Int J Biol Med Res. 2013; 4(3) :3479 - 3482

Contents lists available at BioMedSciDirect Publications

International Journal of Biological & Medical Research

Journal homepage: www.biomedscidirect.com

Original Article

Study of Electrolyte Disturbances in Acute Asthma

[ab]P Ravikumar *, G Priyadarshini Bai, H .V. Suryanarayana

[a]Dr. Priyadarshini Bai G: Assistant professor, Department of Pharmacology, Sri Siddhartha Medical College, Tumkur, Karnataka, India
[b]Dr. H V Suryanarayana: Associate Professor and HOD, Department of TB and Chest Diseases, Sri Siddhartha Medical College, Tumkur, Karnataka, India

ARTICLE INFO

Keywords:
Acute asthma
GINA
ß$_2$-agonists
Electrolyte disturbances
Hypomagnesemia

ABSTRACT

Aims: The purpose of the study is to determine the prevalence of electrolyte disturbances during acute exacerbation and after standard treatment. Methods: A total of 50 patients admitted with acute asthma were enrolled in the study with random selection. Treatment started according to GINA (Global INitiation of Asthma) protocol. Serum electrolyte levels were measured at intervals of 0 min, 90 minutes and 180 minutes and 24hrs after starting nebulization and followed up to discharge. Results: Electrolyte disturbance at the time of admission was found in 27 patients (54 %); the highest proportion was Hyponatremia 16(32%), followed by Hypomagnesemia 15(30%). After standard treatment decrease in all electrolytes level was noted. Maximum drop in magnesium and potassium levels were noted at 90min, sodium and phosphorous levels at 180min. Severity of asthma was statistically and clinically significant with hypomagnesemia (P=0.04). Other electrolyte disturbances noted were not clinically significant.Conclusion: Electrolyte levels should be checked in acute exacerbation of asthma as it can alter the course of disease progression. As Hypomagnesaemia was significantly associated with severe asthma attack, serum magnesium level should be checked during admission and at least after 2 hours of nebulisation.

1. Introduction

Asthma is a serious health problem throughout the world, affecting people of all ages. When uncontrolled, asthma can limit the daily activities and is sometimes fatal. Acute severe asthma represent progressive airway narrowing to the extent where the patient is distressed at rest and may have signs of cardiac stress. Treatment of acute asthma consists of repeated doses of nebulised ß2-agonists, systemic steroids and intravenous aminophylline in unresponsive cases [1]. Nebulised ß2-agonists are known to cause electrolyte disturbances in acute asthma and can alter the course of the disease. There is limited data on electrolyte disturbances in acute Asthma. Hence present study is carried out to determine the prevalence of electrolyte disturbances during acute exacerbation and after standard treatment.

Electrolyte disturbance in asthmatics is well known for serum potassium, especially linked to ß2- agonist's therapy [2, 3]. Hypokalemia was the first electrolyte disturbance reported in acute asthma, and was related to the use of ß2-agonists and aminophylline therapy [4, 5, 6]. Tremors, tachycardia, palpitation, and anxiety are well-known side effects of ß2-agonists [7]. After some time hypomagnesemia, hypophosphatemia, and hypocalcemia have also been reported with ß2-agonists in asthmatic patients [8, 9]. The mortality rate in patients with asthma is still rising and has been partly attributed to adverse effects of ß2-agonists during acute asthma management [10]. In 1970s increased incidence of deaths in asthma were noted due to non-selective ß-agonists (Isoproterenol) and Fenosterol [11]. Hypokalemia, Hypomagnesemia and Hypocalcaemia are well-known causes of cardiac arrhythmia [12, 13]. Hypophosphatemia can worsen even respiratory failure in acute severe asthma through impairment of respiratory muscle performance [14]. There are only few studies related to above subject and its clinical relevance. Therefore, the present study was carried out to assess the prevalence of electrolyte disturbances in patients presenting with acute asthma and its relation to severity and to assess whether the therapeutic agents used to treat acute asthma have any effect on electrolyte levels and its clinical significance.

