Electrolyte disturbance in Sudanese patients with cancer

A thesis submitted in partial fulfillment of the requirement of M.Sc. degree in Medical Laboratory Sciences (Clinical chemistry Department)

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بسم الله الرحمن الرحيم

قال تعالى:

(ما يجعل الله عالما بعد حكمك إن شاء كذلك وأنت من الشاكرين)

صدق الله العظيم

سورة النساء (147)
Dedication

To that who taught to write the first letter of the alphabet, my beloved ................ mother

To the mydear ................. father

To my lovely ............... sisters

To my lovely ......brothers

To all my teachers in all my educational stages

To my ................. friends

To all who love me and I love them

To ................... patients

To all those, I dedicate this work.
Acknowledgment

First and foremost, praise to ALLAH, who gave me the strength to do this work. I am gratefully acknowledge and appreciation to my nice supervisor Dr. Abdalkarim A. Abdrabo for his advises and encouragement during this study which might have not been completed without his supervision.

A humble thank to Dr. Hameeda AbdElazeem who gave me a lot of assistance and facilities. I extend appreciation to Dr. Mariam Abbas ibrahim the head of department, and extend to all my family in clinical chemistry department.

My greatest thanks to my colleagues (Amir, Omer, Sami, salih, Rabab, Zoba, Nada, Abuobida, Mohamed, , Habeeb, Saad. Badraldeen).
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Table 4.5, pig17: shows a descriptive summary of the mean and SD of plasma sodium, potassium, calcium and phosphorous concentrations between cervix cancers and control group.
### List of abbreviation

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<td>ALL</td>
<td>Acute lymphoblastic leukemia</td>
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<td>CML</td>
<td>Chronic myeloid leukemia</td>
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<td>AML</td>
<td>Acute myeloid leukemia</td>
</tr>
<tr>
<td>HPV</td>
<td>Human papilloma virus</td>
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<tr>
<td>Na</td>
<td>Sodium</td>
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<tr>
<td>K</td>
<td>Potassium</td>
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<td>Ca</td>
<td>Calcium</td>
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<td>Ph</td>
<td>Phosphorous</td>
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<td>SD</td>
<td>Standard deviation</td>
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Abstract

This study was performed in Khartoum state during the period from January to April 2015. The aim of the study was to assess the effect of cancer on sodium, potassium, Calcium and phosphorous levels as a markers of electrolyte imbalance in Sudanese cancer patients. 90 blood samples were collected divided to 50 blood sample from Sudanese cancer patients, and 40 samples from apparently healthy individuals as control group for the comparison. Plasma levels of sodium and potassium were estimated by iron selective electrode while levels of calcium and phosphorous were estimated by spectrophotometer (Biosystem 310). Statistical analysis showed that there is a significant decrease in the sodium level in patients when compared with control group (mean±SD) (132.65±6.6) and (138.75± 2.4) respectively with P value = 0.000. and significant decrease in the potassium level in the breast cancer patients when compared with the control group (mean±SD) (3.3±1) and (4.±0.53) respectively with P value = 0.039. While showed no statistical significances in potassium, Calcium, phosphorous level in, myeloid, lymphoid and cervical cancer when compared with control groups were (3.58±.85), (4.2±.67), (3.8±.65), (4±.0.53) P values 0.290, 0.0626, 0.671 respectively. (8.46 ±1.2), (8.63 ±1.17), (8.25 ±.96), (8.45 ±.38) (8.83± .52), P value0.699,0.314,0.144 respectively. (3.25±1.1), (3.3±.78), (3.7±.31), (3.5±.33), (4. 34±0.48) P values 0.313, 0.961, 0.462 respectively.

In this study it was concluded that plasma sodium level decreased in some types of cancer and potassium level is decreased in breast cancer. While level of calcium and phosphorous were not affected in myeloid, lymphoid, cervical cancer patients.
الخلاصة

أجريت هذه الدراسة في ولاية الخرطوم خلال الفترة من يناير إلى أبريل عام 2015. الهدف من هذه الدراسة هو تقييم تأثير السرطان على مستويات الصوديوم، البوتاسيوم، الكالسيوم والفسفور في الدم، وعظام خلاصات الدراسة في مرضى السرطان السودانيين. تم جمع 90 عينة دم مقسمة كالآتي: 50 عينة من مرضى السرطان و 40 عينة كمجموعة قياسية للمقارنة. أعمارهم في كلا المجموعتين في منتصف العمر. تم قياس مستوي الصوديوم والبوتاسيوم بجهاز iron selective electrode (Biosystem310).

وجد هناك انخفاض كبير في مستوى الصوديوم في مرضى السرطان بالمقارنة مع المجموعة القياسية كانت (6.6 ± 2.4) و (132.65 ± 6.6) على التوالي، وأظهرت النتائج الإحصائية فرقا مهما للغاية بين المجموعتين. P = 0.000.

النتائج SOCIALbronze.jpg في مستوى البوتاسيوم في مجموعات سرطان الثدي بالمقارنة مع المجموعة القياسية (3.3 ± 1) و(3.8 ± 0.65) تحقق P = 0.039.

لم يظهر أي فرق مهم في مستوي البوتاسيوم أو الكالسيوم أو الفوسفور في أي المجموعات التالية:

السرطان اللمفاوي, الميلود وعرق الرحم عندما تم مقارنتهم مع المجموعات القياسية (8.5 ± 3.5) (0.85 ± 0.67) و (8.6 ± 1.2) و(8.25 ± 0.96) على التوالي.

