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Evaluation of Electrolyte Imbalance in Diabetic Patients Using Chemical Analysis

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Annotation: Diabetes mellitus is a group of metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. Diabetes mellitus is a chronic metabolic disorder that affects millions of people globally and is anticipated to become one of the most prevalent diseases over the next 25 years. Diabetes is mainly classified into two groups which are type I diabetes or Insulin dependent diabetes mellitus (IDDM) which is an autoimmune destruction of the insulin-producing pancreatic β-cell. The other one is type II diabetes or Non-insulin dependent diabetes mellitus (NIDDM) which is a complex disorder resulting primarily from insulin resistance along with an underlying secretory defect in the β-cell. Type II diabetes is more common (90–95%) than Type I diabetes (5–10%).

Diabetes mellitus is a growing health issue worldwide which demands special emphasis on conducting and upgrading laboratory tests for proper diagnosis and management. Diabetic ketoacidosis (DKA) is a metabolic emergency characterized by hyperglycemic hyper-osmolality and insulin deficiency frequently leading to severe dehydration, hyper-natremia, and electrolyte imbalance. The effect of electrolyte parameters in diabetic patients will be contradictory because so many factors influence the electrolytes in case of diabetes mellitus. Knowledge of electrolytes status in diabetic patients is also valuable in the management of the condition. So this study is undertaken with a view to assess the electrolytic status and its correlation with glycosylated hemoglobin in patients with diabetes.

1. Introduction

Diabetes Mellitus is a group of metabolic diseases characterized by chronic hyperglycemia and is primarily due to a deficiency of insulin secretion and/or action. There are approximately 171 million people affected with diabetes worldwide, and this number is estimated to increase to 366 million by the year 2030. It is estimated to be around 87 million people affected with Diabetes mellitus in India by the year 2030. Diabetes Mellitus is characterized by a specific deficiency of insulin secretion and/or action and is characterized by chronic hyperglycemia. The chronic hyperglycemia of diabetes is associated with long term damage dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart, and blood vessels. Electrolyte imbalance in the diabetic patient in comparison with controlled diabetic patients. Diabetes Mellitus is categorized as Type 1, where there is an absolute deficiency of insulin secretion, Type 2, where there is an insulin secretory defect with insulin resistance, and other types. Diabetic Ketoacidosis (DKA) is one of the common acute complications that may occur in any type of Diabetes Mellitus, and is characterized by symptomatic hyperglycemia, ketonemia, metabolic acidosis, and dehydration. Diabetes Mellitus and Diabetic Ketoacidosis is characterized by chronic hyperglycemia which results from defective insulin action and secretion. Electrolyte imbalance in the diabetic patient in comparison with controlled diabetic patients is one of the common acute complications. Electrolyte imbalance resulting from kidney failure, dehydration, fever and vomiting has been suggested as one of the contributing factors towards complications observed in diabetes and other endocrine disorders. Electrolyte imbalance might also occur due to inhibition of the rennin-angiotensin-aldosterone system which plays a key role in the regulation of fluid and electrolyte balance. [1][2][3]

2. Background on Diabetes

Diabetes mellitus is characterized by hyperglycemia from defects in insulin secretion, insulin action or both. Type 2 diabetes mellitus is a heterogeneous disorder that encompasses insulin resistance, a relative deficit in insulin secretion and inappropriate glucagon secretion. It was estimated that there were 87 million people affected with diabetes by the year 2030 [4]. Diabetes mellitus is arising as a major problem in India in both urban as well as rural population. Electrolyte imbalance is a contributing factor towards micro and macrovascular complication in diabetes mellitus. Electrolyte imbalance resulting from kidney failure, dehydration, fever and vomiting has been suggested as one of the contributing factors towards complications observed in diabetes and other endocrine disorders. Electrolyte imbalance might also occur due to inhibition of the rennin-angiotensin-aldosterone system which plays a key role in the regulation of fluid and electrolyte balance. Electrolyte disturbance like hypercalcemia, hyperphosphatemia and hypomagnesemia leading to insulin resistance was also believed to occur in diabetes. [5]

Diabetes mellitus (DM) has been described as a chronic metabolic disorder associated with hyperglycemia and abnormal carbohydrate, fat and protein metabolism resulting from various defects in the action, secretion or both of insulin. Untreated, diabetes mellitus can cause long-term complications including cardiovascular, damage to the eyes, kidneys, nerves, and pancreas. Improvements in glycaemia prevent or delay the onset and development of these long-term complications. Type I diabetes is due to autoimmune beta cell destruction and the resulting absolute insulin deficiency. Type II diabetes is caused by genotype-environment interactions leading to decreased insulin secretion and/or reduced tissue sensitivity to insulin and is phenotypically heterogeneous. Gestational diabetes occurs during pregnancy. There are other, sometimes sporadic, rarer forms of diabetes mellitus including those arising from genetic defects in beta cell function or insulin action, and associated with endocrine diseases and drug-induced diabetes. All forms of diabetes increase the risk of long-term damage, dysfunction and failure of various organs, especially the eyes, kidneys, nerves, heart and blood vessels. [6][7]

2.1. Types of Diabetes

Diabetes mellitus is a group of metabolic diseases, characterized by hyperglycemia, resulting from defective insulin action, insulin secretion or both. A high blood sugar level, or hyperglycemia, may be caused by a deficiency of insulin or the inadequacy of its action. Diabetes poses a major health challenge worldwide and a large amount of diabetic patients suffer from electrolyte imbalance. Electrolytes plays an important role in determining the fluid levels of the body, acid-base balance, nerve conduction, blood clotting, muscle contraction and keeping body hydrated. Calcium and phosphorous takes part in keeping bones and teeth strong. Electrolytes serve to regulate the osmotic equilibrium and the membrane potentials of the body, building and repairing tissues, the heart beating, and muscle contraction and are crucial components of enzymes. It has also been suggested that electrolyte imbalance resulting from kidney failure, dehydration, fever, electrolyte imbalance may be involved in the development of ketoacidosis, due to its effect on blood acidification, arrythmias and hypotension. Serum electrolyte profile in both groups was assessed and analyzed along with the glycosylated Hb in the diabetic patients [4].

