (9.2)**	**60 (15.3)**	**6 (1.5)**	**10 (2.5)**	**34 (8.7)**	**5 (1.3)**
Diuretics 72 (40)	Iatrogenic	Iatrogenic 22 (44.8)	Iatrogenic	CKD	Malignancy	Re-feeding syndrome	CKD	Drugs
	5 (50)		20 (55.5)	27 (43.3)	4 (66.6)	4 (40)	25 (73.5)	3 (60)
Infections 36 (20)	Dehydration	GI/hepato-biliary causes	Heart failure	Vitamin D deficiency	Primary hyper-parathyroidism	Dietary causes	Undetermined	GI losses
	3 (30)	10 (20.4)	10 (27.7)	11 (18.3)	1 (16.6)	1 (10)	7 (20.5)	1 (20)
CLD	Hypothalamic lesion	Decreased intake	Renal causes	Low PTH	Immobilization	Vitamin D deficiency	Tumor lysis syndrome	Alcohol
21 (11.6)	1 (10)	4 (8.1)	3 (8.3)	16 (26.6)	1 (16.6)	1 (10)	1 (2.9)	1 (20)
Malignancy 10 (5.5)	Diabetes insipidus	Dialysis	Pseudo-hyperkalemia	Poor intake		Hypo-parathyroidism	Enema	
	1 (10)	6 (12.2)	3 (8.3)	4 (6.6)		1 (10)	1 (2.9)	
Heart failure / CAD		Hypo-magnesemia		Acute pancreatitis		Undetermined		
18 (10)		7 (14.2)		2 (3.3)		3 (30)		
SIADH								
10 (5.5)								
Acute Gastro-enteritis								
7 (3.8)								
Undetermined								
6 (2.7)								

The outcome of patients with various dyselectrolytemias is shown in table 4. Out of 390 geriatric patients having dyselectrolytemia, 373 (95.6%) improved whereas 17 (4.3%) succumbed. Hyponatremia was the commonest electrolyte disorder in these 17 patients followed by hypokalemia.

DISCUSSION

In our study, electrolyte imbalance was present in more than 70% of the elderly population hospitalized for any reason; nearly two-third patients were asymptomatic on this count. Hyponatremia was the commonest electrolyte abnormality followed by hypocalcemia and hypokalemia. Elderly females were observed to be more prone to develop various dyselectrolytemias such as hypokalemia (4). For the sake of understanding, we wish to discuss the results under the following sub-headings- prevalence, co-morbidities and their causes.

Prevalence

Around 11% of hospitalized elderly patients are hyponatremic (5,6);though figures as high as 33% have also been reported. (7) Most of these studies ncluded the subjects who were symptomatic due to the dyselectrolytemia. We observed hyponatremia in 46.1% patients, more than the previous studies presumably due to the selection of patients irrespective of whether or not they were symptomatic. The female preponderance of hyponatremia in elderly observed by us was also reported in studies conducted by Miller M et al (8) and Ayus JC et al (9).

Cross-sectional studies suggest a 1 prevalence of hypernatremia in nursing home residents (10). Other studies including ours observed hypernatremia between 0.3- 3.4% (11). Although the percentages differ, the absolute numbers are more or less similar as the sample sizes in the studies mentioned above vary from too small to considerably large.

We observed hypokalemia in 12.5% subjects similar to 15% and 13.1% reported by Krakauer et al and Clark et al respectively. (12,13) Like hyponatremia, elderly females with hypokalemia outnumbered their male counterparts consistent with the observations of Kleinfeld M et al (4).While female predominance of hypokalemia in their study was not diuretic-dependent, diuretics were the most important cause of hypokalemia in elderly population irrespective of the gender in ours. Sagild has done pioneer work on the female predominance of hypokalemia in the elderly. He measured exchangeable body potassium per kilogram body weight in normal subjects and observed lowest values in men less than 30 years of age and in females of more than 60 years of age. He proposed a relative increase in fat and decrease in lean body mass in elderly females as the cause of this disparity. (14)

We observed mixed electrolyte disorders in various patients especially those with chronic kidney disease (CKD) and congestive heart failure. Hypocalcemia and hyperphosphatemia were seen in 5.7% of elderly patients while hypernatremia and hypocalcemia were observed in 14.3% patients. Dyselectrolytemias like hypocalcemia, hyperphosphatemia and hyperkalemia are known to occur frequently in CKD, the problem is more in the elderly presumably due to age-related decline in glomerular filtration rate. (15) Csaba P et al also described hypernatremia and hyponatremia as independent predictors of mortality, however, because of low mortality in our study, we cannot draw such a conclusion (16).

Co-morbidities

Co-morbidities in the elderly is one of the leading reasons of occurrence of hyponatremia presumably compounded by the drugs prescribed to treat them. Diabetes mellitus has been described as an independent risk factor for hyponatremia. For every 5mmol/l rise in serum glucose level, there is fall in serum sodium by 1.6 to 2.4 mmol/l as glucose is an osmotically active substance. (17) In our study 50% patients with hyponatremia were diabetics and 32.2% hypertensives. Elderly hypertensive females on thiazide diuretics are known to be more susceptible to develop hyponatremia, cause of which remains unclear. (18) The common co-morbidities observed in 73% patients with hyponatremia are hypertension (51%), psychiatric illnesses (19%), diabetes (16%), chronic obstructive airway diseases (17%), malignancies (15%) and thyroid disorders (13%). (19) Similarly, we observed co-morbidities in 60% patients with hyponatremia-diabetes (25.4%), hypertension (17.7%), coronary artery disease (6.8%) and COPD (4.5%). Hypertension and drugs like ACE inhibitors and diuretics are associated with development of hypokalemia in the elderly. (20) Likewise, we observed that 15 (30.6%) patients with hypokalemia had hypertensive.