في هذه الدراسة تم التوصل إلى أن مستوي الصوديوم انخفض في بعض أنواع السرطان وأن مستوي البوتاسيوم انخفض في سرطان الثدي. بينما لم تتأثر مستويات الكالسيوم والفسفور في سرطان الليمفاوي, الميلودي وسرطان عرق الرحم.
Chapter one
1. Introduction and Literature Review

1.1 Introduction

Cancers are a large family of diseases that involve abnormal cell growth with the potential to invade or spread to other parts of the body (cancer sheet WHO, 2014). They form a subset of neoplasms. A neoplasm or tumor is a group of cells that have undergone unregulated growth, and will often form a mass or lump, but may be distributed diffusely (Cancer Glossary, American Cancer Society, 2013).

The progression from normal cells to cells that can form a discernible mass to outright cancer involves multiple steps known as malignant progression (Hanahan et al., 2011).

In Sudan hospitals in 2000, cancer was the third leading cause of death after malaria and viral pneumonia, accounting for 5% of all deaths.

In the 18 years to 1984 nasopharyngeal carcinoma and NHL were the most common tumors in Sudanese males. In the last 20 years CML became the predominant cancer, while lymphomas remained the second most common cancer in men. In women, breast, cervical and ovarian cancer remained the three most common cancers over both time periods, but there was also an increase in the incidence of CML among a women (H. M. A. Hamad, 2006).

Electrolytes are chemicals in the body that regulate important physiological functions and include sodium, chloride, magnesium, potassium and calcium. When dissolved in water, electrolytes separate into positively and negatively
charged ions. Nerve and muscle function are dependent upon the proper exchange of these ions in and out of the cells.

Electrolytes must exist in the body within a narrow concentration range in order to effectively serve a variety of critical functions. The normal range is measured per liter of blood (Tietz et al, 2008).

1.2 Literature review

1.2.1 Cancer

Cancers are a large family of diseases that involve abnormal cell growth with the potential to invade or spread to other parts of the body (cancer sheet WHO, 2014). They form a subset of neoplasms. A neoplasm or tumor is a group of cells that have undergone unregulated growth, and will often form a mass or lump, but may be distributed diffusely (Cancer Glossary, American Cancer Society, 2013).

Six characteristics of cancer have been proposed:

- self-sufficiency in growth signaling
- insensitivity to anti-growth signals
- evasion of apoptosis
- enabling of a limitless replicative potential
- induction and sustainment of angiogenesis
- activation of metastasis and invasion of tissue

The progression from normal cells to cells that can form a discernible mass to outright cancer involves multiple steps known as malignant progression.
1.2.1.1 Common types of cancer

1.2.2.2 Acute lymphoblastic leukemia (ALL)

is an acute form of leukemia, or cancer of the white blood cells, characterized by the overproduction of cancerous, immature white blood cells—known as lymphoblasts. In persons with ALL, lymphoblasts are overproduced in the bone marrow and continuously multiply, causing damage and death by inhibiting the production of normal cells—such as red and white blood cells and platelets—in the bone marrow and by spreading (infiltrating) to other organs. ALL is most common in childhood with a peak incidence at 2–5 years of age, and another peak in old age (Weinblatt, et al 2013).

1.2.1.3 Breast cancer

is cancer that develops from breast tissue. Signs of breast cancer may include a lump in the breast, a change in breast shape, dimpling of the skin, fluid coming from the nipple, or a red scaly patch of skin. In those with distant spread of the disease, there may be bone pain, swollen lymph nodes, shortness of breath, or yellow skin (Saunders et al, 2009).

Risk factors for developing breast cancer include: female sex, obesity, lack of physical exercise, drinking alcohol, hormone replacement therapy during menopause, ionizing radiation, early age at first menstruation, having children late or not at all, and older age. About 5–10% of cases are due to genes inherited from a person's parents including BRCA1 and BRCA2 among
others. Breast cancer most commonly develops in cells from the lining of milk ducts and the lobules that supply the ducts with milk. Cancers developing from the ducts are known as ductal carcinomas, while those developing from lobules are known as lobular carcinomas. In addition, there are more than 18 other subtypes of breast cancer. Some cancers develop from pre-invasive lesionssuch as ductal carcinoma in situ (World Cancer Report WHO, 2014).

1.2.1.4 Chronic myeloid leukemia (CML)

is a cancer of the white blood cells. It is a form of leukemia characterized by the increased and unregulated growth of predominantly lymphoid cells in the bone marrow and the accumulation of these cells in the blood. CML is a clonal bone marrow stem cell disorder in which a proliferation of mature granulocytes (neutrophils, eosinophils and basophils) and their precursors is found. It is a type of myeloproliferative disease associated with a characteristic chromosomal translocation called the Philadelphia chromosome (Besa et al, 2013).

1.2.1.5 Acute myeloid leukemia (AML)

Acute myeloid leukemias a cancer of the myeloid line of blood cells, characterized by the rapid growth of abnormal white blood cells that accumulate in the bone marrow and interfere with the production of normal blood cells. AML is the most common acute leukemia affecting adults, and its incidence increases with age (Jemal A, et al, 2002).