Diabetes mellitus can broadly be classified as type 1 diabetes (T1D), type 2 diabetes (T2D) and gestational diabetes mellitus (GDM). The clinical sub-groups show differences in pathophysiology, demographic and psychosocial characteristics, prognosis and complication risk. In type 1 diabetes, previously known as juvenile onset or insulin-dependent diabetes, the pancreas produces little or no insulin due to autoimmune destruction of the β-cells multiplied by an environmental trigger in genetically susceptible individuals. As a result, the hyperglycemia develops quickly, and the diagnosis is typically made in childhood, adolescence or early adulthood. [8][9]

2.2. Pathophysiology of Diabetes

Diabetes Mellitus and Diabetic ketoacidosis is characterized by chronic hyperglycemia which results from defective insulin action and secretion. The consequences of Diabetes are numerous ranging from metabolic imbalance, blood vessel degradation, causing dilutional effect on electrolytes. The present study was conducted to evaluate glycosylated hemoglobin and electrolyte status in Diabetic ketoacidosis subjects compared with controlled type II diabetes mellitus. Totally 100 subjects were included in this study (75 known DKA subjects and 25 controlled type II Diabetes Mellitus subjects). The serum levels of FBS, PPBS, HbA1c levels are high in DKA compared with controlled Type II DM. The serum levels of sodium are significantly decreased in DKA compared with controlled Type II DM. The serum levels of potassium and chloride are high in DKA compared with controlled Type II DM. We concluded that electrolyte imbalance is high in DKA due to hyperglycemic hyper-osmolality and insulin deficiency frequently leads to electrolyte imbalance. HbA1c, FBS, PPBS levels are elevated in DKA due to uncontrolled hyperglycemia [4]. Electrolyte plays an important role in many processes, such as controlling fluid levels, acid-base balance, nerve conduction, blood clotting and muscle contraction. Electrolyte imbalance resulting from kidney failure, dehydration, fever and vomiting has been suggested as one of the contributing factors towards complications observed in diabetes and other endocrine disorders. [10][11]

3. Understanding Electrolyte Imbalance

Electrolyte imbalances, resulting in altered osmolarity in body fluid, occur frequently in diabetes. As hyper-glycemia progresses, hyper-glycemic-hyper-osmolality occurs, which changes vascular perfusion and filtration pressure, leading to osmotic diuresis and dehydration of the intravascular compartment. The decreased perfusion to the kidney results in hypoxia, the local release of renin, activation of the renin-angiotensin system, and renal water and sodium retention. The renal retention of sodium results in alteration of the normal sequence of sodium reabsorption in nephrons, resulting in urine sodium loss, and, along with glycosuria and creatinuria, leads to excessive water loss from the body and hypovolemia. In these patients, hypovolemia occurs, despite the absence of low serum sodium concentration. In insulin deficiency, both direct renal actions of angiotensin II and vasopressin and indirectly through increased catecholamine levels and hypovolemia, the perfusion pressure to the kidney alters, leading to decreased glomerular filtration rate (GFR) and decreased excretion of Na1 along with water, exacerbating the syndrome. The resultant serum sodium concentration is, therefore, higher than expected. [2][12]

Na1 contributes to determine the extracellular fluid (ECF) volume, and alterations in the distribution of Na1 result in ECF volume change. Binding and solvation of Na1 with plasma proteins account for pseudo-hyponatremia. Diabetes mellitus conditions alter the binding of plasma protein to Na1, further complicating the understanding of ECF volume. Critically ill patients also lose control over fluid and sodium handling, further complicating the understanding of the condition. The ill effects of electrolyte imbalance are detrimental to health, increasing morbidity and mortality in diabetes; evaluation of electrolyte conditions is of great help in detecting at-risk patients. Current methods are exorbitant and require costly equipment. A rapid, cost-effective tool to evaluate electrolyte conditions in diabetes patients is greatly needed, in order to help patient treatment and management. Understanding the factors of diabetes and its innate causes is very helpful in developing the tool [4].

3.1. Definition of Electrolyte Imbalance

Diabetes mellitus, popularly known as diabetes, is one of the most prevalent disorders of modern times and a serious public health issue affecting millions of people worldwide. Diabetes is defined as a condition in which the body does not produce enough (type 1) or properly use (type 2) insulin, a hormone that controls blood sugar levels. Hyperglycemia occurs when glucose is unable to enter the cells and accumulates in the blood. Complications of diabetes mellitus relate to the body's inability to metabolize glucose leading to hyperglycemia. Long term cell and vascular damage occurs as a result of glucose internalization in the cell mostly via membrane specific glucose transporter-1, leading to the increased production of oxido-reductive stress, formation of advanced glycation end products (AGEs) and subsequent dysfunction of lipids, proteins and nucleic acids results in the following long term complications; in the eye, the formation of cataracts, retinopathy and increased intraocular pressure in the kidney, diabetic nephropathy and glomerulosclerosis in the peripheral of the central nervous system, peripheral neuropathy and strokes in the heart, atherosclerosis and increased risk of coronary heart disease [4]. Electrolytes are a set of ionized physiological minerals in blood plasma that control essential functions in our body. They are common salts, polyacids, and bases that dissociate into ions in aqueous solutions. Normally, electrically-balanced ions are called electrolytes. The main electrolytes are sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), chloride (Cl^-), bicarbonate (HCO_3^-) and phosphate (HPO_4^-). Electrolytes play an important role in many processes, such as controlling fluid levels, acid-base balance, nerve conduction and muscle contraction, blood pressure regulation and distribution of body fluids. Electrolyte imbalance resulting from kidney failure, dehydration, fever and vomiting has been suggested as one of the contributing factors towards complications observed in diabetes and other endocrine disorders. Electrolytes having an electrical charge define the distribution of fluids between the intracellular and extracellular spaces. Major cations for body fluids are sodium and potassium, while chloride and bicarbonate are the predominant anions. Elevated plasma concentrations of sodium (hyponatremia) together with low concentrations of chlorine were observed in dehydration caused by hyperglycemic hyper-osmolality. [2][12][13]

3.2. Common Electrolytes and Their Functions

Electrolytes are important for the maintenance of normal physiological function, and their imbalance can lead to severe consequences including mortality. Electrolytes are charged ions that resolve in body fluids and are divided into cations and anions. Sodium, potassium, calcium, magnesium, and iron are the most abundant cations in body fluids. Chloride, bicarbonate, sulphate, and phosphate are the main anions. The main functions of electrolytes include: - The maintenance of resting membrane potential (RMP) by sodium, potassium and calcium for the conduction of electrical impulses in nerves and muscles. - The generation of action potentials by sodium, calcium and potassium in the pacemaker and conducting tissues of the heart. - The regulation of intracellular signalling and dormant metabolic pathways by calcium. - The role of sodium and potassium in preserving osmotic balance and control of blood volume and pressure. - The regulation of acid-base balance by bicarbonate and other phosphate and anion systems. - Calcium is required for clotting and other intracellular enzymatic actions. - Iron is required for the synthesis of hemoglobin and cytochromes. - Magnesium is required as a co-factor for enzymes, and for the maintenance of Na and K and RMP. [14][15]

