INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 15, No. 5, p. 1-8, 2019

RESEARCH PAPER OPEN ACCESS

Effect of blood electrolytes in hypertensive and heart attack patients

Aamir Khan Awan[1*], Yar Muhammad Khan[1], Matiullah[1], Rahmat Ali Khan[2], Khayal Muhammad[3]

[1]*Department of Biotechnology, University of Science and Technology UST Bannu, KPK, Pakistan*

[2]*Department of Biotechnology, University of Science and Technology UST Bannu, KPK, Pakistan*

[3]*Department of Pharmacy, COMSATS University, Abbotabad Campus, KPK, Pakistan*

Key words: Blood electrolytes (sodium, potassium and calcium), hypertension, heart attack.

http://dx.doi.org/10.12692/ijb/15.5.1-8 Article published on November 15, 2019

Abstract

A number of electrolytes are involved in the regulation of blood pressure (BP) and the pathophysiology of heart attack (HA). In present study, we have studied blood sodium (Na), calcium (Ca) and potassium (K) concentration in hypertensive and heart attack patients. Our hypothesis was that whether the hypertensive and heart attack patients have high levels of Na+, Ca+2 and K+2. Twenty five (25) patients of heart attack, twenty five (25) patients of hypertension and 10th control healthy individuals were randomly selected from blood sampling. Informed consent was taken from each patient before sampling, blood was centrifuged and plasma was separated. Flam photometer was used to analyze electrolytes concentration in these samples. Unpaired t-test was used for statistical analysis. Statistical analysis has shown that sodium (Na) and potassium (K) shows more significant deference in in hypertensive patients (BP), and less significant in heart attack (HA) patients. Similarly Calcium (Ca) shows less significant in hypertensive patients (BP) and heart attack (HA) patients. In the light of our experiment, we conclude there that increase of sodium (Na) in blood may cause to rise blood pressure which lead to risk of hearts attack, In balance conditions potassium (K) and calcium (Ca) have role in maintenance of normal blood pressure. However there is no conclusive and correct statement about calcium in this respect. In current studies, it was suggested that the unbalance condition of sodium (Na) and potassium (K) may increase risk factors of BP and heart attack patients.

* **Corresponding Author:** Aamir Khan Awan ✉ janbaznurar@yahoo.com

Introduction

Electrolytes are the substances which on dissociation produce positive and negative ions. Our bodies especially blood consist sodium, potassium, calcium, magnesium, chloride, sulphate and carbonate ions. For example sodium chloride (NaCl) is break down into sodium (Na^+) and chloride (Cl^-) ions. Body electrolytes maintain balance of whole body. And may causes serious problems in living bodies. The normal WHO recommended value of serum potassium is 3.5.5.1mmol/l. Extracellular and intracellular cells keep constant the level of blood by Na, K ATPase inflate present in cell membranes. Other electrolytes of human body are chloride, bicarbonate, intracellular and extracellular calcium and magnesium. These electrolytes perform deferent function in the human body (Lobo *et al.*, 2013, Turban *et al.*, 2013). Electrolytes perform different function in our bodies including, maintain muscle contraction, body's hydration, hypertension (BP) and normal heart beating. The tissues of neuron are activated by balance electrolytes. They maintain electrical balance of muscles, heart, and cell membrane. They are also involved to take electrical impulses to others cells. In our bodies renal and its hormones maintain balance of electrolytes in the body. Body losses electrolytes ions in the form of sweeting during more exercise. These losses of electrolytes are regained by using vegetables and fruits. Whenever in our body the electrolytes level then the kidneys excrete them through urine. The conditions in which blood sodium level become high then it cause hypernatremia, while low level of serum sodium cause hyponatremia (Lee, 2010). Similarly high potassium level cause hyperkalemia and low potassium cause hypokalemia and so on. Old age peoples mostly affected by loss of body fluid and over hydration in which the kidneys are do not keep electrolytes normal level. A lot of observations and experiments are performed on both men and animals which suggested that electrolytes have significant role on hypertension (Meneely and Battarbee, 1976, Tobian, 1960. One of the most serious issues in ICU is abnormalities of blood electrolytes in which kidneys unable to control the body electrolytes level balance and thus may cause morbidity and mortality in patients. These abnormalities may cause trauma, blood pressure, heart problems, brain damage and severe burns etc disorders. A high sodium level increases blood pressure (Kesteloot *et al.*, 1980).