* Corresponding Author : **Dr. P. Ravikumar**
Assistant Professor,
Department of TB and Chest Diseases,
Sri Siddhartha Medical College, Tumkur, 572107.
Karnataka, India, Mob: +919448342916

2. Materials and Methods

This prospective Study was carried out on randomly selected patients who were admitted to Bhagwan Mahaveer Jain hospital with acute exacerbation of asthma from March 2007 to August 2008. A total of 50 subjects were selected randomly after they gave consent to participate in the study. Spirometrically and clinically confirmed cases of asthma were taken into study. The severity was assessed based on GINA guidelines. PEF was done at emergency department during admission. Chest X-ray, ECG, ABG, Haemogram, and other routine investigations were done. Salbutamol nebulisation was given at admission (0 min) and repeated at every 30 min intervals for first 2 hrs and then every fourth hourly up to 24 hrs and then repeated according to need. IV steroids were administered according to GINA protocols. Unresponsive patients were started with nebulized Anticholinergics. Serum electrolyte levels were measured at the time of admission (0 min), 90 minutes, 180 minutes and 24 hrs after starting nebulisation.

The Excel and SPSS 10.5 (SPSS Inc, Chicago) software packages were used for data entry and analysis. The results were averaged (mean + standard deviation) for each parameter for continuous data and numbers and percentage for categorical data are presented in Table and Figure. The student 'T' test was used to determine whether there was a statistical difference between male and female subjects in the parameters measured. Proportions were compared using Chi-square test. One-way analysis of variance was used to test the difference between groups. In all the above tests a "p" value of less than 0.05 was accepted as indicating statistical significance.

In this study among 50 patients 58 % were female and 42% were male. Overall mean age was 54 ± 18 years. Mean age of onset was 28 ± 16 yrs. Severity of exacerbations were not statistically significant with respect to age (p value=0.182) and gender (p value=0.760).

Electrolyte disturbance at the time of admission was found in 27 patients (54 %). Among them 18 (66.7%) patients had single electrolyte disturbance and 9(33.4%) had two electrolyte disturbances as shown in Table-1. With respect to individual variation in electrolyte disturbance incidence of Hyponatremia was relatively high as shown in Table 2 [16(32%), followed by magnesium 15(30%), potassium 4(8%) and phosphorous 4(8%)].

Changes in Sodium, Potassium, Magnesium and phosphorous levels at various intervals with nebulisation

The changes in sodium, potassium, magnesium and phosphorous levels at various intervals are shown in table-3. Mean concentration of sodium at various intervals are plotted in figure-I. 16(32%) asthmatic patients were found to have low serum sodium level (< 135 mmol/L). This number increased to 19(38%), & 23(46%) after 90min and 180min of starting treatment respectively. Maximum decrease in mean concentration of sodium was noted at 180min (by 0.74l mmol/L). Mean concentration of Potassium are plotted on figure-II. In the present study hypokalemia (<3.5meq/l) was found in 4(8%) of patients, it increased to 13(26%), 9(18%) and 6(12%) at 90min, 180min and 24hrs respectively after starting nebulisation. Maximum drop in potassium level was noted at 90min (by 0.162meq/l). However no clinical manifestations of hypokalemia were noted during the study. Mean concentrations of Magnesium are plotted on figure-III. Hypomagnesemia (<1.8mg/dl) was found in 15(30%) of patients, and it increased to 22(44%), 16(32%) and 7(14%) at 90min and 180min and 24 hours respectively. Maximum drop in magnesium level was noted at 90min (by 0.162 mg/dl). In 2 cases of severe hypomagnesaemia recovery delayed, first patient discharged after 6 days, second patient was ventilated and recovered with magnesium correction and discharged on 10th day. Multiple logistic regression analysis showed significant association of severity of asthma with hypomagnesaemia (p=0.04). Mean concentrations of