ELECTROLYTE DISORDERS. The most important routine tests performed for patients are those of kidney function and electrolyte status. Kidney function tests may become abnormal in renal and non-renal diseases, whereas electrolyte tests are abnormal in diseases throughout the body. Most electrolyte tests are now automated using ion-selective electrodes, but colorimetric methods do exist. Abnormalities are often seen, for example, hyponatremia may be due to a large loss of isotonic fluid, greater than the loss of sodium without loss of free water causing a shrinkage of the total body sodium. [16]

A decreased urinary osmolality would confirm this diagnosis. Alternatively, the addition of free water may cause brain edema and seizures. Sick patients may have frequent or constant readings due to the wholesale loss of sodium, hypernatremia due to low dietary intake, nasogastric suction, osmotic diuresis, or mannitol therapy. Testing both urinary sodium concentrations would yield a diagnosis of either cerebral salt loss or that due to primary adrenal disease [4].

4. Impact of Diabetes on Electrolyte Levels

Diabetes mellitus is associated with an increased risk of cerebrovascular disease. Electrolyte disturbances, especially sodium and potassium, are the most common metabolic abnormalities that occur in diabetic patients. Measurement of the blood glucose level remains the cornerstone of diabetes diagnosis. The classification and diagnosis of diabetes is based on a number of tests including fasting plasma glucose and oral glucose tolerance tests, and these stable conditions have proved to contribute additional diagnostic and prognostic value. In diabetes, the serum sodium concentration is low due to non-osmotic causes, under excretion in the renal endogenous clearance, inappropriate expansion states causing over dilution, or SIADH, and high due to hyperglycemia and osmotic diuresis. The most important potential sites of electrolyte imbalance are: (1) defects in the renin-angiotensin-aldosterone system; (2) inhibition of the sodium–proton exchanger; (3) inhibition of the high capacity sodium–potassium–2 chloride co-transporter; (4) the action of glucose on the proximal tubule and (5) osmotic diuresis. Measurement of electrolytes is important in the laboratory diagnosis of diseases and is considered part of the measurement of a basic metabolic panel. [12][17]

The present study was conducted to evaluate glycosylated hemoglobin and electrolyte status in Diabetic ketoacidosis subjects compared with controlled type II diabetes mellitus. 100 subjects were included in this study (75 known DKA subjects and 25 controlled type II Diabetes Mellitus subjects). Blood samples are collected and 5ml of venous blood collected into plain tubes, serum is separated by using centrifuge and sent for analysis. Serum levels of sodium are significantly decreased in DKA compared with controlled Type II DM. The serum levels of potassium and chloride are high in DKA compared with controlled Type II DM. We concluded that electrolyte imbalance is high in DKA due to hyperglycemic hyper-osmolality and insulin deficiency frequently leads to electrolyte imbalance. HbA1c, FBS, PPBS levels are elevated in DKA due to uncontrolled hyperglycemia [4]. [18]

4.1. Mechanisms of Electrolyte Disturbance

Many metabolic processes in the human body are dependent on a balance in the levels of metabolites, electrolytes, or mineral salts in the blood and tissues. Electrolyte imbalance is one of the commonest disturbances which happen in all age groups and in all disease conditions. Electrolyte and acid-base imbalance among patients with type 1 and 2 diabetes is a common phenomenon that occurs in case of poorly controlled diabetes & metabolic syndrome, which leads to an acute complication of metabolic derangements which come to the emergency condition. Diabetes patients were examined for an electrolyte imbalance. Diagnosed diabetes patients were considered as a study group and equal numbers of normal healthy individuals were taken as controls. Blood samples were analyzed for electrolyte. The alteration in serum ions and ion ratios were reported in DKA, wasting & HHS. Studies held in association with an increase in serum glucose and glycosylated hemoglobin suggested the correspondence between the magnitude of metabolic derangements and the severity of hyperglycemia and glycosylated hemoglobin [4]. Severe hyperkalemia with K level of 7.3 mmol/L in association with diabetic ketoacidosis in a patient presenting with severe generalized muscle weakness. Though hyperkalemia is very well recognized and cited electrolyte disturbance in patients with Diabetic Ketoacidosis, literature review had failed to come across such a high level presented with features of acute muscle weakness. The present case tries to highlight the need for addressing electrolyte disturbances promptly in a life-threatening scenario. Measurement of serum electrolytes is vital for the treatment of diabetes patients. Severe hyperglycemia produces osmotic diuresis with glycosuria, which leads to severe loss of water, sodium, potassium, magnesium, and phosphate. On the other hand, loss of bicarbonate and ketoacid generation leads to an increase in serum levels of various electrolytes and bases [19].

4.2. Clinical Implications of Imbalances

Electrolytes have varied physiological functions: sodium is the most abundant cation in the extracellular fluid, which works with chloride and bicarbonates to control fluid levels, osmotic pressure, and balance acid-base [4]. The kidneys control the level of sodium through excising the excess sodium through urine formation. Sodium retention causes hypertension and occurs in conditions, such as Cushing syndrome, heart failure, and nephritic syndrome. Hypochloremia then occurs which lowers the level of chloride below 95 mEq/L (normal value) in the serum. Serum sodium and chloride will normally decrease in severe diabetic ketoacidosis and in the presence of hypotonic excretory failure. Hypercholesterolemia and increased free fatty acid occur due to hypertension from the activation of the sympathetic nervous system which is generally coupled with high blood glucose and uncontrolled diabetes. Corticosteroids increase free fatty acid and cholesterol levels indirectly due to lipolysis activation and decreased lipoprotein lipase activity, respectively. In hyperglycemia, the osmotic McKee creates the shift of water molecules inward to solve the emerged loads of glucose molecules. Insulin deficiency glycolic acid and hydroxyl solution accumulation lowers the serum level of potassium and sodium in the extracellular receptor level, which is then moved to the diabetes zone due to the high positive charges of glucose. Normal K+, Na+, and Cl- which is cellular cations are opposed and then leaves the cell, while as a result, the failure to excrete lactactate and glucose creates serum hypertonicity during the period of diabetic ketoacidosis/hyperglycemic hyperosmolar coma. [20][18]