Sodium plays an significant role in balance and moment of body. In food it is present in the form of sodium chloride (NaCl, table salt), from where it is absorbed to the blood stream. The recommended normal level of Na in blood plasma is from 135-145 meq/l or 3100-3300mg/l. When the blood sodium level in increased or decreased from normal level then it causes hypernatremia and hyponatremia and may cause some other serious problems like diabetes, Cushing syndrome etc (Skorecki and Ausiello, 2011). When sodium (Na) concentration become high from its normal range (135-145 meq/l) then it cause hypernatremia. This condition is occurred due to abnormalities of kidneys in which the kidneys are unable to keep constant the normal concentration of sodium in blood. The hypernatremia may lead to cause acute cerebral edema in patients. The cerebral edema developed into herniation of brain stream and respiratory arrest (Lee, 2010).. Similarly the mal functioning of kidneys cause hyponatremia in which the concentration of blood sodium become very low from its normal range. During this condition the kidneys are not able to retain and excrete body water or fluid in body and thus cause dehydration. Hyponatremia may cause vomiting and diarrhea (Rose, 1977).

Potassium is one the most important element of intracellular bodies. The normal range of blood potassium is 3.5 to 5.1 mmol/l or 200mg/l. Potassium control the sodium level in intracellular and extracellular body fluids. Potassium control muscles movements especially muscles contraction of heart and kidneys function. The human bodies get it through food. It has positive charge ion ($K^{+)}$. K also controls body homeostasis, pH, enzymes and optimal function of heart [2]. When the potassium level is rises from its normal range (3.5 to 5.1 mmol/l) then it causes hyperkalemia. If become very low (less than

3.5 mmol/l) from normal range then it leads to hypokalemia. Hypokalemia is caused due to diet having insufficient amount of K as well as during the transportation of K from gastrointestinal to renal cells. It may lead to anemia.).To differentiate more and less amount of kidneys potassium and urinary excretion should be examined. (Capasso and Unwin, 2011). Calcium is mineralized and an important form of bone. It also play role in muscle and nerve contraction, electrical activity, enzyme and hormonal regulation. It is mostly present in bone, but in some what also present in blood and intercellular Calcium is a significant element of bone and mineralized structures. It is also important for nerve (Pravino, *et al*, 2013). Its effect is controlled by calmodulin. In blood plasma it is bound with phosphate and citrate complex. Gut absorption and renal exertion are used to check the normal level of calcium. Plasma calcium is extremely controlled.

Hypercalceamia is caused by the increase of serum calcium from normal range (2.5mmol/l) or greater than normal level. The plasma protein is used to measure and manipulate the total calcium in blood stream. It is common disease and about 1% of population of the world is affected by hypercalceamia. Hypercalceamia is chronically and a common disease, but if the calcium level rises to its high pick then it became a life threating disease. Hypercalceamia is worldwide systemic disease which may cause lethargy, constipation, kidneys stones, polyuria, nephrocalcinosis and malaise. In sever condition it leads to weakness of muscles, confusion, toxicity of heart and abdominal pain. If the calcium level becomes very low then such condition is called hypocalcaemia. Hypocalcaemia is very reared as a compare to hypercalceamia. It is mostly caused due to dietary deficiency and kidneys failure. It also related to heat arrhythmias, seizures and mostly reduces the albumin level and cause hypoalbuminaemia. Hypocalcaemia condition (hyperphosphataemic states) may decrease the phosphate bind with calcium. Hypocalcaemia patients may shows symptoms of some other diseases like, paraesthesia, muscle cramps, weakness, bronchospasm and laryngospasm. Clinically it is better and useful to measure the fraction excretion of calcium. Later on calcitriol is used to remove and overcome the failure of kidneys. Shortages in diet and sun exposure should be lectured if needed (Capasso and Unwin, 2011).

