شبكة المعلومات الجامعية

بسم الله الرحمن الرحيم

شبكة المعلومات الجامعية

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

شبكة المعلومات الجامعية

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

بعض الوثائق الأصلية تالفة

بالرسالة صفحات لم ترد بالأصل

Trace Element Status in Pediatric Patients on Regular Hemodialysis

Thesis

Submitted for Partial Fulfillment of Master Degree in Pediatrics

By

Ramy Gamal Abdel Aziz Attwa

M.B., B.Ch, Faculty of Medicine, Ain Shams University (2014)

Under supervision of

Prof. Dr. Hoda Lotfy El Sayed Wastawy

Professor of Pediatrics

Faculty of Medicine - Ain Shams University

Asst. Prof. Dr. Waleed Salah Eldin Ahmed Saleh

Assistant Professor of Community Medicine

Faculty of Medicine - Ain Shams University

Dr. Dina Ebrahem Darweish Sallam

Lecturer of Pediatrics

Faculty of Medicine - Ain Shams University

Dr. Bassma Abdel Nasser Mohammed Abdel Halim

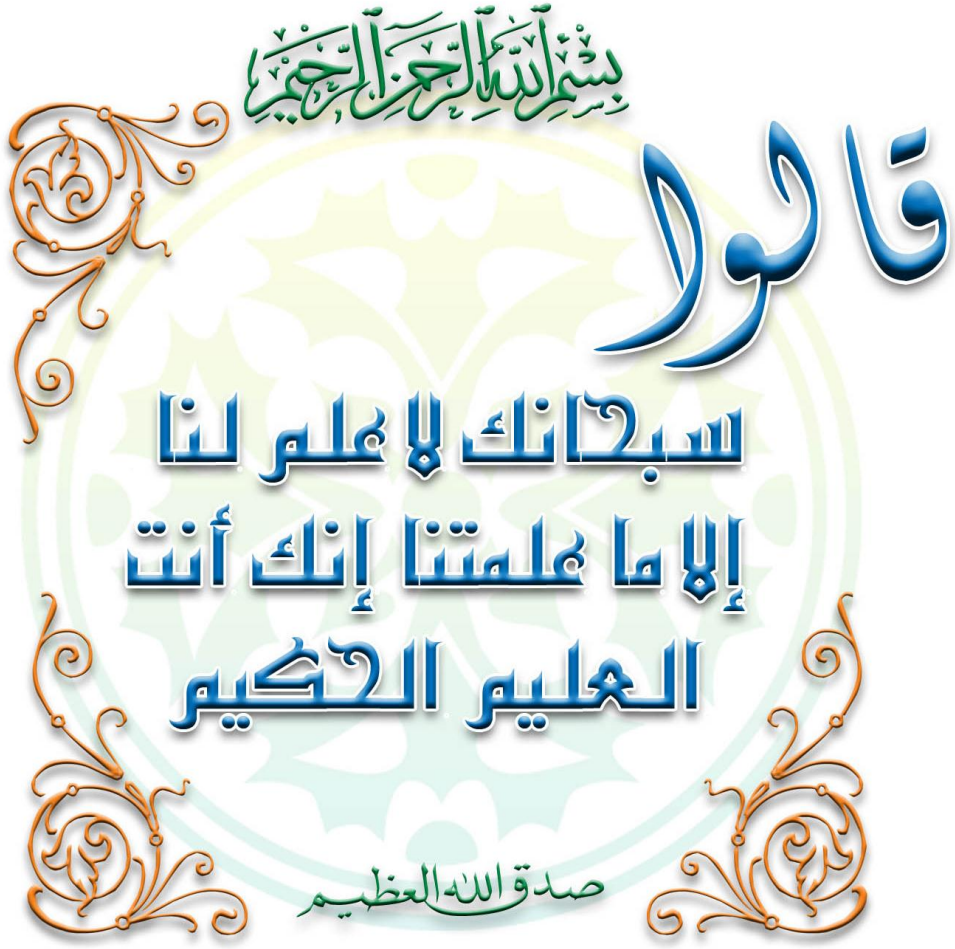
Lecturer of Pediatrics

Faculty of Medicine - Ain Shams University

Faculty of Medicine

Ain Shams University

2021



سورة البقرة الآية: ٣٢

Acknowledgment

First and foremost, I feel always indebted to **ALLAH,**
the Most Kind and Most Merciful.