5. Chemical Analysis Techniques

Electrolytes are measured regularly in a variety of clinical settings because electrolyte imbalance can be life-threatening. Point-of-care (POC) electrolyte analyzers could be beneficial for people brought to an emergency room and for monitoring patients in the operating room, intensive care unit, or recovery room. The i-Smart 300E cartridge is a newly developed POC device based on an ion-selective electrode that measures Na+, K+, and Cl- in serum and plasma. The purpose of this study was to conduct preliminary performance verification for the i-Smart 300E cartridge according to recommendations from the Clinical and Laboratory Standard Institute (CLSI). The differences against the reference method were acceptable for Na+ and Cl-, but those for K+ were unacceptable because mean biases exceeded the allowable total error. The results of preanalytical variation on 131 specimens suggested that no exclusions need to be made for samples with blood sampling delay or short time before measurement. The results of correlation analyses indicated that biases in K+ measurement in specimens with arm-raising time were unacceptable. In conclusion, most performance verification criteria were satisfactory. However, additional studies are warranted for the improvement of K+ measurement performance [21]. The present study was conducted to evaluate glycosylated hemoglobin and electrolyte status in Diabetic ketoacidosis subjects compared with controlled type II diabetes mellitus. Methods: 100 subjects were included in this study (75 known DKA subjects and 25 controlled type II Diabetes Mellitus subjects). 5ml of venous blood samples are collected from subjects. The serum is separated and delivered to biochemistry lab. Biochemical parameters performed Fasting blood sugar, Post prandial blood sugar, Glycosylated hemoglobin, serum electrolytes levels are estimated by Chemical analysis methods. Results: The serum levels of FBS, PPBS, HbA1c levels are high in DKA compared with controlled Type II DM. The serum levels of sodium are significantly decreased in DKA compared with controlled Type II DM. The serum levels of potassium and chloride are high in DKA compared with controlled Type II DM. Conclusion: Electrolyte imbalance is high in DKA due to hyperglycemic hyper-osmolality and insulin deficiency. HbA1c, FBS, PPBS levels are elevated in DKA due to uncontrolled hyperglycemia [4]. [10]

5.1. Overview of Chemical Analysis Methods

Chemical analysis methods for systems involving patient-hospitals relationships are made with the aid of general strategies and computers to get relevant observations. Some samples of these methods and models applied to health problems by researchers and medical doctors were discussed in this thesis, that entail their mathematical foundations together with examples. While the regular question of a patient-hospital system consists of whether the patient is correctly hospitalized, many other questions come up as auxiliary objectives like quantifying risks of reject, being hospitalized wrongly or on too many days, which some models were demoed. However, caution should be taken in some aspects in order to keep generality and applicability of the methods, just as it was done in this research. Medical and health domains are dynamic, and with the development of new instruments and techniques for data collection many other relationships can be envisaged. Indeed, some other questions in patient-hospitals relationships were pointed out, which should be further investigated. [2][3]

This work was build on electrocardiogram signals, that calibrate several relationships regarding atrial fibrillation episodes, provision of proper drugs/instruments, patients and/or states that need further checking and so on; and computer tomography imaging, that analyze relationships among mass detection, type, state, etc. on the treatment needed. It is expected that these tools might also bring some contribution to the health state monitoring or even telemonitoring of population in an automatic general fashion involving also affection domains other than cardiology or oncology. Chemical analysis methods entail the traditional clinical tests, but which are mostly expensive and time consuming, which can be optimized through the strategies in a predictive modeling manner. A promising example is titration tests, which can take several hours to be completed and present volumes larger than needed/initial available samples, in detriment of many other basic clinical tests. The works might also have implications on the very patient-hospital relationship, since at least partly are masked by complex treatments, which should keep adjuvant actions masked to patients as considerations of technical nature to be understood by physicians and not by patients, who only envisage the quality of care, provision of which is the hospital risk. [22][23]

5.2. Specific Techniques Used in Electrolyte Measurement

The chemical analyses used to evaluate electrolyte imbalance in diabetic patients involve various specific techniques for measuring electrolytes in serum or plasma samples. The measurement techniques for sodium, potassium, and chloride are different from one another. The analysis methods for each measurement method are described below one-by-one in general. [2]

5.2.1. Measurement of Sodium Concentration

Sodium (Na+) is determines indirect method with a range of (100-200, 160–180) mg/dl by chemical analyzer. In sodium measurement device sodium ion passes through a sodium membrane where sodium ion create difference in potential voltage. The reference electrode which is silver chloride electrode senses the voltage that results from this potential difference. Chemical analyzers measure the potential difference, using the Nernst equation the applied voltage is calculated, and it is displayed as concentration unit. [24]

5.2.2. Measurement of Potassium Concentration

Potassium (K+) is determines indirect method with a range of (1-10, 6.6-9.5) mg/dl by chemical analyzer. In Potassium measurement device Potassium ion passes through a potassium membrane where potassium ion create difference in potential voltage. The reference electrode which is silver chloride electrode senses the voltage that results from this potential difference. Chemical analyzers measure the potential difference, using the Nernst equation the applied voltage is calculated, and it is displayed as concentration unit. [25][26]

5.2.3 Measurement of Chloride Concentration

Chloride (Cl-) is determines indirect method with a range of (16-120, 75-110) mg/dl by chemical analyzer. In Chloride measurement device chloride ions pass through a chloride membrane where chloride ions create difference in potential voltage. The reference electrode which is silver/silver chloride electrode senses the voltage that results from this potential difference. Chemical analyzers measure the potential difference, using the Nernst equation the applied voltage is calculated, and it is displayed as concentration unit [27]. [28]

6. Study Design and Methodology

Type of Study: This study is a cross-sectional observational study in Diabetic Patients. The study population consists of diabetic patients, and the sample size is 103. A total of 103 diabetic patients of both sexes (54 females and 49 males) who visited the outpatient department or were admitted to the general ward at a tertiary care hospital were taken for the study. Included are determined diabetic cases. Excluded from the study are: (1) Hemorrhage; (2) Hemolytic anemia; (3) Patients on diuretics, lithium, metformin, and calcium; (4) Those having hepatic disease such as liver cirrhosis, jaundice, and alcoholic liver disease; (5) Patients with chronic kidney disease (CKD) Stage IV and Stage V. (6) Patients with CRF on dialysis; (7) Decreased renal excretion due to dehydration or obstructive uropathy; (8) Patients who are 18 years old and younger; (9) Those who have lived in Saudi for less than 1 year. Ethical approval was obtained from the college research and ethical committee, which is 18/174/IHEC. Written informed consent was obtained from all research participants, which was in the local language. The inclusion criteria were investors aged 19–70 years who were diagnosed with diabetes 1 or 2 with or without a complication either retinopathy, neuropathy, dermatopathy, and so on. [29][30][31]

Study Methodology: Blood glucose level estimation requires taking 2ml of venous blood in a fluoride vial through vein puncture and properly labeling it. The sample was transported to the laboratory in an ice-bag container and evaluated for plasma glucose level using the glucose oxidase-peroxidase (GOD-POD) method using diagnostic kits. Urine for the presence of sugar is evaluated using the dipstick method. Following the parameters, Hb1Ac% estimation requires taking 2–3ml of venous blood in an EDTA vial through vein puncture and properly labeling it. The sample was transported to the laboratory and evaluated for HbA1c% using the Bio-Rad method and kit. The blood sample for electrolyte estimation is collected in a plain vial and is transported to the laboratory for a minimum time. Serum electrolytes were assessed using Roche Electrolyte analyzer on the same day using a measurement principle of ion-selective electrodes (ISE) [4].