Hypertension

The flow rate or circulatory system of blood is called blood pressure. In other words we can also say that is the measurement of the force that uses to heat to pump the blood into circulatory system of the body. The normal blood pressure of human being is 80/120mmHg. It depends upon the age of person. Blood pressure may be increased and decreased. The condition in which the flow rate of blood become higher from its normal range (80/120mmHg) is called hypertension, but when become very low from its normal range (80/120mmHg) then such is called hypotension or low blood pressure. In high blood pressure the blood flow exert force on the walls of blood arteries (vein). Due to increase of blood pressure the beating rate of heart also increase which may lead to heart and kidneys failure. Hypertension also causes strokes disorder (Rana *et al.*, 2014). Now e day's hypertension is one of the main reasons of cardiovascular disorders (He and MacGregor, 2003). The researchers have been suggested that hypertension is caused from genetics factors, such as obesity, stress, alcohol intake, physical inactivity, Excess of salt in diet and environmental effects (Li *et al.*, 2005).

Heart attack

The condition in which the heart does not keep constant the flow of blood in blood vein or arteries is called heart attack. Obstructions are the main cause of heart attack in which blood become clot in arteries. It resists and completely stops the flow of blood, result to damage of muscular contraction of heart and cause heart attack. Heart attack patient shows the symptoms of breaking of breathing, high blood pressure, stress, feel squeezing and chest pain. Heart attack may be occur suddenly or slowly (Rana *et al.*, 2014). It also causes other cardiovascular disease. The doctors suggested that obesity is the considerable

evidence to heart attack (Barrett-Connor and Khaw, 1985). Actually, some probable experimental studies have been suggested that systemic chronic inflammatory disorder is related with greater risk of heart diseases and death (Hwang *et al.*, 1997, Ridker and Morrow, 2003).

Aims and objectives

1. To investigate that whether blood electrolytes sodium, potassium and calcium are involved in high blood pressure.
2. To determine that whether the blood electrolytes are involved in risk factors of heart attack

Materials and methods

Graph pad Prism 5. Version 5.01 was used for. In this method unpaired t-test was used to analyze the significant differences between hypertensive, heart attack patients compared with normal healthy individuals.

Stock solution of Sodium (Na), potassium (K) and Calcium (Ca)

2.54g of NaCl, 1.88g of KCl and CaCl was taken through analytical balance and dissolved in 1000 ml volumetric flask. After that the solution was diluted up to 1000 ml distilled water. All the stock solutions were prepared in a separate volumetric flask. The solution was shacked for few mints and then placed in Lab for further analysis.

Preparation of Standard solutions

For the calibration of blood electrolytes low and high standard 5ppm, 10ppm, 20ppm, 50ppm, 100ppm and 300ppm solutions were prepared from the respective stock solution. All the standard solutions were prepared in a separate volumetric flask. It may be prepared in one combined solution and were placed for further analysis.

10 ppm standard solution

Standard ppm solution is prepared by musing $M_1V_1=M_2V_2$ formula. According to this formula 0.5ml (500 micro liter) Na, 0.5ml of K, 0.5ml of Ca was taken from their respective stock solutions into 50ml volumetric flask. After that they were diluted up to 50 ml of distilled water.

20 ppm standard solution

By musing $M_1V_1=M_2V_2$ formula 20ppm Standard solutions were prepared by 1ml (1000 micro liter) Na, 1ml of K, 1ml of Ca from their respective stock solutions into 50ml volumetric flask. After that they were diluted up to 50 ml of purified water. The above same method was used for the preparation of 500 ppm, 100 ppm and 300 ppm slandered solution and were placed in the laboratory for further analysis.

