Assessment of Acid Base and Electrolyte Status in Patients with Chronic Kidney Disease

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ABSTRACT

Background: Blood gas measurements are being used to evaluate oxygenation and acid/base status. They are typically ordered if a patient has worsening symptoms of an acid/base imbalance, difficulty in breathing or shortness of breath. Blood gas analysis has been a cornerstone in the management of acutely ill patients with presumed acid/base and electrolyte imbalance.

Objective: The aim of this study was to study the blood gases and electrolyte status in patients with chronic kidney disorder.

Methods: A prospective study was conducted in the department of Clinical Biochemistry, Sher-I Kashmir Institute of Medical Sciences Srinagar. A total of 171 patients were included in the study of which 91 were males and 80 were females. The age of the patients ranged between 4 - 80. These patients were admitted in the Nephrology ward of SKIMS. Out of these 171 patients included in the study 99 had CKD, 42 had ARF, 11 had metabolic acidosis, 6 had nephritic syndrome, 2 had lupus nephritis and 11 had complications like dysuria, HTN, glomerular diseases etc. The medical history of the patients with CKD was recorded and Samples were obtained for blood gas analysis. Venous samples were obtained for VBG analysis and arterial samples were obtained for ABG analysis. These samples were analysed for determining the blood gas status. Hemoglobin levels and kidney function test were performed manually. Hemoglobin was estimated by cyanmet-hemoglobin method. Urea was estimated by Diacetyl monoxime (DAM) method. Creatinine was estimated by Jaffe's reaction.

Results: CKD patients showed acidosis, hypocapnia and hypoxia. Among electrolytes almost all the patients with CKD had hyponatremia and increased anion gap.

Conclusion: It was concluded from the observation that male predominance was seen in chronic kidney disease. Blood gas parameters including pH, PCO₂, PO₂, HCO₃ were found to be deranged in most of the patients with CKD. Among electrolytes sodium was found to be mostly deranged in patients with CKD and Anemia was the most common finding in patients with this disorder. JMS 2013; 16(2):86-89

Keywords: Blood gas analysis, CKD, ARF, Electrolytes, Urea, Creatine, ESRD

INTRODUCTION

Blood gas analysis is used to measure the pH and the partial pressures of oxygen and carbon dioxide in the blood. The investigation is relatively easy to perform and yields information that can guide the management of acute and chronic illnesses. This information indicates a patient's acid- base balance, the effectiveness of their gas exchange and the state of their ventilatory control that is blood gas analysis is often performed in to assess acid-base disturbances, and to diagnose and quantify respiratory insufficiency. Blood gas analysis is a means of determining the amount of oxygen or carbon dioxide being carried in the

blood and in some cases of the discovering the identity of toxic gas, such as carbon monoxide that may be present. Also, the determination can be made as to whether the blood is too acidic or too alkaline, which may help the physician in his diagnosis.¹ An arterial blood gas analysis is performed on blood from arteries. An ABG analysis evaluates how effectively the lungs are delivering oxygen to the blood and how efficiently they are eliminating carbon dioxide from it. The test also indicates how well the lungs and kidney are interacting to maintain normal blood pH (acid base balance). Blood gas studies are usually done to assess respiratory disease and other conditions that may affect the lungs and to manage patients receiving oxygen therapy (respiratory therapy).² In addition, the acid-base component of the test provides information on kidney function. Blood gas analysis measures the partial pressures of oxygen

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and carbon dioxide in the blood, as well as oxygen content, oxygen saturation, bicarbonate content and blood pH.³ Electrolytes are present in the human body and the balance of the electrolytes in our bodies is essential for normal function of our cells and our organs. They help to regulate myocardial and neurological functions, fluid balance, oxygen delivery, acid base balance and much more. Some of the most important electrolytes in blood are sodium, potassium and chloride.⁴ The levels of each electrolyte is kept within normal range by several mechanisms. Any change in their level leads to electrolyte imbalance, which if severe can lead to life threatening consequences.

Chronic renal failure (CRF) or more appropriately chronic kidney disease (CKD) refers to a decline in the glomerular filtration rate (GFR) caused by a variety of diseases such as diabetes, glomerulonephritis and polycystic kidney disease. Patients with CKD have a high prevalence of hypertension. CKD may be categorized as mild (GFR of 60-89ml/min), moderate (GFR of 30-59ml/min), severe (GFR of 15-29ml/min) or end stage renal disease (ESRD). Some patients with CKD eventually receive kidney transplantation before (a few cases) or after (most recipients) the initiation of hemodialysis or peritoneal dialysis.⁵ The present study was conducted to study the blood gases and electrolyte status in patients with chronic kidney disease (CKD).