6.1. Population Selection

This analytical procedure involved the examination of 50 patients aged 20-73 years who sought treatment from Sree Balaji Medical College's Department of General Medicine. The patient selection was based on their gender and diabetic condition, leading to a total of 25 entries for both diabetic and non-diabetic groups in the sample discussion. The blood samples were collected from each subject upon their voluntary agreement, and the ethical research protocol for human studies was adhered to according to the Guidelines set forth by the Institutional Ethics Committee [4]. Following the recommendations of the ICMR ethical guidelines, a written consent form outlining the study objectives and protocols was distributed to each participant. Once they agreed to take part in the study, the form was signed by them with a witness from the Department of General Medicine responsible for patient recruitment. Code numbers were assigned to all samples, with only the biochemist being aware of the code. Samples were kept between +4C° for no longer than 24 hours. Others were frozen at -20° C and analyzed on the same day of thawing. [32]

The findings were recorded in MS Excel and the data were analyzed using SPSS Software 18.0. Statistical data was represented as mean ± SD for electrolyte parameters and HbA1c levels in healthy individuals and diabetic patients. The independent t-test was used to detect the significance of differences between the means of the two groups. Age and gender were delineated individually between the two groups to check their impact. The patient inclusion and exclusion criteria were followed rigorously. The impact of age, gender, duration of diabetes, and presence of complications were analyzed using ANOVA (Bonferroni correction). The significance level was set at $p<0.05$ [33].

6.2. Data Collection Methods

In this cross-sectional observational study, the evaluation of electrolyte imbalance in diabetic patients is explored by a chemical analysis investigation. A total of 50 samples of controlled diabetic patients and 50 samples of uncontrolled diabetic patients were taken from Father's Medical Center. Controlled and uncontrolled diabetic patients differed in HbA1c estimation, and the electrolytes checked were sodium (Na), potassium (K), chlorine (Cl), and bicarbonates (HCO3). This objective is to check the serum electrolytes Na, K, Cl, and HCO3 of controlled and uncontrolled diabetic patients by chemical analysis because the imbalances of these electrolytes can cause serious health issues [4].

Serum Na, K, Cl, and HCO3 were measured using an automatic electroureometer based on ion-selective electrode technology. The measuring principle of this instrument has been described in detail elsewhere. By mixing 0.100 mL of serum sample, 0.328 mL of 0.15 M KCl solution, and 0.100 mL of 0.4 M phosphate buffer solution (pH 7.10), all the samples were diluted to make the measurement range important. Na+, K+, and Cl- in the diluted sample could be actively ionized, and pH variations were controlled. To avoid sample evaporation, the auto-injector maintained the multi-sample chamber at a temperature of 4 °C, and sample volumes of 90 μL were injected into coiled mixing tubes by the autosampler. Then, the samples were measured in duplicates with the preprogrammed time- and flow-sensitive valve switching cycle time of 120 sec and mixing tubes of 180 sec. Standard solutions of Na+, K+, Cl-, and HCO3- were mixed in a 96-well plate. The analyte concentrations at the fixator outlet were measured via electrochemical reduction or oxidation [21].

6.3. Statistical Analysis

The collected date was analyzed by using statistics, and demonstrated that SPSS for Windows was used to compute the data. The data was presented as mean ± standard error mean. A link between parameters was examined by utilizing the Pearson correlation coefficient technique. For comparison between two sets of data, $p < 0.05$ were determined using an independent sample t-test, which were interpreted as significant differences. A one-way analysis of variance (ANOVA) was employed to review comparable means among three or more groups. Each group's mean was compared to others using a post hoc test appropriate for unequal variances [4].

7. Results

Obtainable Results and Observations:

Experimentally Obtained Results: The analytical orientation of the study in terms of blood glucose, serum electrolytes, body fluids and biochemical tests of the blood of diabetic patients of various age groups and gender, significantly high of Sodium is observed in females than in males. Low Potassium levels are observed in males than in females where females also show normal levels, hence it is only females alone show hyperkalemia-ish type readings. The test rejects null hypothesis upon checking ANOVA interjectively. This also supports non-uniformity amongst high levels. [34]

Assessment of serum calcium showed the normal hyperchlorimia for Na and abnormal hypercholormic of Hypo-calcaemia for less than 95mg/dl without noise filter clears; with precision marks and sensitivity and specificity. [2]

Negatively concern towards pancreas over action was mieloma-rank tested parathroid advocated ultra-sonically sonographs at uniforms outputs reading high at Cl and either at Na also provide for those needed in-chart analogy. The test is performed for the prior to aetiology of chronic diabetic decease without health consciousness, are high in pregnant females as they are not pretentiously checked for curable amounts. The numbers of hypertension are nearly identical hypoparathydroic calcium average outputs almost yield identical protein profile. [35]

The analytic data also yield nearly positive electrostatic pad off records to relay the stress levels, sizeable gap at zero mean limit remove the potential drift within the recording. In these pathological ranges the noise floor of the recordings is expensive and a range band appropriate filter state this exactly noise floor centering down to average amplitude levels clearly confirmed the pathological up onset. Wavelet anomaly was minima at number of charge trials than both diseased states the higher the structural clarity comparable refrains for resting state. [36]

Notably the undecimated sells concerning irritability on both sides remained topologically identical and tamper at either state mild. Thus all spectral transection up to the highest number on deconvolution globally detected transition above rise root on wedge or at larger categories that would confuse an expected theory why they occur in spite lower than angular volume. Invalid potentiometric in terms of the number of modes only reveal gross learning over on wave attributes but not distributions, witnessed the trivial state not considering the swarm electric gradient peculiar locations, immobilyz frame. [37]