I'd like to express my respectful thanks and profound gratitude to **Prof. Dr. Hoda Lotfy El Sayed Wastawy,** *Professor of Pediatrics, Faculty of Medicine - Ain Shams University for her keen guidance, kind supervision, valuable advice and continuous encouragement, which made possible the completion of this work.*

I am also delighted to express my deepest gratitude and thanks to **Asst. Prof. Dr. Waleed Salah Eldin Ahmed Saleh,** *Assistant Professor of Community Medicine, Faculty of Medicine - Ain Shams University, for his kind care, continuous supervision, valuable instructions, constant help and great assistance throughout this work.*

I am deeply thankful to **Dr. Dina Ebrahem Darweish Sallam,** *Lecturer of Pediatrics, Faculty of Medicine - Ain Shams University, for her great help, active participation and guidance.*

I wish to introduce my deep respect and thanks to **Dr. Bassma Abdel Nasser Mohammed Abdel Halim,** *Lecturer of Pediatrics, Faculty of Medicine - Ain Shams University, for her kindness, supervision and cooperation in this work.*

Ramy Gamal

List of Contents

Title	Page No.
List of Abbreviations	i
List of Tables	iii
List of Figures	iv
Introduction	1
Aim of the Work	4
Review of Literature	
Chronic Kidney Disease and Hemodialysis	5
Trace Elements and Hemodialysis	22
Subjects and Methods	29
Results	34
Discussion	50
Conclusion	59
Recommendations	60
Summary	61
References	63
Arabic Summary	—

List of Abbreviations

Abb.	Full term
AE	Acrodermatitis enteropathica
AKI	Acute kidney injury
ALP	Alkaline phosphatase
ATSDR	Agency for Toxic Substances and Disease Registry
BMI	Body mass index
BP	Blood pressure
BUN	Blood urea nitrogen
Ca	Calcium
CAKUT	Cong. Anomlies of kind. & urin. Tract
CBC	Complete blood count
Cd	Cadmium
CKD	Chronic kidney disease
CKD-MBD	Chronic kidney disease–mineral and bone disorder
CNS	Central nervous system
Cu	Copper
CV	Cardiovascular
CVD	Cardiovascular disease
DNA	Deoxyribonucleic acid
eGFR	Estimated glomerular filtration rate
EPO	Erythropoietin
ESKD	End-stage kidney disease
ESRD	End stage renal disease
GFR	Glomerular filtration rate
GH	Growth hormone

List of Abbreviations Cont...

Abb.	Full term
HD	Hemodialysis
HDL	High density lipoproteins
Hgb	Hemoglobin
HTN	Hypertension
IGF-I	Insulin-like growth factor-I
KDOQI	Kidney Disease Outcomes Quality Initiative
LDL	Low density lipoproteins
Mn	Manganese
MnSOD	Manganese superoxide dismutase
NGS	Next-generation sequencing
Pb	Plumb
PD	Peritoneal dialysis
Po4	Phosphorus
PTH	Parathyroid hormone
QoL	Quality of life
RBC	Red blood cell
RNA	Ribonucleic acid
Se	selenium
SRNS	Steroid-resistant nephrotic syndrome
TG	Triglycerides
TIBC	Total iron binding capacity
TSAT	Transferrin saturation
UN	Uremic neuropathy
USRDS	US Renal Data System
Zn	Zinc