1.2.1.6 Cervical cancer

Cervical cancer is a cancer arising from the cervix. It is due to the abnormal growth of cells that have the ability to invade or spread to other parts of the
Early on there are typically no symptoms. Later symptoms may include: abnormal vaginal bleeding, pelvic pain or pain during sexual intercourse, bleeding after sex may be not serious; however, may also be due to cervical cancer (Tarney et al. 2014).

Human papillomavirus (HPV) infection appears to be involved in the development of more than 90% of cases, most people who have had HPV infections, however, do not develop cervical cancer (Dunne et al., 2013).

Other risk factors include: smoking, a weak immune system, birth control pills, starting sex at a young age and having many sexual partners, but these are less important, cervical cancer typically develops from precancerous changes over 10 to 20 years, there are a few types of cervical cancer. About 90% are squamous cell carcinomas, 10% are adenocarcinoma and a small number are other types (National Cancer Institute, 2014).

1.2.2 Electrolyte

Electrolytes are minerals found in bodily fluids that carry an electric and muscles functioning properly. As such, it is important to maintain a precise and constant balance of electrolytes to stay healthy. The kidneys play an important role in ensuring that electrolyte levels remain invariant despite any changes the body may undergo. Having an excess or an insufficiency of electrolytes in the body can be dangerous and in some cases fatal (Tietz et al., 2008).

1.2.2.1 Electrolyte Function

One of the major roles of electrolytes is to keep that fluid levels inside and outside the cell are balanced. The cell can adjust its fluid levels by changing the concentration of electrolytes. For example, an increase in electrolytes within the
cell draws more fluid in whereas a decrease in electrolytes promotes an efflux of fluids. Sustaining this type of osmotic gradient is essential for nerve and muscle function, hydration, and maintaining blood pH levels. Additionally, electrolytes carry electrical impulses across the cell and to neighboring cells in order to promote muscle contractions and nerve impulses.

The most common electrolytes found in the body are calcium, sodium, potassium, phosphate, chloride and magnesium. The serum values and individual functions for these electrolytes are:

**1.2.2.2 Calcium**

Calcium is the most abundant electrolyte in the body. 99 percent of calcium is stored in the teeth and bones where it helps to make and keep them strong. Moreover, calcium is also critical for muscle contraction, nerve signaling, blood clotting and maintaining normal heart function. Normal serum calcium values range from 8.5 to 10.2 milligrams per deciliter (mg/dL) (Tietz et al., 2008).

**1.2.2.3 Sodium**

Sodium is the major cation extracellular fluid. Because it represents approximately 90% of ~154 mmol of inorganic cation per liter of plasma, Na is responsible for almost one half osmotic strength of plasma. It has central function in the maintaining the normal distribution of water and osmotic pressure in extracellular fluid compartments. Freely filtered by the glomeruli, seventy to eighty percent of the filtered sodium load is then actively reabsorbed in the proximal tubules, it regulates the total amount of water in the body and plays a major role in neuronal and nerve signaling. Normal serum sodium values range from 135 to 145 milliequivalent/liter (mEq/L) (Tietz et al.,
1.2.2.4 Potassium

Potassium is the major intracellular cation. In tissue cells, its high intracellular concentration is maintained by the Na,K-ATPase pump. This pump is a critical factor in maintaining and adjusting the ionic gradients on which nerve impulses and contractility of muscle depend. Average concentration is essential for the proper functioning of the heart, kidneys, muscles, nerves, and digestive system. The normal blood potassium level is 3.5 to 5.0 mEq/L (Tietz et al., 2008).

1.2.2.5 Phosphate

Phosphate is the majority of the body's phosphate is found in the bones and teeth where it promotes their formation. It also plays an important role in the body's utilization of carbohydrates and fats. Phosphates are also critical in the synthesis of proteins that promote the growth, maintenance, and repair of cells and tissues. Normal values range from 2.4 to 4.1 mg/dL (Tietz et al., 2008).

1.2.2.6 Chloride

Chloride is the major anion (negatively charged ions) found outside the cell. Chloride plays a critical role in keeping the proper balance of body fluids and maintaining the body's acid-base balance. The normal chloride values are 96 to 106 mEq/L (Tietz et al., 2008).

1.2.2.7 Magnesium

Magnesium is the fourth most abundant mineral in the body. Magnesium is
needed for more than 300 biochemical reactions in the body. It helps maintain normal muscle and nerve function, keeps the heart rhythm steady, supports a healthy immune system, and keeps bones strong. Magnesium also helps regulate blood sugar levels, promotes normal blood pressure, and is also involved in energy metabolism. Normal serum values of magnesium are 1.7 to 2.2 mg/Dl (Tietz et al., 2008).
2. Rationale and Objectives

2.1. Rationale.
Epidemiological studies have consistently shown association between the cancer and electrolyte imbalance. Cancer cells secrete some substances change cells functions and hormones that affect electrolytes. This study was conducted to verify the effect of cancer on electrolyte imbalance using sodium, potassium, calcium and phosphorous as a marker for electrolytes disturbance.

2.2 Objectives

2.2.1 General objective
To assess the effect of cancer on electrolyte among Sudanese cancer patients at Khartoum state during January to April 2015

2.2.2 Specific objectives
-To determine level of sodium, potassium, calcium and phosphorus in Sudanese cancer patients.
-To determine the association of specific type of cancer with electrolytes.
Chapter three
3. Material and Methods

3.1 Study approach

A quantitative methods were used to measure sodium, potassium, calcium and phosphorous in Sudanese cancer patients in Khartoum state, during a period from January to April 2015.