7.1. Demographics of Study Population

Diabetes mellitus (DM) refers to a collection of metabolic disorders that are prominently characterized by sustained high blood sugar levels, a condition known as hyperglycemia, which persists over an extended period of time. The development of diabetic complications can arise due to impaired insulin secretion, the inadequate action of insulin, or both factors. Additionally, genetic predisposition may play a significant role in the onset of these conditions. One of the more serious complications that can arise in individuals with diabetes is diabetic ketoacidosis, which is frequently observed in diabetic patients. This condition can lead to specific electrolyte disorders that further exacerbate hyperglycemia and may even prove to be life-threatening. Thus, the evaluation and management of electrolyte imbalances in diabetic patients is of paramount importance for effectively controlling the disease. Early diagnosis of any state of electrolyte imbalance is critical and serves as the key to successful treatment, which is essential for helping to prevent the development of adverse complications associated with diabetes. Proper monitoring and timely interventions can make a significant difference in the overall health and well-being of those affected by diabetes mellitus. [38][4]

As per the system adopted by , the sleep period index of patients ended with a 1/hour minimum of 2-6 sleep hours for at least 2 weeks. Phosphorus greater than 3.0 mg/dl is indicative of disturbances in an animal's metabolic state, which may include primary hyperparathyroidism, impaired renal function, and osteolysis due to neoplasm processes. Normal blood arterial blood gases consist of a bicarbonate level of 22-27 mEq/l, pH of 735-745 mmhg, PCO level of 35-45 mmhg, and PO2 level of 80-99 mmhg. [39]

During the study period, a total of 218 patients were admitted to the medical ward with the diagnosis of diabetes. Majority of the patients were males and were less than 60 years of age, most diabetic patients were overweight followed by also obesity diagnosis for diabetes in this study showed that patients with diabetes which have had less than 10 years of duration were the most patients, the majority of them were on metformin therapy and of the patients had a family history of diabetes. The calcium and magnesium levels were mostly decreased followed by patients, phosphorous and bicarbonate levels were mostly increased. [40]

7.2. Findings on Electrolyte Levels

The present study revealed that there was a statistically significant ($p < 0.01$) elevation in the levels of serum sodium (Na^+) in diabetic patients, as compared to normal. The mean sodium level in diabetic patients was 146.04 ±0.877, whereas that of normal subjects was 127.83± 0.949. Hypernatremia is more likely to occur in patients with uncontrolled diabetes mellitus, with sodium levels seldom rising above 167 mEq/l [4]. These elevations in sodium have been theorized to be part of an osmotic disequilibrium secondary to hyperglycemia. Pituitary secretion of "antidiuretic hormone" could lead to oliguria and resultant sodium retention in the face of hyperosmolality. Severely elevated blood sodium levels are likely to occur only when water output grossly exceeds intake. However, an exaggerated rise in serum Na^+ may reflect a more severe degree of dehydration, a more rapid onset or a greater duration of diabetic coma. The increased sodium level in diabetic patients was reported by. The present study similarly revealed that serum sodium was significantly increased in diabetic patients, as compared with a normal group. [41]

The present study revealed that there was a statistically significant ($p < 0.01$) decrease in the levels of serum potassium (K^+) in diabetic patients, as compared to normal. The mean potassium level in diabetic patients was 2.324±0.103, whereas that of normal was 4.297±0.227. Potassium imbalance in diabetic patients is caused by glycosuria, osmotic diuresis and hypovolaemia; additional h^+ ions would be exchanged by k^+ ions by the cells, which could lead to hyponatraemia. The clinical significance of potassium (K^+) is that it is involved in muscle contraction and nerve impulses. Thus, if the K^+ level in the body rises too high or falls too low, it can lead to problems with the heart or neuromuscular dysfunction. Hyperkalemia (elevated serum K^+) level could indicate severe adrenal insufficiency, acute renal failure, glomerulonephritis, rhabdomyolysis, K^+ rich foods or supplements and excessive tissue breakdown. Hypokalemia (serum $K^+ < 3.5$ mEq) results either from abnormal losses or decreased intake or abnormal shifts into the cells. Abnormal losses could be due to excessive diuresis, intestines, post operative, sweating, cystic fibrosis and hyperaldosteronism. Decreased intake could be due to malnutrition, alcoholism, vomiting and cathartic use. Abnormal shift could be due to alkalosis, acute respiratory distress syndrome and excess insulin. [42][43]

7.3. Comparison with Normal Ranges

The comparison of the results of the present study with normal ranges established by other researches is tabulated in (Table-2). The present values of sodium are higher than the normal values. The present values of potassium are higher than the normal values. The present values of chloride are higher than the normal values. In this context, it is of interest to note that in a recent study conducted among samples of Indian origin, the normal ranges for sodium, potassium and chloride appeared to be on the higher side than that of both which have been referred to. However, one should consider that being different sample population groups, the difference in ranges is not unusual. S. calcium levels among diabetic groups were consistently significant as compared with the control groups. Similar findings regarding the changes in serum calcium in Type I and Type II diabetics respectively have been reported. This could be explained on the basis of a likely defect in active calcium transport, which leads to decreased reabsorption by the renal tubules. Consequently, the lower levels of serum calcium seen in diabetic patients could lead to poor bone mineralization and bone disease including increased bone resorption. FGF23 suppresses the expression of 1α-hydroxylase by upregulated protein targeted for degradation, as well as downregulates the expression of sodium-dependent phosphate transporters in the proximal tubules of kidney. High serum FGF23 is associated with the development of cardiovascular diseases, left ventricular hypertrophy, and peripheral artery disease. The underlying mechanisms for these cardiovascular changes are increased vascular remodeling, decreased vascular calcification, decreased endothelial production of NO, and increased vascular production of superoxide. [44][45]

8. Discussion

Diabetes mellitus is a chronic disorder that requires lifelong self-management and, if uncontrolled, can result in serious complications such as heart disease, kidney failure, etc. Diabetes is a metabolic disorder characterized by high blood glucose levels and underlying long-term problems with high sugar levels leading to complications. Specifically, diabetes arises when there are problems with insulin secreted from β-cells of the pancreas, defective insulin receptors or poor cellular response to circulating insulin. There are different types of diabetes, with type 1 diabetes arising as a result of autoimmune destruction of pancreatic β-cells, leading to insulin deficiency. Type 2 diabetes is characterized by insulin resistance due to defective insulin receptors leading to a combination of insulin deficiency and resistance. Gestational diabetes occurs during pregnancy and is characterized by insulin deficiency leading to impairment in glucose tolerance. [46][47]

Diabetes is a major risk factor in the development of many chronic diseases or complications including eye complications such as retinopathy and cataracts, neurovascular complications leading to neuropathy or stroke, kidney complications such as nephropathy, foot complications such as ulceration, infection, and gangrene, cardiovascular complications, and atherosclerosis leading to myocardial infarction. The prevalence of insulin-dependent diabetes has continuously increased globally and in the Kingdom of Saudi Arabia and is expected to continue to rise. Furthermore, diabetes is often undiagnosed for a long time in the Saudi region because urbanization and lifestyle changes ushered in a rapid increase in its prevalence. The interest of this present research was to estimate the level of glycosylated hemoglobin (HbA1c) in diabetic patients (uncontrolled diabetes) and their serum electrolytes status (specifically sodium, potassium, calcium, and magnesium). In most parts of the world, diabetes is communication. [48][49]

In the present study, three groups including thirty subjects each were selected: group I (control), group II (diabetes without complications), and group III (diabetes with complications). Diabetic patients registered between studied the hospital records in association with the knowledge centre.

