The Application of Different Regimens of Online Hemodiafiltration on Egyptian Children with Chronic Renal Failure on Regular Hemodialysis

Thesis

Submitted for partial fulfillment of MD in

Pediatrics

PRESENTED BY

Muhammad Abdelhafeez Mubarak

M.B., B.Ch, - MSc. of Pediatrics
Assistant Lecturer of Pediatrics
Ain Shams University

UNDER SUPERVISION OF

Prof.Dr. Magid Ashraf Abdel-Fattah Ibrahim

Professor of Pediatrics
Faculty of Medicine, Ain-Shams University

Prof.Dr. Ihab Zaki El-Hakim

Professor of Pediatrics
Faculty of Medicine, Ain-Shams University

Dr. Ragia Marei Ali Said

Lecturer of Pediatrics
Faculty of Medicine, Ain-Shams University

Ass.Prof.Dr. Dina Ahmed Soliman

Assistant Professor of Clinical and Chemical Pathology
Faculty of Medicine, Ain-Shams University

FACULTY OF MEDICINE
AIN SHAMS UNIVERSITY
2015

دراسة تطبيق الطرق المختلفة للإستصفاء الدموي الإرتشاحي على الأطفال المصريين المصابين بالفشل الكلوي

رسالة

توطئة للحصول على درجة الدكتوراه
فى طب الأطفال

مقدمة من

طبيب/محمد عبد الحفيظ مبارك
بكالوريوس الطب و الجراحة- ماجستير طب الأطفال
مدرس مساعد طب الأطفال
كلية الطب- جامعة عين شمس

تحت إشراف

أ.د/ ماجـد أشرف عبد الفتاح إبراهيم
أستاذ طب الأطفال
كلية الطب - جامعة عين شمس

أ.د/ إيهاب زكي الحكيم
أستاذ طب الأطفال
كلية الطب-جامعة عين شمس

د/ راجيه مرعي علي سعيد
مدرس طب الأطفال
كلية الطب-جامعة عين شمس

أ.م.د/ دينا أحمد سليمان
أستاذ مساعد الباثولوجيا الإكلينيكية والكيميائية
كلية الطب-جامعة عين شمس

كلية الطب
جامعة عين شمس
٢٠١٥

بسم الله الرحمن الرحيم

قُلْ إِنَّنِي هَدَانِي رَبِّي إِلَى صِرَاطٍ مُسْتَقِيمٍ دِينًا قِيَمًا
مِلَّةَ إِبْرَاهِيمَ حَنِيفًا وَمَا كَانَ مِنَ الْمُشْرِكِينَ
(١٦١) قُلْ إِنَّ صَلَاتِي وَنُسُكِي وَمَحْيَايَ وَمَمَاتِي
لِلَّهِ رَبِّ الْعَالَمِينَ (١٦٢) لَا شَرِيكَ لَهُ وَبِذَلِكَ
أُمِرْتُ وَأَنَا أَوَّلُ الْمُسْلِمِينَ (١٦٣)

صدق الله العظيم

سورة الأنعام الأيات (١٦١-١٦٣)

Acknowledgement

First, thanks to **Allah** Whose magnificent blessing was the main factor in accomplishing this work.

I wish to express my deepest thanks, gratitude and profound respect to ***Prof. Dr. Magid Ashraf Abdel-Fattah Ibrahim,*** *Professor of Pediatrics, Faculty of Medicine, Ain Shams University, for his meticulous supervision. I consider myself fortunate to work under his supervision. His constant encouragement and constructive guidance were of paramount importance for the initiation, progress and completion of this work.*

No words can describe the effort and help of ***Prof. Dr. Ihab Zaki El-Hakim,*** *Professor of Pediatrics, Faculty of Medicine, Ain Shams University, his great support, facilities, careful supervision of every step on the way and continuous advice and guidance were the cornerstone for this work and helped me overcome many difficulties.*

I am also deeply grateful and would like to express my sincere thanks and gratitude to ***Dr. Ragia Marie Ali Said,*** *Lecturer of Pediatrics, Faculty of Medicine, Ain Shams University for her help, advice and meticulous revision of this work.*

I would like to thank ***Assist. Prof. Dr. Dina Ahmed Soliman,*** *Assistant professor of Clinical and Chemical Pathology, Faculty of Medicine, Ain Shams University for her contribution and advice in the laboratory work.*

Many thanks to ***Grants office,*** *Faculty of Medicine, Ain Shams University for their financial support in this work.*

Last but not least many thanks to my dear patients, nurses, and colleagues.

List of Contents

Title	Page No.