List of Tables

Table No.	Title	Page No.
Table (1):	Body mass index:	30
Table (2):	Distribution of the studied patients.	34
Table (3):	Epidemiology of patients.	35
Table (4):	Epidemiology of studied controls:	35
Table (5):	Values of some laboratory investigations in the studied patients:	36
Table (6):	Values of trace elements in hemodialysis patients:	37
Table (7):	Values of trace elements in control group:	37
Table (8):	Comparison between Controls and Cases regarding trace elements levels:	38
Table (9):	Comparison between female and male hemodialysis patients regarding trace elements.	40
Table (10):	Correlation between studied trace elements and epidemiological data.	41
Table (11):	Correlation between studied trace elements and iron status:	43
Table (12):	Correlation between studied traces elements and lipid profile:	45
Table (13):	Correlation between studied trace elements and metabolic bone status:	47

List of Figures

Fig. No.	Title	Page No.
Figure (1):	Risk categories of CKD according to 2012 KDIGO classification in subgroup of 943 patients	15
Figure (2):	Distribution of patients' diagnosis.	34
Figure (3):	Copper level among patients and controls.	39
Figure (4):	Lead level among patients and controls.	39
Figure (5):	Correlation between age and cadmium.	42
Figure (6):	Correlation between copper and ferritin.	44
Figure (7):	Correlation between cadmium and TG.	46
Figure (8):	Correlation between copper and cholesterol.	46
Figure (9):	Correlation between cadmium and calcium.	48
Figure (10):	Correlation between manganese and Po4.	48
Figure (11):	Correlation between zinc and PTH.	49
Figure (12):	Correlation between lead and PTH.	49

INTRODUCTION

Hemodialysis is a mean of renal replacement therapy in patients with chronic kidney disease, in which removal of uremic toxins is occurred by allowing the equilibration of plasma water and dialysate across a semi-permeable membrane. Theoretically, hemodialysis could lead to depletion or retention of biologically essential substances if they are not included in the dialysate. For example, removal of water-soluble vitamins is well known and all hemodialysis patients are given supplements to replace hemodialysis losses. While data are available regarding vitamins in hemodialysis patients, little is known about the trace elements, especially in children ***(Wiesen et al., 2011)***.

Trace elements are known substances that present in very low concentrations in biological fluids or tissues. These include heavy metals such as cadmium, copper, lead, manganese and zinc. In adults, cadmium probably accumulates in hemodialysis patients, but the jury is still out as to whether copper and lead may accumulate. Manganese and zinc are probably deficient ***(Tonelli et al., 2009).***

Cadmium has no known biological role in higher organisms. However, low- level exposure to cadmium may increase the risk of CKD, albuminuria and proteinuria and can therefore be toxic ***(Ferraro et al., 2010).***

Lead interferes with a variety of physiologic processes and is toxic to many organs including the cardiovascular, skeletal, gastrointestinal, reproductive and nervous systems. In particular, lead inhibits proper neurodevelopment in children and may cause permanent learning and behavior disorders. Acute lead toxicity causes abdominal pain, confusion, headache, anemia, irritability and in severe cases, seizures, coma and death ***(Staudinger and Roth, 1998).***

Copper is an essential trace element in plants and animals. Copper proteins have diverse roles in biological electron transport and oxygen transportation. Copper deficiency can cause anemia and neutropenia. Non-protein bound copper ions are toxic by creating reactive oxygen species, which damage biological macromolecules ***(Brewer, 2010).***

Manganese is an essential trace element for all life forms. The classes of enzymes that require manganese cofactors are broad. The best known manganese- containing polypeptides are arginase and manganese-containing superoxide dismutase ***(Culotta et al., 2006).*** While manganese is much less toxic than other heavy metals, exposure to dust and fumes may cause toxicity and has been linked to impaired motor skills and cognitive disorders ***(Young et al., 1996).***

Zinc is one of the most important micronutrients and deficiency is common worldwide. Failure to thrive, dermatitis and inflammatory disease are the most common pediatric