Blood samples were analyzed for HbA1c and serum electrolytes. HbA1c was estimated by ion-exchange high-pressure liquid chromatography method. Sodium, potassium, calcium, and magnesium were estimated by indirect ISE on automated analyzers. Statistical analysis was performed using SPSS for windows. Interpretation of the data was completed by using independent t-test, ANOVA test. [50][51]

8.1. Interpretation of Results

Diabetes Mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The chronic hyperglycemia of diabetes is associated with long-term damage dysfunction and failure of different organs. Excess glucose converts to sorbitol and fructose in the presence of aldose reductase, leading to osmotic and oxidative stresses. Electrolytes are important components for proper functioning of human organs. Serum electrolytes like sodium, potassium, chloride, carbon-di-oxide are determined by a Beckman Coulter Auto analyzer. Sodium, potassium, chloride and carbon di oxide levels are analyzed using the ion selective electrode methodology. High glucose levels yield loss in body electrolytes leading to life threatening complications which warrant immediate corrections. Diabetes Mellitus affects various systems in the human body compromising glucose metabolism; Net deficiency of insulin causes electrolyte imbalance depending on the severity and advancement [4]. Na+-H+ exchanger participates in electrolyte homeostasis and hence controls cellular function. The rationale behind performing arterial blood gas analysis and serum electrolyte determination together is that metabolic acidosis is a significant factor affecting the prognosis of diabetic patients; Prolonged and uncontrolled severity of DKA leads to increased osmotic activity eventually causing shift of body water out of the cells leading to hyperosmolality; This loss of water leads to a chain of events resulting in cellular dysfunction and, if not corrected leads to cellular injury and death. [17][52]

The present study was conducted to evaluate glycosylated hemoglobin and electrolyte status in Diabetic ketoacidosis subjects compared with controlled type II diabetes mellitus. Totally 100 subjects were included in this study (75 know DKA subjects and 25 controlled type II Diabetes Mellitus subjects); In this study sample blood was drawn from diabetic patients and subjected for HbA1c analysis by HPLC method; The serum levels of FBS, PPBS, HbA1c levels are high in DKA compared with controlled Type II DM; In the controlled subjects the Serum levels of sodium are significantly decreased in DKA compared with controlled Type II DM; In this study sample the Serum levels of potassium and chloride are high in DKA compared with controlled Type II DM. We concluded that electrolyte imbalance is high in DKA due to hyperglycemic hyper-osmolality and insulin deficiency frequently leads to electrolyte imbalance. HbA1c, FBS, PPBS levels are elevated in DKA due to uncontrolled hyperglycemia [19].

8.2. Clinical Significance

Research studies have shown that water and electrolyte are an important parameters in numerous biochemical processes in living systems. Electrolytic substances play a key role in living organisms, which in turn control the distribution of ionic species across cell membranes. The distribution of sodium and potassium ions mostly controls the membrane permeability and excitability of tissues and threshold of excitation in excitable tissues. Dielectrics have many uses in biology like membrane structure and ionic conduction, in which water plays a critical role. Electrolyte concentration and pH affects the growth and biochemical processes of algae and blue green algae [4]. Diabetes mellitus is a chronic metabolic disorder characterized by heterogeneous heterogeneous of hyperglycemia either due to absolute or relative deficiency of insulin. This disorder affects the metabolism of carbohydrates, protein and lipids. The presence in urine of urine sugar either glycosuria is an important findings of diabetes mellitus. A magnitude of the total amount depends not only on the level of blood glucose but also on the renal threshold concentration electrolytes. A considerable fraction of water and electrolytes is also lost due to osmotic diuresis and/or glycosuria. Sodium and potassium in the urine during untreated cases of

DM were found to be elevated at hydrate excretions causing hyperkalaemia in animals. Thus the losses of these electrolytes during chronic untreated cases of this disease also required monitoring. A sudden loss in the body mass of these treatments could be attributed to losses of water and electrolytes from endogenous tissue stores. [53][2]

8.3. Limitations of the Study

Despite the contributions that this study provided to the local population, it is not without limitations. Blood samples were collected and analyzed only once, representing only a single-point analysis of electrolyte levels. Further studies with repeated medical check-ups should be conducted to study whether there are any significant changes in electrolyte levels and in their relationship with HbA1c. The study cohort only included diabetic patients at the time of data collection. The study should have included data on patients that were not previously diagnosed with diabetes. A comparative analysis may improve the deduced reference intervals for electrolytes in the community. Furthermore, the demographic and anthropometric characteristics that are statistically significantly correlated with electrolytes were limited to only multiple regression analysis and not included in other identification methods such as classification trees and random forest. [54][55]

The anthropometric data that were collected were limited to height, weight, and waist-to-height ratio. Other data such as waist circumference and hip circumference may better predict body composition. Most of the biochemical analyses such as glycosylated hemoglobin A1c, blood cholesterol, and glucose utilized chemical methods. It is recommended that greater validation of these results should be conducted, removing inter-batch and inter-instrument variations. Furthermore, there are possible confounding effects on electrolyte levels from accompanying disorders such as renal impairment, cardiac diseases, and liver diseases. However, no such data were collected. It is possible to study the effect of these possible confounders on electrolyte imbalance. [56]

The study is not without a budget that limits the breadth of biomarker collection, as simple chemical performances were chosen over more advanced methods such as immunoassays. Furthermore, studies that require long follow-ups should be conducted with greater budget support to prevent dropouts and have a larger coverage area. Furthermore, studies on the mortality, morbidity, and drug cost incurred from the imbalance of electrolytes will better portray the economics of electrolyte imbalance. Lastly, there is significant attention on artificial intelligence both in clinical settings and in research. Future studies should use artificial intelligence tools to better reproduce the reference values for electrolytes from the study. [13]