Proportion of Electrolyte disturbances at admission

Proportion of Electrolyte disturbances	Percentage
One electrolyte disturbance	18 (66.7%)
Two electrolyte disturbances	9 (33.3%)
Three electrolyte disturbances	0 (0%)
Total	27 (54%)

Proportion of Electrolyte disturbances Percentage

Table 1: Proportion of Electrolyte disturbances at admission

Type of Electrolyte disturbances	Percentage
Hyponatremia	0-min
Hypomagnesemia	90-min
Hypokalemia	180-min
Hypophosphatemia	Mild

Table 3: Changes in Sodium, Potassium, Magnesium, phosphorous levels at various intervals with nebulisation

Time after nebulisation	Sodium (mg/dl)	Potassium (mg/dl)	Magnesium (mg/dl)	Phosphorous (mg/dl)
0-min	135.38 ±3.752	4.004 ±0.431	1.970 ±0.359	3.646 ±0.866
90-min	134.90 ±3.3030	3.842 ±0.466	1.808 ±0.334	3.426 ±0.697
180-min	134.64±3.1540	3.928±0.452	1.906±0.364	3.408±0.766

Table 4: Comparison of Mean Hospital Stay according to Severity*

Severity	No. of cases	Mean Hospital Stay (Days)	Std. Deviation	Minimum	Maximum
Mild	14	2.71	.611	2	4
Moderate	28	3.29	.600	2	4
Severe	8	6.00	1.852	4	10

***'P' value <0.001**

Phosphorous are plotted on figure-IV. Hypophosphatemia <0.8mmol/l (<2.5 mg/dl) has also been reported in patients with acute asthma. Hypophosphatemia was seen in 4(8 %) of patients and it decreased to 3(6%), 3(6%) and 4(8%) cases at 90 min, 180 min and 24 hours. Maximum drop in phosphorous level was noted at 180min (0.240 mg/dl). The changes in electrolytes level at various intervals are not statistically significant (p value-0.605).

Mean duration of hospital stay was 4 days; maximum number 24(48%) patients discharged on 3rd day and by 4th day 43(86%) patients were discharged. Number of days of hospital stay was statistically significant with respect to severity (p value=0.001) as shown in Table-4.

FIGURES: Study of Electrolyte Disturbances in Acute Asthma

I.Mean Sodium Concentration after Nebulisation

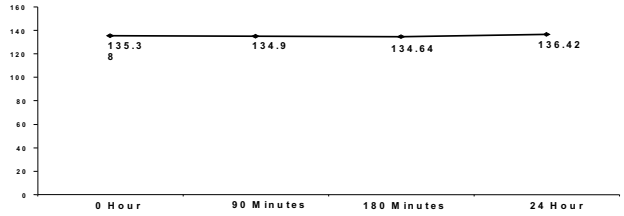

Figure legend: Mean sodium concentration was 135.38 meq/l at 0 min which was dropped by 0.42 (134.9) meq/l at 90 min, 0.74 (134.64) meq/l at 180 min and reached normal range (136.42) meq/l after 24 hours of starting nebulisation.

II. Mean Potassium Concentration after Nebulisation

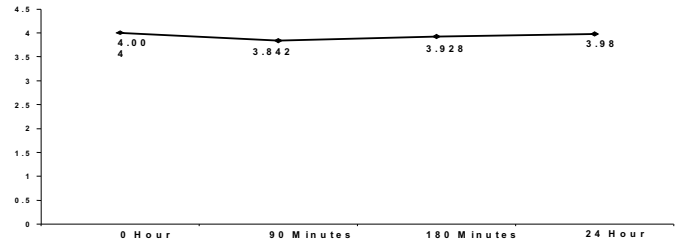

Figure legend: Mean potassium concentration at 0 min was 4.004 meq/l which was dropped by 0.162(3.842) meq/l at 90 min, 0.076(3.928) meq/l at 180 min and 0.024(3.98) meq/l after 24 hours of starting nebulisation.