Sampling

The Blood samples was collected from Khalifa Gul Nawaz Hospital, DHQ Hospital and local areas of district Bannu .The blood sample were taken from 35^{th} Heart attack, 35^{th} hypertensive patients (male and female) and 20^{th} from control (normal, healthy) individuals. Blood was taken by not reusable syringe and then injected into EDTA tube, avoid blood from denaturing. After that it was placed in refrigerator and then centrifuges for 15-20min at 150rpm. Plasma (serum) was separated completely from red blood cells. The plasma (blood serum) was separated into another micro tube. This blood serum samples were diluted up to 10ml of distilled water. Standard solutions were used as a control to show the concentration of electrolytes in blood serum [16]. Commonly flamephotometer is used for the determination and analysis of metals ions and salts like Ni, Ba, Na, K, and Ca etc. It may be used for the measurement of intensity of metals. It is also called Atomic emission spectrometry.

Flamphotometric assay for electrolytes

Flamphothometer is used to determine and analyzed the concentration of electrolytes in samples. During experiment a gas is sprayed over the blood sample which controlled and gradually carries the sample to excited state. The light energy (hv) having properties of wavelength is used to again convert the exited state of sample into normal condition. The strength of light is related to the concentration of electrolytes (Na, K, Ca,). The apparatus was connected at zero. 10ppm,

20ppm, 50ppm, 100ppm and 300ppm standard solutions of Na, K, and Ca. The concentrations of samples were appeared on screen and to be noted directly. The results may be taken in print form (Musso, 2009). Some scientists reviews that mostly publics used up diet having high amount of salt, which is the main factor of hypertension.

Statistical analysis

Graph pad Prism 5. Version 5.01 was used for analysis. In this method unpaired t-test was used to analyze the significant differences between hypertensive and heart attack patients compared with normal healthy individuals.

Results

Sodium (Na) concentrations in hypertensive (BP) and heart attack (HA) patients

In our results hypertensive and heart attack patients were compared to individuals having normal blood pressure. More significance difference was shown in sodium of hypertensive and less significant by heart attack patients. Fig. 1 shows concentration of Na in hypertensive patients and Fig. 2 shows concentration of Na in heart attack patients. Unpaired t-test was used for the determination of significance differences in the Na concentration among control, BP and heart attack patients.

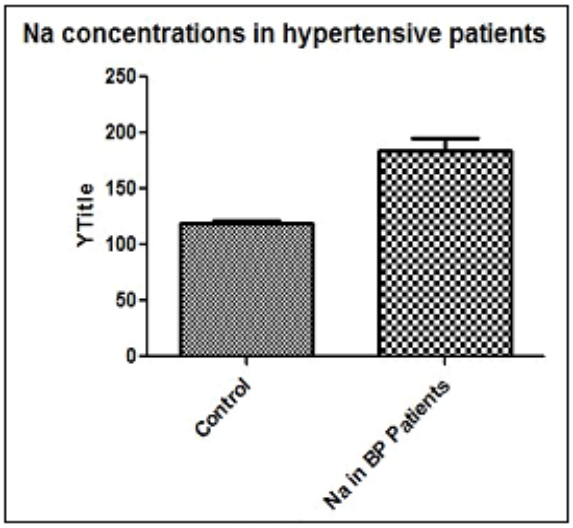

Fig. 1.

In the current studies it is analyzed that increase of sodium may cause risk of high blood pressure and cardiovascular diseases.

Potassium (K) concentrations in hypertensive and heart attack patients

In results the hypertensive and heart attack patients were compared to individuals having normal blood pressure. Fig. 3 shows K in hypertensive patients and Fig. 4 shows potassium concentration in heart attack patients. Significance difference was shown in concentration of potassium both in hypertensive and heart attack patients. Unpaired t-test shows significance difference in the potassium level between control and hypertensive patients.

From the present studies, it was suggested that abnormalities in potassium may cause risk of high blood pressure and heart attack.