METHODS

This was a hospital based study conducted in the department of Clinical Biochemistry, Sheri Kashmir Institute of Medical Sciences Srinagar. The patients involved in the study were admitted in the Nephrology ward of SKIMS, Srinagar. A total of 171 patients were included in this study of which 91 were males and 80 were females. The age of the patients ranged between 4 years to 80 years. Clinical details and history of said patients was taken followed by assessment of hemoglobin levels and kidney function test. Also heparinised blood samples were obtained for blood gas analysis. Venous samples were obtained for VBG analysis and arterial samples were obtained for ABG analysis. These samples were analyzed for determining the blood gas status. The sampling parameters included in the study were pH, PCO₂, PO₂, HCO₃⁻, Na⁺, K⁺, Cl⁻ and Anion gap.

Hemoglobin was estimated by cyanmethemoglobin method. Urea was estimated by Diacetyl monoxime (DAM) method and Creatinine was estimated by Jaffe's reaction.

Statistical analysis was done by using S.D and probability p values (p<0.05) were considered statistically significant.

RESULTS

171 patients including 91 males and 80 females were included in this study. Maximum number of patients were in the age group of 41 years to 60 years (Table 1). Male : Female ratio was found to be 1.13:1.

Table 1: Age and sex distribution in patients with kidney diseases

Age Group	Male	Female	Total
	n (%)	n (%)	n (%)
0-20	11(12)	6(8)	17(10)
21-40	22(24)	29(36)	51(30)
41-60	38(42)	21(26)	59(35)
61-80	20(22)	24(30)	44(26)
Total	91(53)	80(47)	171(100)

Out of 171 patients 99 had CKD (57.89%), 42 had ARF (24.56%), 11 had metabolic acidosis (6.43%), 6 had nephritic syndrome (3.50%), 2 had lupus nephritis (1.16%), 11 had other diseases (which include HTN, RTA, dysuria, glomerular diseases) (6.43%) (Table 2).

Table 2: Disease distribution of patients

Diseases	n (%)
CKD	99(57.89%)
ARF	42(24.56%)
Metabolic acidosis	11(6.43%)
Nephritic syndrome	6(3.50%)
Lupus nephritis	2(1.16%)
Other diseases (HTN, RTA, dysuria, glomerular diseases).	11(6.43%)

99 patients had CKD (47 males, 52 females). Maximum patients admitted with the diagnosis of CKD were in the age group of 41-60 yrs with a sex ratio {Male : Female ratio=0.90} (Table 3).

Table 3: Age and sex distribution in patients with CKD

Age group	Males	Females	Total
	n (%)	n (%)	n (%)
0-20	5(10)	3(6)	8(8)
21-40	13(28)	17(33)	30(30)
41-60	22(47)	15(29)	37(37)
61-80	7(15)	17(33)	24(25)
Total	47(47)	52(53)	99(100)

Acidosis was seen in 62 (63%) patients with CKD, out of which 15% had mild acidosis and 14% had severe acidosis. Also maximum number of patients with CKD had significant bicarbonate deficit i.e. 78 (80%) while 13(13%) had normal bicarbonate levels (Table 4). 62 (65%) patients had hypocapnia, 30 (31%) patients had normal PCO₂ levels, 4(4%) had high PCO₂ levels. 42 (93.33%) patients with CKD had hypoxia out of which 29% had mild hypoxia, 18% had moderate hypoxia and 47% had severe hypoxia.