3.2 Study design

Case control study was designed.

3.3 Study population

The study covered 50 individuals randomly selected from whole cancer patients with different age and 40 apparently healthy people.

3.3.1 Inclusion criteria

The criteria of inclusion of the test group based on a cancer patients from different ages.

3.3.2 Exclusion criteria

The criteria of exclusion of the control group based on renal disease, hypertension and bone diseases.

3.4 Study variables
Dependent variable: plasma sodium, potassium, Calcium and Phosphorous level.

Independent variables: age, type of cancer.

3.5 Sampling
Convenience sampling technique was used.

3.6 Sampling frame
Khartoum state

3.7 Sampling unit
It was restricted to cancer patients.

3.8 Method of data collection and tools
Data were collected using structural interviewing questionnaire, which was designed to collect and maintain all information concerning each case examined.

3.8.1 Collection of samples
3 ml of venous blood sample was collected from both cases and controls, using sterile disposable syringe and aseptic standard non traumatic vein puncture technique were applied. Was emptied in a heprnized containers. And then centrifuged at 4000 rpm for 10 minutes, then the plasma is separated and transferred in a plain container and processed.

3.9 Method of measuring plasma sodium and potassium

3.9.1 principle of the method:
Iron selective electrode is a transducer (or sensor) that converts the activity of a specific ion dissolved in a solution into an electrical potential, which can be measured by a voltmeter or pH meter. The voltage is theoretically dependent on the logarithm of the ionic activity, according to the Nernst equation. The sensing part of the electrode is usually made as an ion-specific membrane, along with a reference electrode.

3.10 Method of measuring plasma calcium

3.10.1 Principle of the method:

The measurement of calcium in the sample is based on formation of color complex between calcium and o-cresolphthalein in alkaline medium:

\[ \text{OH} \]

\[ \text{Ca}^{++} + \text{o-Cresolphthalein} \rightarrow \text{Colored complex} \]

The intensity of the color formed is proportional to the calcium concentration in the sample.

3.11 Method of measuring plasma phosphorous

3.11.1 Principle of the method

Inorganic phosphorus react with ammonium molybdate in an acid medium to form a phospholybdate complex which absorbs light at 600-675 nm.

The absorbance at this wavelength is directly proportional to the amount of inorganic phosphorus.
present in the sample. Inorganic phosphorus + H2SO4+ Ammonium molybdate
Phosphomolybdate complex

3.12 Data analysis

Data were analyzed by statistical package for social studies (SPSS) software program

3.13 Ethical consideration

An approval was taken from faculty management and verbal consent from individuals under study.

3.14 Instruments

Spectrophotometer device used in this study with following information:
Model =BTS.302
Serial NO. =801560278

3.15 Pretesting

All reagents were tested using control sera.
Chapter four
4. Results

In this study 90 subjects were chosen for determination of plasma sodium, potassium, phosphorous and calcium. Fifteen of them were with breast cancer, fifteen were with myeloid leukemia, ten were with lymphoid leukemia, ten with cervix cancer and the other forty were apparently healthy subjects represent the control group, during the period from January to April 2015. The results obtained were statistically analyzed, using SPSS T.test. The level of significance was expressed as P value < 0.05 for significant.

The mean values of sodium in all cancer patients was significant low when compared to control (132.65±6.6)(138.75±2.4) mmol/L respectively with P=0.000. showed in Table 4.1.

The mean values of potassium in all cancer patients was insignificant when compared to control (3.68±0.84)(4.0±0.53) mmol/L respectively with P=0.153. showed in Table 4.1.

The mean values of calcium in cancer all patients was insignificant when compared to control (8.47±.97) (8.83±.52) mg/dl respectively with P=0.152. showed in Table 4.2.

The mean values of phosphorous in all cancer patients insignificant when compared to control (3.42±0.74)(3.71±.53) mg/dl respectively with P=0.174. showed in Table 4.1.
The mean values of sodium in breast cancer patients significant low when compared to control (132.55±6)(138.13± 2.4) respectively with P=0.001. showed in Table 4.2.

The mean values of potassium in breast cancer patients significant low when compared to control (3.3±1)(4.±0.53) respectively with P=0.039. showed in Table 4.2.

The mean values of calcium in breast cancer patients insignificant when compared to control (8.46 ±1.2)(8.83± .52) respectively with P=0.507. showed in Table 4.2.

The mean values of phosphorous in breast cancer patients insignificant when compared to control (3.25±1.1)(4.34±0.48) with P=0.366. showed in Table 4.2.

The mean values of sodium in myeloid leukemia patients significant low when compared to control (132±9.1)(138.13± 2.4) respectively with P=0.005. showed in Table 4.3.

The mean values of potassium in myeloid leukemia patients insignificant when compared to control (3.58±.85)(4.±0.53) with P=0.290. showed in Table 4.3.

The mean values of calcium in myeloid leukemia patients in significant low when compared to control (8.63 ±1.17) (8.83 ±.52) with P=0.699. showed in Table 4.3.

The mean values of phosphorous in myeloid leukemia cancer patients insignificant when compared to control (3.3±.78)(4.34±0.48 respectively with P=0.313. showed in Table 4.3.
The mean values of sodium in lymphoid leukemia patients significant low when compared to control (133±3.5)(138.13± 2.4) respectively with P=0.001.showed in Table 4.4.