III. Mean Magnesium Concentration after Nebulisation

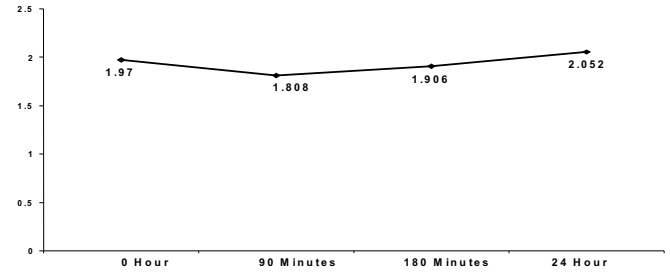

Figure legend: Mean magnesium concentration was 1.970 mg/dl at 0 min which was dropped by 0.162(1.808) mg/dl at 90 min, 0.064(1.906) mg/dl at 180 min and increased to 2.052 mg/dl after 24 hours of starting nebulisation.

IV. Mean Phosphorous Concentration after Nebulisation

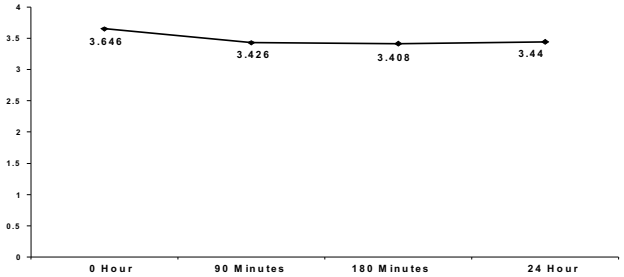

Figure legend: Mean phosphorous concentration was 3.648 mg/dl at 0 min which was dropped by 0.220(3.426) mg/dl at 90 min, 0.240(3.408) mg/dl at 180 min and 0.208(3.44) mg/dl after 24 hours of starting nebulisation.

4. Discussion

Electrolyte disturbance at the time of admission was found in 27 patients (54 %) out of 50 patients. As compared to other studies {Keng Leong Tan et al [15], Alamoudi et al [16]}, two electrolyte disturbances 9 (33.3%) are more in the present study than three electrolyte disturbances. This study showed high prevalence of hyponatremia at admission & increased incidence of hyponatremia with treatment. However these changes did not show any clinical and statistical significance (p value=0.605). No previous studies drew a clear conclusion about prevalence and clinical significance of hyponatremia. Hence further studies are needed to evaluate the significance of this finding.

The changes in potassium levels at various intervals are not statistically significant (p value >0.05). Hence therapeutic drugs administered for the management of acute asthma (nebulised bronchodilators, IV hydrocortisone) might found to have decremental effect on the serum potassium level but not clinically significant to cause signs and symptoms of hypokalemia. This study showed high prevalence of hypomagnesemia at admission & increased incidence with treatment and statistically and clinically significant association with severity of asthma. In the present study there was no change in incidence of Hypophosphatemia after nebulisation. Present study is consistent with study done by Bodenhamer et al [5].

The highest proportion of electrolyte disturbance was found for sodium 16(32%), followed by magnesium 15(30). Following treatment maximum drop in sodium level was noted at 180min (by 0.74 meq/l), in magnesium level at 90min (by 0.162 mg/dl), in potassium level at 90min (by 0.162 meq/l) and in phosphorous level at 180min (by 0.240 mg/dl). Multiple logistic regression analysis showed that severe asthma was associated significantly with hypomagnesaemia (p value=0.04) with two patients showing clinical manifestations of hypomagnesemia. Other electrolyte disturbances noted during study were not associated with any clinical complications.

Therefore, in patients with acute exacerbation of asthma, care should be taken during management to avoid the adverse effects of bronchodilator therapy. If there are of one or more or severe abnormal electrolyte levels during admission the use of such treatment may increase the derangement of the existing abnormal electrolyte levels. Consequently, this may pose potential cardiac and respiratory hazards in the form of myocardial depression, ventricular arrhythmia, and respiratory muscle fatigue, which consequently may increase the incidence of fatal asthma. Extra care should be taken if underlying hypoxia or acidosis or preexisting cardiovascular disease and electrolyte disturbances noted during admission.