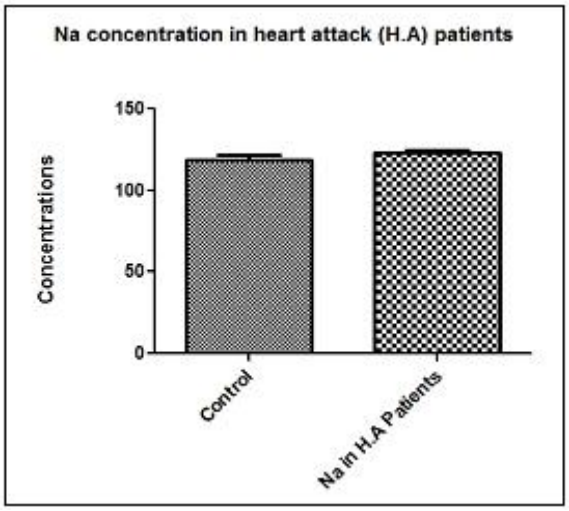

Fig. 2.

Calcium (Ca) concentrations in hypertensive and heart attack patients.

The concentration of calcium (Ca) in hypertensive and heart attack patients is shown in Fig. 5 and Fig. 6. Unpaired t-test was used to analyze the significant deference of calcium (Ca) in hypertensive and heart attack patients compared with control healthy individuals.

Significant differences were shown in both hypertensive (BP) and heart attack (HA) patients as compared to normal healthy persons. From the current studies it was suggested that increase of calcium may cause cardiovascular disease which leads high blood pressure. However, they are not conclusive and there is no any agreement in this respect.

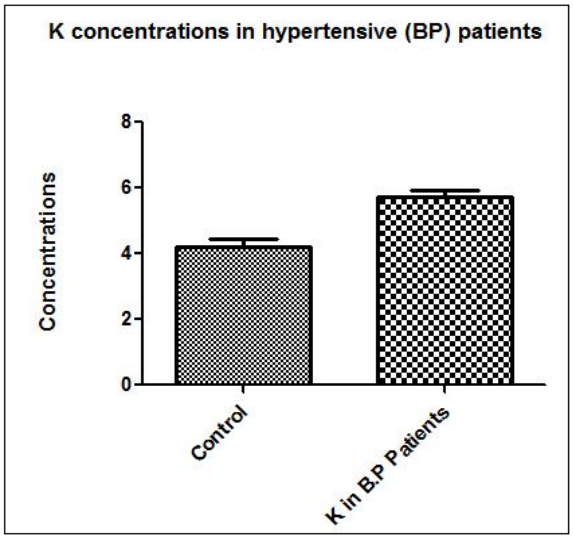

Fig. 3.

Discussion

In the present study, we have examined the concentration of Na, K and Ca in hypertensive (BP) and heart attack (HA) patients. We have found that Na, K and Ca shows significant difference among hypertensive and less significant in heart attack patients as compared to normal individuals. Different animal studies and Mendilian form of syndrome shows evidence for hypernatremia and hyponatremia. For example Liddle syndrome and Burtters syndrome causes hypertension pathophysiology. Data analyses shows that the increase of sodium concentration in kidneys epithelial cell causes hypertension called high BP (Lifton *et al.*, 2001).

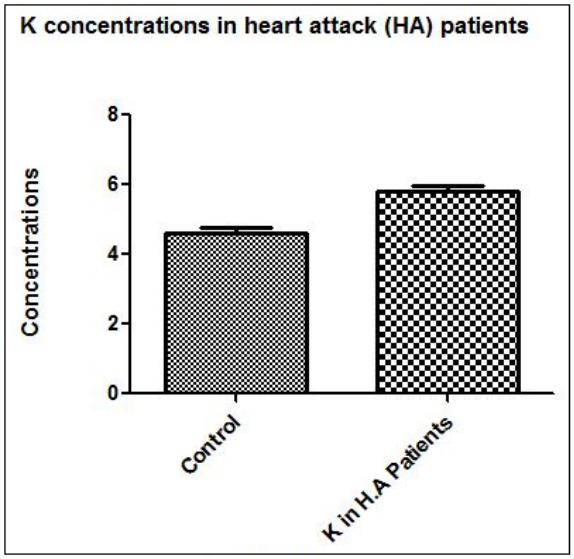

Fig. 4.