The mean values of potassium in lymphoid leukemia patients insignificant when compared to control (4.2±.67)(4.±0.53) respectively with p=0.626.showed in Table 4.4

The mean values of calcium in lymphoid leukemia patients insignificant when compared to control (8.25 ±.96)(8.83± .52) respectively with P=0.314.showed in Table 4.4.

The mean values of phosphorous in lymphoid leukemia patients insignificant when compared to control (3.7±.31)(4.34±0.48) with P=0.961.showed in Table 4.4.

The mean values of sodium in cervix cancer patients significant low when compared to control (133±8.1)(138.13± 2.4)with P=0.01.showed in Table 4.5.

The mean values of potassium in cervix cancer patients insignificant when compared to control (3.8±.65) (4.±0.53) with P=0.671.showed in Table 4.5.

The mean values of calcium in cervix cancer patients insignificant when compared to control(8.45 ±.38)(8.83± .52) respectively with P=0.144.showed in Table 4.5.

The mean values of phosphorous in cervix cancer patients insignificant when compared to control (3.5±.33)(4.34±0.48) respectively with P=0.462.showed in Table 4.5.
Table 4.1a descriptive summary of the mean and SD of serum sodium, potassium, calcium and Phosphorous concentrations between cancers and control group.

<table>
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<tr>
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<th>Patients No: 50</th>
<th>Control No: 40</th>
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<td>Age</td>
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<td>35</td>
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</tr>
<tr>
<td>Sodium</td>
<td>(132.65±6.6)</td>
<td>(138.75±2.4)</td>
<td>0.000</td>
</tr>
<tr>
<td>Potassium</td>
<td>(3.68±084.)</td>
<td>(4.0±0.53)</td>
<td>0.153</td>
</tr>
<tr>
<td>calcium</td>
<td>(8.47±.97)</td>
<td>(8.83±.52)</td>
<td>0.152</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>(3.42±0.7)</td>
<td>(3.71±.53)</td>
<td>0.174</td>
</tr>
</tbody>
</table>

Independent sample t.test, significant<0.05.

Table 4.2 a descriptive summary of the mean and SD of serum sodium, potassium, calcium and Phosphorous concentrations between breast cancer and control group.

<table>
<thead>
<tr>
<th></th>
<th>Patients No: 15</th>
<th>Control No: 40</th>
<th>P.value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>34</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>(132.55±6)</td>
<td>(138.75±2.4)</td>
<td>0.001</td>
</tr>
<tr>
<td>Potassium</td>
<td>(3.3±1)</td>
<td>(4.0±0.53)</td>
<td>0.039</td>
</tr>
<tr>
<td>calcium</td>
<td>(8.46±1.2)</td>
<td>(8.83±.52)</td>
<td>0.507</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>(3.25±1.1)</td>
<td>(3.71±.53)</td>
<td>0.366</td>
</tr>
</tbody>
</table>

Independent sample t.test, significant<0.05.
**Table 4.3** a descriptive summary of the mean and SD of sodium, potassium, calcium and Phosphorous concentrations between myeloid cancers and control group.

<table>
<thead>
<tr>
<th></th>
<th>Patients No: 15</th>
<th>Control No: 40</th>
<th>P.value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>33</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>(132±9.1)</td>
<td>(138.75±2.4)</td>
<td>0.005</td>
</tr>
<tr>
<td>Potassium</td>
<td>(3.58±.85)</td>
<td>(4.0±0.53)</td>
<td>0.290</td>
</tr>
<tr>
<td>Calcium</td>
<td>(8.63±1.17)</td>
<td>(8.83±.52)</td>
<td>0.699</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>(3.3±.78)</td>
<td>(3.71±.53)</td>
<td>0.313</td>
</tr>
</tbody>
</table>

Independent sample t.test, significant<0.05.

**Table 4.4** a descriptive summary of the mean and SD of serum sodium, potassium, calcium and Phosphorous concentrations between lymphoid cancers and control group.

<table>
<thead>
<tr>
<th></th>
<th>Patients No: 10</th>
<th>Control No: 40</th>
<th>p. value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>30</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>(133±3.5)</td>
<td>(138.75±2.4)</td>
<td>0.001</td>
</tr>
<tr>
<td>Potassium</td>
<td>(4.2±.67)</td>
<td>(4.0±0.53)</td>
<td>0.626</td>
</tr>
<tr>
<td>Calcium</td>
<td>(8.25±.96)</td>
<td>(8.83±.52)</td>
<td>0.314</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>(3.7±.31)</td>
<td>(3.71±.53)</td>
<td>0.961</td>
</tr>
</tbody>
</table>
Independent sample t.test, significant < 0.05.

**Table 4.5** A descriptive summary of the mean and SD of serum sodium, potassium, calcium, and phosphorous concentrations between cervix cancers and control group.