5. Conclusion

Electrolyte disturbances are common in acute asthma. Hypomagnesaemia and hyponatremia were found to be the most common electrolyte abnormalities in our study. Therefore, Serum electrolytes level should be checked during admission and at least after 2 hours of nebulisation (especially for patients who have dyselectrolytemia at admission), since maximum fall in electrolytes level noted with in this period. As Hypomagnesaemia was significantly associated with severe asthma attack, checking Magnesium level during admission and after 2 hours of nebulisation is more important. However, further studies are needed to confirm our findings and to clarify these speculations.

Acknowledgement:

This study was conducted with an immense support and invaluable suggestions from Dr Priyadarshini bai .G, Assistant Professor Department of Pharmacology, Sri Siddhartha Medical College, Tumkur, Dr H V Suryanarayana Associate Professor & HOD, Department of TB and Chest Diseases, Sri Siddhartha Medical College, Tumkur.

6. References

[1] Barnes PJ. Postgrad Med J. 1991; 67: 1-3.

[2] Kung M, White JR, Burki NK. The effect of subcutaneously administered terbutaline on serum potassium in asymptomatic adult asthmatics. American Review of Respiratory Diseases 1985;129: 329-332.

[3] Whyte KF, Reid C, and Addis GJ et al. Salbutamol induced hypokalemia: the effect of theophylline alone and in combination with adrenaline. British Journal of Clinical Pharmacology. 1988;25: 571-578.

[4] Haalboom JRE, Deenstra M, Struyvenberg, A. Hypokalemia induced by inhalation of fenoterol. Lancet. 1985;1: 1125-1127.

[5] Bodenhamer J, Bergstrom R and Brown D et al. Frequently nebulized ß-agonists for asthma: effects on serum electrolytes. Annals of Emergency Medicine. 1992; 21: 1337-1342.

[6] Gustafson T, Boman K and Rosenhall L et al Skeletal muscle magnesium and potassium in asthmatics treated with oral ß2-agonists. European Respiratory Journal. 1996; 9: 237-240.

[7] Webb-Johnson DC, Andrews JL. Bronchodilator therapy. New England Journal of Medicine. 1977; 297: 476-482.

[8] Prince RL. Monk KJ and Kent GN et al. Effects of theophylline and salbutamol on phosphate and calcium metabolism in normal subjects. Miner Electrolyte Metabolism. 1988; 14:262-265.

[9] Bos WJW, Postma DS, Doormaal JV. Magnesiuric and calciuric effects of terbutaline in man. Clinical Science 1988; 74:595- 597.

[10] Benatar SR. Fatal asthma. New England Journal of Medicine. 1986; 314: 423-429.

[11] Crane J, Pearce N and Flatt A et al. Prescribed fenoterol and death from asthma in New Zealand, 1981–1983: case-control study. Lancet. 1989;1: 917-922.

[12] Philips PJ, Vedig AE and Jones PL et al. Metabolic and cardiovascular side effects of the ß2-adrenoceptor agonists salbutamol and rimiterol. British Journal of Clinical Pharmacology. 1980;9: 483-491.

[13] Crane J, Burgess CD and Graham AN et al. Hypokalemia and electrocardiographic effects of aminophylline and salbutamol in obstructive airway disease. New Zealand Medical Journal. 1987;100: 309-311.

[14] Aubier M, Murciano D and Lecocguic Y et al. Effects of hypophosphatemia on diaphragmatic contractility in patients with acute respiratory failure. New England Journal of Medicine 1985;313: 420-424.

[15] Tan KL, Rauff S and Cheng SF et a.l electrolyte disturbances in acute asthma; Chest meeting, October, 2004.

[16] Alamoudi OSB, Electrolyte disturbances in patients with chronic stable asthma: effect of therapy, Chest; August 2001; 120:2:431-436.