Causes

Interplay of decrease in total body water and replacement of muscle mass by fat, consequently changing the intracellular volume is responsible for higher prevalence of dysnatremias in geriatric patients. (21,22) Common causes of hypernatremia are decreased ability to concentrate urine in elderly, decrease in thirst stimulation and insensible fluid losses from the body. (23)

Hyponatremia is classified on the basis of volume status of the patient, SIADH being the commonest and over-diagnosed cause of euvolemic hyponatremia. (24,25,26) In contrast to the 58.6% patients diagnosed as having SIADH by Miller et al , we attributed SIADH producing hyponatremia in only 5.5%. The difference appears to be inclusion of

those who were apparently hypovolemic as they actually respond to mineralocorticoid therapy rather than fluid restriction (27). Numerous drugs like thiazide diuretics and serotonin receptors re-uptake inhibitors commonly prescribed to the elderly are responsible for causing hyponatremia. (28)We observed diuretics to be the commonest cause of hyponatremia.

Palevsky PM et al observed that 89% of the hospitalized patients develop hypernatremia due to diuretic induced urine concentrating defects or inadequate administration of intravenous fluids. (29) Another study by Synder NA et al also implicated hypernatremia in 57% elderly to iatrogenic causes (23) concordant with 50% cases in our study.

Factors like hormones, glomerular filtration rate and intracellular transport of potassium ions help in the maintenance of potassium homeostasis which may be affected by drugs such as diuretics (potassium sparing, thiazide), non-steroidal anti-inflammatory drugs, heparin, angiotensin receptor blockers, etc. Aging further decreases trans-tubular potassium gradient and predisposes to hyperkalemia seen commonly in the elderly. (30,31) Diuretic induced hypokalemia in the elderly has been reported as 15% and 13.1% in a couple of studies (32,33). Diuretics and dialysis were the most important causes of hypokalemia in our study.

Magnesium aids in the maintenance and conservation of serum potassium in the body (34) and hypomagnesemia may cause refractory hypokalemia resistant to potassium supplementation as observed in 7 (14.2%) cases in this study with hypokalemia. Spironolactone, a potassium sparing diuretic, was responsible for iatrogenic hyperkalemia in the study by Masoudi FA et al. (35) Likewise, we observed iatrogenic hyperkalemia in 20 (55.5%) patients attributed to potassium sparing diuretics, ACE inhibitors and ARBs.

Costache et al in 2012 observed frequent association of hyperkalemia, hypokalemia and hypernatremia in patients with chronic heart failure predisposing them to arrhythmias. (36) Hyperkalemia was associated with heart failure in 10 (27.7%) cases in our study too. Hyperkalemia is frequently associated with chronic kidney disease (37) and cardiac arrest is common in patients with severe kidney disease (38). More than a fifth of our patients with hyperkalemia had associated acute or chronic renal failure (CRF). Hypocalcemia also co-exists in renal failure and 43.3% of our patients with hypocalcemia had CRF, similar to 50 % reported by Saha M et al (39).

Kagansky et al reported hypophosphatemia in 14.1% elderly, associated mainly with refeeding syndrome and reduced survival especially in malnourished elderly patients. (40) In our study, re-feeding syndrome was the cause of hypophosphatemia in 40% patients in critically ill patients.

Three-fourth of all elderly with hyperphosphatemia in our study had CRF. Age is an important risk factor for the development of end stage renal disease in patients with underlying Chronic Kidney Disease. (41) The study conducted by Drawz et al highlighted the importance of assessing electrolytes like hyperkalemia and hyperphosphatemia in the elderly with low glomerular filtration rate as it has diagnostic and therapeutic implications. (42) Although, it is difficult to specify the dyselectrolytemia as the cause of poor outcome, nevertheless, their contribution cannot be denied when compared with the subjects without any electrolyte disturbance. Another limitation of our study is that the results cannot be extrapolated to the general population in totality. Nevertheless, the study provides an insight into the electrolyte imbalances that affect the elderly, their common and preventable causes from north India from where the data is sparse.

CONCLUSION

The fastest-growing segment of the population in India is people older than 60 years. It is increasingly evident that many disorders common in the aging individual may be accompanied by disturbances of electrolytes, especially hyponatremia. Drugs prescribed for treatment of the common co-morbidities like diabetes and hypertension are the major cause of the dyselectrolytemias noted especially in the elderly. The clinicians should be aware of the potential adverse drugs being prescribed to the elderly. A high index of suspicion should lead to a careful appraisal of the seemingly innocuous drugs like diuretics and intravenous fluids. Moreover, they should not be over-enthusiastic in attempting to correct electrolyte imbalance because the danger of over-treatment produce the opposite and equally dangerous electrolyte imbalance. Cautious patient care and vigilance should be the clinical approach with elderly patients. The overall mortality in the study group was low i.e. 3%. It is imperative to state that the mortalities cannot be attributed to dyselectrolytemia alone and its relative contribution is very less. However, the potential of the various electrolytes to cause a poor outcome cannot be undermined and their appropriate and timely management cannot be over-emphasized.

AUTHORS' CONTRIBUTION

SG, NK, MD, SA: Data collection, Analysis of data, preparation of manuscript, Approval of final manuscript

NS, RB: Analysis of data, Providing critical intellectual inputs, Approval of final manuscript

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