<table>
<thead>
<tr>
<th></th>
<th>Patients No: 10</th>
<th>Control No: 40</th>
<th>P.value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>35</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Sodium</td>
<td>(133±8.1)</td>
<td>(138.75±2.4)</td>
<td>0.01</td>
</tr>
<tr>
<td>Potassium</td>
<td>(3.8±0.65)</td>
<td>(4.0±0.53)</td>
<td>0.671</td>
</tr>
<tr>
<td>Calcium</td>
<td>(8.45±0.38)</td>
<td>(8.83±0.52)</td>
<td>0.144</td>
</tr>
<tr>
<td>Phosphorous</td>
<td>(3.5±0.33)</td>
<td>(3.71±0.53)</td>
<td>0.462</td>
</tr>
</tbody>
</table>

Independent sample t.test, significant < 0.05.
Chapter five
5. Discussion

In the present study, a correlations existed among cancers patients (breast, myeloid, lymphoid and cervix cancers). The associations between cancers and Electrolyte were investigated using plasma sodium, potassium, calcium and phosphorous as marker for Electrolyte abnormality.

We found that there was a significant decrease in the sodium level in all types of cancers when compared with control (mean±SD) (132.65±6.6) (138.75±2.4) P.value **0.000** this finding confirmed by Doshi et al., 2012 in USA they found low level of sodium in all type of cancer (mean) from 130-134 mmol/l.

Also confirmed by abuZeinahGF, et al, they found a mild hyponatraemia is a common electrolyte disturbance among patients with cancer (mean) 130-135 mmol/l.

also confirmed by Hampshire et al, 2009 in UK they found hyponatremia in hematological malignancy mean 130 mmol/l.

Another study done by Jorge J. Castilo, Marc vincent, Eric Justice, confirmed Hyponatremia in Cancer Patients

We found a significant decrease in the potassium level in the breast cancer when compared with control group (mean±SD) (3.3±1) (4.0±0.53) P.value **0.039** respectively we disagree with anyone except some studies regarded side affect of drugs.
While showed no statistical significances in potassium, calcium and phosphorous levels in all types of cancer when compared with control group (3.68±0.84), (8.47±0.97), (3.42±0.7)  \textbf{P.value} 0.153, 0.152, 0.174 respectively, rather than potassium in breast cancer.

**Conclusion and Recommendations**

**Conclusion**

The findings of the study concluded that hyponatremia is most common disturbance in all cancer patients, and low level of potassium in breast cancer, while there is no significant of calcium and phosphorous in myeloid, lymphoid, cervical cancer.

**Recommendations**

- Further explorations of the effect of cancer on other parameters.

- More studies to determine the specific cause of hyponatremia and how to manage it. The comparison of the result with more data collected from patients such as stage of cancer, duration, dose and type of treatment and must be studied.

- Further studies should be done with larger sample and separate type of cancer to determine the exactly association of type of cancer and electrolyte should be carefully analyzed and interpreted.
References


APPENDIX
Questionnaire

Electrolyte disturbance in Sudanese patients with cancer

A thesis submitted in partial fulfillment of the requirement of M.Sc. degree in Medical Laboratory Sciences (Clinical chemistry Department)

Name.................................................................NO(  )

Age (  )

Sex: male (  ) Female (  )

Type of cancer (  )

History of any disease........................................................ ........................................................

................................................................................

................................................................................

History of any drugs

................................................................................

................................................................................

................................................................................
PHOSPHORUS

PHOSPHOMOLYBDATE/UV

PHOSPHORUS
COD 12508 3 x 24 mL + 2 x 15 mL
STORE AT 15-30°C
Reagents for measurement of phosphorus concentration
Only for in vitro use in the clinical laboratory

PRINCIPLE OF THE METHOD
Inorganic phosphorus in the sample reacts with molybdate in acid medium forming a phosphomolybdate complex that can be measured by spectrophotometry1,2.

CONTENTS AND COMPOSITION
A. Reagent: 3 x 24 mL. Sulfuric acid 0.36 mol/L, sodium chloride 154 mmol/L. DANGER: H314: Causes severe skin burns and eye damage. P280: Wear protective gloves/protective clothing/eye protection/face protection. P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.
B. Reagent: 2 x 15 mL. Sulfuric acid 0.36 mol/L, sodium chloride 154 mmol/L, ammonium molybdate 3.5 mmol/L. DANGER: H314: Causes severe skin burns and eye damage. P280: Wear protective
gloves/protective clothing/eye protection/face protection. P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.

For further warnings and precautions, see the product safety data sheet (SDS).

**STORAGE**

Store at 15-30°C.

Reagents are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.

Indications of deterioration:
- Reagents: Presence of particulate material, turbidity, absorbance of the blank over the limit indicated in "Assay parameters".

**AUXILIARY REAGENTS**

Biochemistry Calibrator (BioSystems cod. 18011) or Biochemistry Calibrator Human (BioSystems cod. 18044).

**REAGENT PREPARATION**

Reagents are ready to use.

Reagents open and kept in the refrigerated compartment of the analyzer are stable 2 months.

**SAMPLES**

Serum, heparinized plasma or urine collected by standard procedures.

Phosphorus in serum or plasma is stable for 7 days at 2-8°C.

Collect 24-hour urine in a bottle containing 10 mL of 10% (v/v) hydrochloric acid. Stable for 10
days at 2-8°C. Centrifuge or filter the sample and dilute 1/10 with distilled water before measurement.

**REFERENCE VALUES**

Serum3:

Adults: 2.5-4.5 mg/dL = 0.81-1.45 mmol/L

Children: 4.0-7.0 mg/dL = 1.29-2.26 mmol/L

Urine3: 0.4-1.3 g/24-h = 12.9-42 mmol/24-h

Concentrations in plasma are about 0.25 mg/dL (0.08 mmol/L) lower than in serum. These ranges are given for orientation only; each laboratory should establish its own reference ranges.