In our study Na shows significant changes in hypertensive and less significant in heart attack patients. It suggesting that the patients have been suffered from BP and HA due to some other causes like physical activities, overweight, stress oldness and too much Na. Abrupt modification in Ca is one of the risk of heart diseases, which may cause heart attack and intern cause hypertension (Riaz *et al.*, 2007).

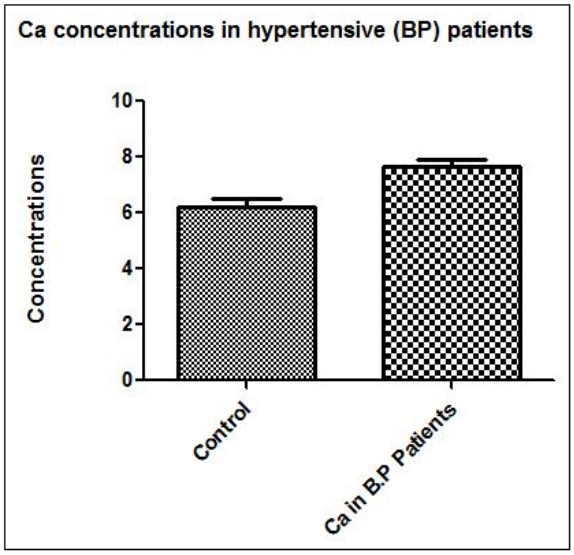

Fig. 5.

Calcium in fewer amounts may cause heart disease. In our study blood calcium showed significant difference as a compered to controlled healthy individuals. Thus, significant changes occur in the calcium levels in BP, HA and control individuals. The lack of change in Ca level in our study suggest again other cause for BP and HA induction. It has been reported that K is the main mineral electrolyte which performs our muscular contraction, function of nerves, and normal renal function to filter blood. The normal K concentration maintains normal heart beating. It is studied that high K level has effects on BP, heart diseases and kidney diseases. In kidney diseases the kidneys are unable to remove potassium, as a result K level is increased that causes hypertension and heart diseases. (Kotchen *et al.*, 1998). These reports support our findings of higher potassium levels in heart attack (HA) patients and may be responsible in case of BP patients, speculating that elevated levels of K may be the one cause for the induction of HA because of its role in muscular contraction. The lack of difference in the case of BP patient suggests multiple causes for the induction of BP.

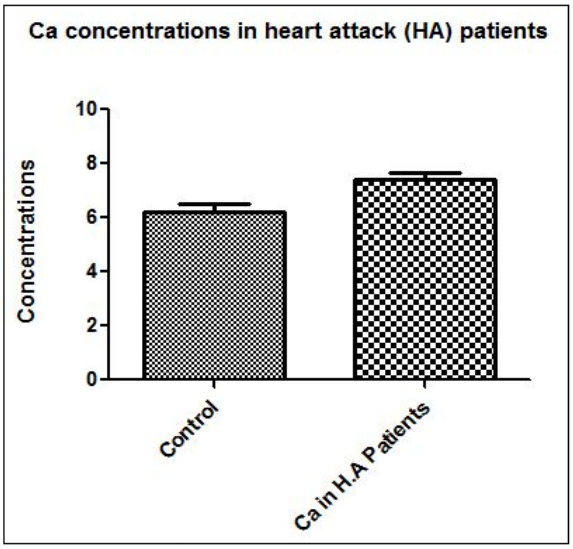

Fig. 6.

Conclusion

From the current study, it is concluded that the increase in sodium (Na) in hypertensive patients is suggesting one of the cause of blood pressure and showed significant difference as a compered to controlled healthy individuals. Potassium (K) also showed significant difference in hypertensive and heart attack patients. Calcium has not been shown any significant differences in hypertensive and heart attacks patients.

In summary, we can say Ca have no role in the induction of BP and cordial diseases but sodium (Na) and potassium K has an important role in BP and HA patients. It is very important to explore in future studies the exact mechanism and molecular signaling of K to cause BP and HA.