Table 4: Blood gases status in patients with CKD

Parameters	Clinical Conditions	n (%)
pH n= 99	Mild acidosis	15(15)
	Moderate acidosis	33(33)
	Severe acidosis	14(14)
	Normal	34(34)
	Alkalosis	3(3)
PO ₂ n= 45	Mild hypoxia	13(29)
	Moderate hypoxia	8(18)
	Severe hypoxia	21(47)
	Normal	3(7)
	Hyperoxia	Nil
	Not assigned	54(55)
PCO ₂ n= 96	Mild hypocapnia	28(30)
	Moderate hypocapnia	28(30)
	Severe hypocapnia	6(6)
	Normal	30(31)
	Mild hypercapnia	4(4)
	Not Assigned	3(3)
HCO ₃ n= 97	Mild HCO ₃	23(24)
	Moderate deficit HCO ₃	13(13)
	Severe HCO ₃	42(43)
	Normal HCO ₃	13(13)
	Mild HCO ₃	6(6)
	Not Assigned	2(2)

Table 5: Electrolyte status in patients with CKD

Parameters	Clinical Conditions	n (%)
Na ⁺ n = 99	Mild hyponatremia	28(29)
	Moderate hyponatremia	40(41)
	Severe hyponatremia	10(10)
	Normal	18(18)
	Mild hyponatremia	2(2)
	Not assigned	1(1)
K ⁺ n =99	Mild hypokalemia	16(16)
	Moderate hypokalemia	5(5)
	Severe hypokalemia	7(7)
	Normal	53(54)
	Mild hyperkalemia	18(18)
Cl ⁻ n = 61	Hypochloremia	36(59)
	Normal	22(36)
	Hyperchloremia	3(5)
	Not Assigned	38(38)
Anion gap n = 60	Increased anion gap	51(85)
	Normal	6(10)
	Decreased anion gap	3(5)
	Not Assigned	39(40)

Almost all the electrolytes were deranged in patients with CKD but Hyponatremia was highly significant than hyperkalemia and hyperchloremia. 78(80%) patients with CKD had hyponatremia and only 18(18%) patients had normal sodium levels. 28(28%) patients with CKD had hypokalemia, 8(18%) of patients had hyperkalemia and 53(54%) of patients had normal potassium levels. Hyperchloremia was seen in 36(59%) patients with CKD while 22(36%) had normal chloride levels and 3(5%) had hypochloremia. 51(85%) patients had elevated anion gap and 6(10%) had normal anion gap (Table 5).

Anemia was the most common finding in patients with this disorder. Mild anemia was reported in 7(12%) of patients. Moderate anemia was found in 39(67%) of patients. 10(17%) of patients had severe anemia and 2(3%) had normal hemoglobin levels (Table 6).

Table 6: Hemoglobin results in patients with CKD

Hemoglobin (g/dl)	n (%)
Mild anemia (n= 58)	7(12)
Moderate anemia (n= 58)	39(67)
Severe anemia (n= 58)	10(17)
Normal (n= 58)	2(3)
Not assigned	41(41)

Table 7: Lab parameters in patients with CKD

Laboratory parameters	Mean	Range
Hb	8.60g/dl	(6.2-9.9)
Urea	175.57g/dl	(101-309)
Creatinine	8.44g/dl	(3.07-17.73)

DISCUSSION

An ABG analysis evaluates how effectively the lungs are delivering oxygen to the blood and how efficiently they are eliminating carbon dioxide from it. An arterial blood gas (ABG) test measures the acidity pH and the levels of oxygen and carbondioxide in the blood from an artery. They are typically ordered if a patient has worsening symptoms of an acid /base imbalance, difficulty in breathing or shortness of breath. Chronic kidney disease is the most prevalent disease in kidney disorders. Anemia is the most common complication of this disease Anemia was reported in 56 (96%) out of 58 patients with CKD. It has multiple causes, the most important of which is decreased production of erythropoietin by the kidney. Its prevalence and severity increases with deteriorating renal function. This is in agreement with the findings of Kammerer et al, 2002.⁶ In CKD increased levels of urea and creatinine are attributed to rapid decline in renal filtration function. Same was also reported by a group of scientists who found that in CKD stage 4-5 hyperkalemia emerges, in addition to that sodium, chloride and bicarbonate levels also change.⁷

In most CKD patients electrolyte levels are deranged. Hyponatremia, Hyperkalemia is often associated with CKD.⁷ Also Phosphorous and calcium levels are altered and Metabolic acodosis is associated with CKD.⁷ In the present study it was concluded that male predominance was seen in kidney disorders that is number of male patients was more than female patients and among the kidney disorders the most prevalent disease was CKD followed by ARF, metabolic acidosis, nephritic syndrome, lupus nephritis, glomerular diseases etc. We conclude that hyponatremia is highly significant than hyperkalemia and hyperchloremia. Despite the disease breathlessness, decreased urinary output, swelling facial puffiness were the mostly commonly observed symptoms in patients.

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