**CALIBRATION**

It is recommended to do a reagent blank every day and a calibration at least every 2 months, after reagent lot change or as required by quality control procedures.

**ASSAY PARAMETERS**

A25 A15

GENERAL Test name PHOSPHORUS PHOSPHORUS

Analysis mode bireagent differential

bireagent differential

Sample type SER/URI SER/URI

Units mg/dL mg/dL

Reaction type increasing increasing

Decimals 2 2
No. of replicates 1 1
Test name in patient report - -
PROCEDURE Reading monoch.monoch.
Volumes Sample 3 3
Reagent 1 210 210
Reagent 2 90 90
Washing 1.2 1.2
Predilution factor - -
Postdilution factor 2 2
Filters Main 340 340
Reference - -
Times Reading 1 60 s 72 s
Reading 2 300 s 312 s
Reagent 2 75 s 96 s
CALIBRATION Calibration type multiple multiple
Calibrator replicates 3 3
Blank replicates 3 3
Calibration curve - -
OPTIONS Blank absorbance limit 0.500 0.500
Kinetic blank limit - -
Linearity limit 20 20

QUALITY CONTROL
It is recommended to use the Biochemistry Control Serum level I (cod. 18005, 18009 and 18042), level II (cod. 18007, 18010 and 18043) and the Biochemistry Control Urine (cod. 18054) to verify the performance of the measurement procedure.
Each laboratory should establish its own internal Quality Control scheme and procedures for corrective action if controls do not recover within the acceptable tolerances.

**METROLOGICAL CHARACTERISTICS**

The following data were obtained using an A25 analyser. Results are similar with A15. Details on evaluation data are available on request.

- Detection limit: 0.13 mg/dL = 0.04 mmol/L.
- Linearity limit: 20 mg/dL = 6.46 mmol/L.

- **Repeatability (within run):**
  
  Mean concentration CV n
  
  3.80 mg/dL = 1.23 mmol/L 1.9 % 20
  9.18 mg/dL = 2.96 mmol/L 1.2 % 20

- **Reproducibility (run to run):**
  
  Mean concentration CV n
  
  3.80 mg/dL = 1.23 mmol/L 2.5 % 25
  9.18 mg/dL = 2.96 mmol/L 2.3 % 25

- **Trueness:** Results obtained with this procedure did not show systematic differences when compared with a reference procedure. Details of the comparison experiments are available on request.

- **Interferences:** hemoglobin (10 g/L), lipemia (triglycerides 10 g/L) and bilirubin (20 mg/dL) do not interfere. Other drugs and substances may interfere.

**DIAGNOSTIC CHARACTERISTICS**
Approximately 80% of the phosphorus in the human body is found in the calcium phosphate salts, which make up the inorganic substance of bone. The remainder is involved in the esterification of carbohydrate metabolism intermediaries and is also found as a component of phospholipids, phosphoproteins, nucleic acids and nucleotides. Hypophosphatemia can be caused by shift of phosphate from extracellular to intracellular spaces, increased renal loss (renal tubular defects, hyperparathyroidism) or gastrointestinal loss (diarrhea, vomiting), and decreased intestinal absorption. Hyperphosphatemia is usually secondary to inability of the kidneys to excrete phosphate due to renal failure or hypoparathyroidism. Clinical diagnosis should not be made on the findings of a single test result, but should integrate both clinical and laboratory data.

**BIBLIOGRAPHY**


CALCIUM-CRESOLPHTHALEIN
O-CRESOLPHTHALEIN COMPLEXONE

CALCIUMCRESOLPHTHALEIN

COD 11811
1 x 200 mL

COD 11812
1 x 500 mL

STORE AT 15-30ºC

Reagents for measurement of calcium concentration

Only for in vitro use in the clinical laboratory

PRINCIPLE OF THE METHOD

Calcium in the sample reacts with o-cresolphthaleincomplexone (o-CPC) forming a coloured complex that can be measured by spectrophotometry1.

CONTENTS

COD 11811 COD 11812
A. Reagent 1 x 160 mL 1 x 400 mL
B. Reagent 1 x 40 mL 2 x 50 mL
S. Standard 1 x 5 mL 1 x 5 mL

COMPOSITION

A. Reagent. Ethanolamine 900 mmol/L.

B. Reagent. o-CresolphthaleinComplexone 0.3 mmol/L, 8-hydroxyquinoline 28 mmol/L, hydrochloric acid 100 mmol/L.

DANGER: H314: Causes severe skin burns and eye damage. P280: Wear protective gloves/protective clothing/eye protection/face protection. P303+P361+P353: IF ON SKIN (or
hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower.

S. Calcium/Magnesium Standard. Calcium 10 mg/dL (2.5 mmol/L), magnesium 2 mg/dL.
Aqueous primary standard.
For further warnings and precautions, see the product safety data sheet (SDS).

**STORAGE**
Store at 15-30ºC.
Reagents and Standard are stable until the expiry date shown on the label when stored tightly closed and if contaminations are prevented during their use.
Indications of deterioration:
− Reagents: Presence of particulate material, turbidity, absorbance of the blank over 0.500 at 560 nm.
− Standard: Presence of particulate material, turbidity.