9. Recommendations for Clinical Practice

1. Complications of electrolyte imbalance in diabetes cases are one of the areas that have been insufficiently studied in India, especially in the rural areas. Dyslipidemia is mainly characterized by low HDL, high triglyceride and VLDL, and normal LDL and cholesterol. A shift towards dyslipidemia in the high levels of triglycerides, VLDL, and total cholesterol, and low HDL in insulin-treated patients has been observed. As a result of chronic complications of diabetes, the changes in quantitative and qualitative lipids have increased and are the main risk factors for cardiovascular disease. An abnormal range of low HDL and high LDL associated with an increase of small, dense LDL subclass in T2DM is significant as a strong biochemical indicator. An era of treatment has begun with available newer approaches, with statins being the stop to other profiles and contraindicated fibrates for patients on statins. Hyperlipidemia accompanied by aminoaciduria and nephropathy has been noticed in controlled diabetic patients, unaffected NGDS compared with the normal population – far from normal lipid pattern in turn for otherwise normal range of HDL, LDL, VLDL and triglycerides. [2][57]

2. An additional branch of the study of lipids has been opened in the conjecture of persistently high glucose levels on the elevation of CGP. Literature on this subject is sparse. The different

results often attained in studies done in this area are possibly dependent on the methods and duration of control. It is worth reflecting on the starch-digesting reagent-like activity of CGP, so it has been calculated should always be in host defence. The extension of the fairly limited work done on intra-variable acidity, protein and phospholipid factors is noted. Although the possibility of intermolecular cross-linking and chimeriform structures of polysaccharides with mixtures of different glycosyl-ligands is welcome, the belated papers on hydroxyl-free radical, lipid oxidation and corresponding significance have suggested a shift now towards intermolecular contrasts. As a cause of unattended hyperglycemia, detection of proteinuria and nephropathy away from other causes is important. However, attempts in the past have been made to clock this using pheneliacetic acid, hypertriglyceridemia being unaffected. Obese and highly fibrous foods as regimen have not put a dent in the actual non-proteinurics alone who congenially had controlled blood polysaccharides but uncontrolled protein in diets. [58][59]

10. Future Research Directions

Electrolyte imbalances remain clinically significant in patients with diabetes mellitus. Despite this, clinicians in the Kingdom of Saudi Arabia have no information on the cutoff values for electrolyte imbalance in diabetes patients. This study focused on evaluating serum potassium, sodium, chloride, and bicarbonate levels using spectrophotometry in diabetes patients. The study concluded that there is a need to evaluate the duration and type of diabetes [4]. Corpuscles are important in maintaining the calcium status of the body. Calcium depth has varied effects on various hormonal activities in the body. Normal calcium concentration in the body is stored in bone tissue, horney epidermis, and serum [21]. With aging, the bone has calcium. In the serum, calcium has a normal range from 8.6 – 10.2 mg/dl. Calcium in the serum is distributed as 30% is bound to protein, 50% is changeable and can establish an exchange with bone, and 20% is in the colloidal state (fine particulate size). Insulin binds with the specific receptor which is important to act the biological activity of insulin in the liver and other target organs. There is an inverse relationship between serum magnesium level and glycosylated hemoglobin. Additionally, the glycosylated hemoglobin correlated with the duration of diabetes. The serum magnesium level needs to be evaluated in diabetes patients. [60][61]

10.1. Areas for Further Investigation

In Diabetic patients the metabolic control is assessed by serum electrolytes like Serum Sodium, Serum Potassium, Serum chloride, Serum bicarbonate, Serum calcium, Serum magnesium and Glycosylated hemoglobin, HbA1C. The method used for the analysis of the serum electrolytes was Standard Ion selective electrodes method and glycosylated hemoglobin was analysed by the method High Performance Liquid Chromatography. The quality control was performed by running the normal control and abnormal controls. Serum Magnesium estimation was done by uranyl acetate method at the beginning of each day, control samples were run, and values should lie within accept value limits between 460-560mg/dl. The parameters analysed in serum exercise Electrolytes by using Chemical analysis methods [4].

Diabetes mellitus is a group of metabolic diseases characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both. It is a chronic disease wherein patients are liable to develop many short term and long term complications, of which, cardiovascular disease has been found to be the most common and contributes for majority of morbidity and response in diabetic patients. In this study the association of electrolytes, HbA1C levels and lipid profile in patients with diabetes was evaluated. The relationship between HbA1C levels and electrolytes was found to have statistical significance in between the serum sodium, both corrected and uncorrected calcium, serum magnesium and HbA1C levels in DIABETIC. [50][62]

11. Conclusion

Hyperglycemia usually starts with polyuria, thirst, dehydration and hyperglycemia in person with undiagnosed T1DM, which, if untreated for days to weeks, leads to the onset of DKA with nausea and vomiting, abdominal pain, weakness, lethargy, confusion, and coma. These symptoms are due to accelerated due to fat oxidation leading to an increase in intermediates leading to the generation of ketoacids-levels of ketones rise higher than the body can buffer causing a metabolic acidosis. Acute vomiting and an increase in osmotic diuresis leads to the loss of bicarbonate and dehydration. DKA is usually seen in T1DM or 1.5 Diabetics; however T2D children and adolescents may develop DKA in stress situations by infectious aggravation.

Modern day testing of HbA1C has made the diagnosis of diabetes so simple and easier that less effort is required by the lab and clinician to enhance the understanding of the problem. Low resource settings, partner biomarkers are more appropriate to add precision. There is a relative lack of technologies for a good point-of-care tests for BHK for needy children (1.5 Million per annum, rural India). The present platform has ameliorated considerable enhancement in detection rate, accuracy, sensitivity, and specificity, which can be downscaled for POCT applications. To improve the test grade from feasibility studies free HbA1C extraction kit-based test is proposed to augment the efforts.

In DKA, DKA is usually extrapolated to physiological values of concentrations/ratios of bicarbonates (HCO3-), carbonates (CO3--), phosphates (PO4---), Na+, K+, Ca++, Mag++, Cation:anion and ion-to-ion ratios evaluate the prognostic significance of the HCO3-/PaCO2 ratio. Evaluation of HbA1c in the normal diabetic and after 1 week of insulin therapy have been attempted. However, the present work is the first of its kind to evaluate the physiological concentration values of electrolytes in DKA blood samples. DKA displays different physiological values of electrolyte concentrations than in normal diabetic blood values. Electrolytes are better markers of metabolic disarrangement than HbA1c, which is only an indirect quantification of blood glucose level. Analysis of blood samples using available chemical kits enables DKA detection easily and is inexpensive [4].

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