References

Azizi F, Ghanbarian A, Madjid M, Rahmani M. 2002. Distribution of blood pressure and prevalence of hypertension in Tehran adult population: Tehran Lipid and Glucose Study (TLGS), 1999–2000. Journal of human hypertension **16(5),** p 305.

Barrett-Connor E, Khaw K. 1985. Is hypertension more benign when associated with obesity? Circulation **72,** 53-60.

Bloch MJ, Fash F, Basile FJ. 2001. Cardiovascular risks of hypertension.

Capasso G, Unwin R. 2011. Electrolytes and acid–base: common fluid and electrolyte disorders. Medicine **39,** 317-324.

He F, Macgregor G. 2003. Cost of poor blood pressure control in the UK: 62 000 unnecessary deaths per year. Journal of human hypertension **17,** 455-457.

Hwang SJ, Ballantyne CM, Sharrett AR, Smith LC, Davis CE, Gotto AM, Boerwinkle E. 1997. Circulating adhesion molecules VCAM-1, ICAM-1, and E-selectin in carotid atherosclerosis and incident coronary heart disease cases the Atherosclerosis Risk In Communities (ARIC) study. Circulation **96,** 4219-4225.

Kesteloot H, Park B, Lee C, Brems-Heyns E, Joossens J. 1980. A comparative study of blood pressure and sodium intake in Belgium and in Korea. Epidemiology of arterial blood pressure. Springer.

Kotchen TA, Mccarron DA, Committee N. 1998. Dietary electrolytes and blood pressure a statement for healthcare professionals from the American Heart Association Nutrition Committee. Circulation **98,** 613-617.

Lee JW. 2010. Fluid and electrolyte disturbances in critically ill patients. Electrolytes & Blood Pressure **8,** 72-81.

Li JJ, Fang CH, Hui RT. 2005. Is hypertension an inflammatory disease? Medical hypotheses **64,** 236-240.

Lifton RP, Gharavi AG, Geller DS. 2001. Molecular mechanisms of human hypertension. Cell, **104,** 545-556.

Lobo DN, Lewington AJ, Allison SP. 2013. Basic concepts of fluid and electrolyte therapy. Bibliomed, Melsungen.

Meneely GR, Battarbee HD. 1976. High sodium-low potassium environment and hypertension. The American journal of cardiology **38,** 768-785.

Musso CG. 2009. Magnesium metabolism in health and disease. International urology and nephrology, **41,** 357-362.

Pravina P, Sayaji D, Avinash M. 2013. Calcium and its role in human body. International Journal of Research in Pharmaceutical and Biomedical Science **4(2),** p 659-668.

Rana S, Karumanchi SA, Lindheimer MD. 2014. Angiogenic factors in diagnosis, management, and research in preeclampsia. Hypertension **63,** 198-202.

Riaz K, Forker A, Ahmed A. 2007. Hypertensive heart disease. Retrieved online August, **22,** 2009.

Ridker PM, Morrow DA. 2003. C-reactive protein, inflammation, and coronary risk. Cardiology clinics, **21,** 315-325.

Rose BD. 1977. Clinical physiology of acid-base and electrolyte disorders, McGraw-Hill.

Simonetti G, Mohaupt M. 2007. Calcium and blood pressure. Therapeutische Umschau. Revue therapeutique **64(5),** p 249-252.

Skorecki K, Ausiello D. 2011. Disorders of sodium and water homeostasis. Goldman L, Schafer AL. Goldman's Cecil medicine. Philadelphia, PA: Saunders, Elsevier**,** 720-34.

Tobian L. 1960. Interrelationship of electrolytes, juxtaglomerular cells and hypertension. Physiological reviews **40,** 280-312.

Turban S, Thompson CB, Parekh RS, Appel LJ. 2013. Effects of sodium intake and diet on racial differences in urinary potassium excretion: results from the Dietary Approaches to Stop Hypertension (DASH)-Sodium trial. American Journal of Kidney Diseases **61,** 88-95.