**REAGENT PREPARATION**
Standard is provided ready to use.
Working Reagent (Note 1):
• Cod. 11811: Pour the contents of the Reagent B into the Reagent A bottle. Mix gently. Other volumes can be prepared in the proportion: 4 mL Reagent A + 1 mL Reagent B. Stable for 2 days at 2-8ºC.
• Cod. 11812: Transfer 100 mL of Reagent B into a Reagent A bottle. Mix gently. Other volumes
can be prepared in the proportion: 4 mL Reagent A + 1 mL Reagent B. Stable for 2 days at 2-8°C.

**ADDITIONAL EQUIPMENT**

Analyzer, spectrophotometer or photometer able to read at 560 ± 20 nm.

**SAMPLES**

Serum, heparinized plasma or urine collected by standard procedures (Note 1). Calcium in serum or plasma is stable for 10 days at 2-8°C. Anticoagulants other than heparin should not be used.

Collect a 24-hour urine specimen in a bottle containing 10 mL of 50 % (v/v) nitric acid. Stable for 10 days at 2-8°C. Centrifuge or filter and dilute ½ with distilled water before testing.

**PROCEDURE**

1. Pipette into labelled test tubes: (Notes 1,2)
   
   Blank Standard Sample
   
   Calcium Standard (S) ¾ 13 ?L ¾
   
   Sample ¾ ¾ 13 ?L
   
   Working Reagent 1.0 mL 1.0 mL 1.0 mL
   
2. Mix thoroughly and let stand the tubes for 4 minutes at room temperature.
3. Read the absorbance (A) of the Standard and the Sample at 560 nm against the Blank. The colour is stable for at least 1 hour.

**CALCULATIONS**

The calcium concentration in the sample is calculated using the following general formula:
If the Calcium Standard provided has been used to calibrate (Note 3):
Serum and plasma Urine
x 10 = mg/dL calcium x 20 = mg/dL calcium
x 2.5 = mmol/L calcium x 5 = mmol/L calcium

**REFERENCE VALUES**
Serum and plasma2: 8.6-10.3 mg/dL = 2.15-2.58 mmol/L
Urine2: 100-300 mg/24-h = 2.5-7.5 mmol/24-h
These ranges are given for orientation only; each laboratory should establish its own reference ranges.

**QUALITY CONTROL**
It is recommended to use the Biochemistry Control Serum level I (cod. 18005, 18009 and 18042),
level II (cod. 18007, 18010 and 18043) and the Biochemistry Control Urine (cod. 18054) to verify the performance of the measurement procedure.
Each laboratory should establish its own internal Quality Control scheme and procedures for corrective action if controls do not recover within the acceptable tolerances.

**METROLOGICAL CHARACTERISTICS**
- Detection limit: 0.26 mg/dL calcium = 0.06 mmol/L calcium.
- Linearity limit: 20 mg/dL calcium = 5 mmol/L calcium. For higher values dilute sample 1/2 with distilled water and repeat measurement.
- Repeatability (within run):
Mean calcium concentration CV n
9.58 mg/dL = 2.40 mmol/L 1.7 % 20
13.6 mg/dL = 3.40 mmol/L 1.4 % 20
- Reproducibility (run to run):

Mean calcium concentration CV n
9.58 mg/dL = 2.40 mmol/L 2.2 % 25
13.6 mg/dL = 3.40 mmol/L 1.6 % 25

- Trueness: Results obtained with this reagent did not show systematic differences when compared with reference reagents (Note 3). Details of the comparison experiments are available on request.

- Interferences: Bilirubin (< 20 mg/dL), hemolysis (hemoglobin < 10 g/L) and lipemia (triglycerides < 30 g/L) do not interfere. Other drugs and substances may interfere.

These metrological characteristics have been obtained using an analyzer. Results may vary if a different instrument or a manual procedure are used.

**DIAGNOSTIC CHARACTERISTICS**

Calcium is the most prevalent cation found in the body, distributed in bone (99%), soft tissues and extracellular fluid. Its concentration in plasma is regulated by parathyroid hormone, vitamin D and calcitonin. Calcium ion is important in the transmission of nerve impulses, in the maintenance of normal muscle contractility, as a cofactor in certain enzyme reactions, and in the coagulation of the
blood.

Hypercalcemia can be due to vitamin D intoxication, enhanced renal retention, osteoporosis, sarcosidosis, thyrotoxicosis, hyperparathyroidism, multiple myeloma, idiopathic hypercalcemia of infancy, and carcinoma metastatic to bone\textsuperscript{2,4}.

Elevated calcium concentration in urine is found in nephrolithiasis and metabolic acidosis\textsuperscript{2,4}.

Hypocalcemia may be caused by primary and secondary hypoparathyroidism, pseudohypoparathyroidism, vitamin D deficiency, malnutrition and intestinal malabsorption\textsuperscript{2,4}.

Clinical diagnosis should not be made on the findings of a single test result, but should integrate both clinical and laboratory data.

**NOTES**

1. Contamination of glassware with calcium will affect the test. Use acid-washed glassware or plastic tubes.

2. These reagents may be used in several automatic analysers. Instructions for many of them are available on request.

3. Calibration with the provided aqueous standard may cause a matrix related bias, specially in some analysers. In these cases, it is recommended to calibrate using a serum based standard (Biochemistry Calibrator, cod. 18011 and 18044).

**BIBLIOGRAPHY**


A Sample
A Standard
x C Standard x Sample dilution factor = C Sample
A Sample
A Standard