List of Abbreviations i

List of Tables iv

List of Figures viii

Introduction and Aim of the Work 1

Review of Literature 3

- Chronic Kidney Disease and End Stage Renal Disease 3
- Hemodialysis and Hemodiafiltration 24

Patients and Methods 61

Results 79

Discussion 129

Conclusion and Recommendations 143

Summary 145

References 149

Arabic Summary

List of Abbreviations (Cont…)

Abb.	Full term
$	*US Dollar*
€	*Euro*
AAMI	*Association for Advancement of Medical Instrumentation*
AFB	*Acetate Free Biofiltration*
AGE	*Advanced Glycosylated End Products*
ANP	*Atrial Natriuretic Peptide*
APR	*Acute Phase Reactants*
BMP	*Bone Morphogenetic Protein*
CaSR	*Calcium Sensing Receptors*
CAVH	*Continous Arterio-Venous Hemofiltration*
CAVHD	*Continous Arterio-Venous Hemodiafiltration*
CEA	*Cost Effectiveness Analysis*
CFU	*Colony Forming Unit*
CHF	*Continous Hemofiltration*
CKD	*Chronic Kidney Disease*
CKD-MBD	*Chronic Kidney Disease-Metabolic Bone Disease*
CONTRAST	*Randomized Controlled Convective Transport Study*
CRP	*C-reactive protein*
cTnT	*Cardiac Troponin T*
CVVH	*Continous Veno-Venous Hemofiltration*
CVVHD	*Continous Veno-Venous Hemodiafiltration*
D	*Dalton*
DOPPS	*Dialysis Outcome and Practice Patterns Study*
EGP	*Egyptian Pound*
ELISA	*Enzyme- linked immunosorbent assay*
EPO	*Erythropoietin*
EQ-5D	*EuroQuality of Life -5 Dimension Questionnaire*
ERI	*Erythropoietin resistance index*
ESAs	*Erythropoietin Simulating Agents*
ESRD	*End stage renal disease*
EU	*Endotoxin Unit*
EUDIAL	*EUropean DIALlysis Group*
FGF23	*Fibroblast growth factor 23*
GFR	*Glomerular filtration rate*
HD	*Hemodialysis*
HDF	*Hemodiafiltration*
HF	*Hemofiltration*
HF-HD	*High Flux Hemodialysis*
HFR	*Hemodiafiltration with online regeneration of ultrafiltrate*

List of Abbreviations (Cont…)

Abb.	Full term
hs-CRP	*Highly sensitive C-reactive protein*
ICER	*Incremental Cost-Effectiveness Ratio*
IFN-γ	*Interferon Gamma*
IGFBPs	*insulin-like growth factor binding proteins*
IHF	*Intermittent Hemofiltration*
IQR	*Inter quartile range*
ISH	*Intradialytic Symptomatic Hypotension*
K_0A	*Mass transfer Coeffecient of the Dialyzer*
kDa	*Kilo dalton*
KDIGO	*Kidney Disease Improving Global Outcomes*
KDOQI	*Kidney Disease Outcomes Quality Initiatives*
Kt/V	*K:Dialyzer's clearance, t:time of the session, V: volume of clearance*
K_{UF}	*Ultrafiltration Coefficient of the Dialyzer*
LF-HD	*Low Flux Hemodialysis*
LMWH	*Low Molecular Weight Heparin*
LPS	*Lipopolysaccharide*
LVH	*Left ventricular hypertrophy*
MM	*Middle Molecule*
MPO	*Membrane Permeability Outcome*
NAPRTCS	*North American Pediatric Renal Trials and Collaborative Studies*
NHANES	*National Health and Nutrition Examination Survey*
OCM	*Online Conductivity Monitoring*
OD	*Optical Density*
OL-HDF	*OnLine Hemodiafiltration*
OxSt	*Oxidative Stress*
PBMC	*Peripheral Blood Mononuclear Cells*
pmp	*Per Million Population*
PTH	*Parathyroid hormone*
QALY	*Quality-Adjusted Life Year*
Q_b	*Blood Flow on dialysis machine*
Q_d	*Dialysate Flow Rate in dialysis machine*
QOL	*Quality of life*
rhGH	*Recombinant Growth Hormone*
RKF	*Residual Kidney function*
RO	*Reverse Osmosis*
RPM	*Round Per Minute*
S	*Sieving Coefficient of the Dialyzer*
SAL	*Sterility Assurance Level*
SDS	*Standard Deviation Score*

List of Abbreviations (Cont…)

Abb.	Full term
SGA	*Subjective Global Assessment*
SSPS	*Statistical Package for Social Sciences*
TMP	*Trans Membrane Pressure*
TNF-α	*Tumor Necrosis Factor- α*
UF	*Ultrafiltration*
UFH	*Unfractionated Heparin*
UKM	*Urea Kinetic Modeling*
WTP	*Willingness To Pay*
Xa	*Active Factor Ten*
β_2m	*Beta-2 microglobulin*

List of Tables

Table No.	Title	Page No.
Table (1):	Classification of CKD.	3
Table (2):	Causes of CKD in children.	5
Table (3):	Solutes that accumulate in uremia and their proposed toxicity	8
Table (4):	Hemoglobin levels from NHANES III for boys and girls of all race/ethnic groups according to age	13
Table (5):	Electrolyte composition of dialysate fluid	27
Table (6):	Definitions of water and dialysate quality (levels given as an upper limit for water-quality definition)	29
Table (7):	Dialyzer classification	33
Table (8):	Modes of OL-hemodiafiltration:	40
Table (9):	Rules for calculation of Benefit Score.	67
Table (10):	Comparison between the initial and 3 months evaluations in all patients as regards clinical parameters.	80
Table (11):	Comparison between the initial and 3 months evaluations in all patients as regards frequency of patients in each BP category.	80
Table (12):	Comparison between the initial and 3 months evaluations in all patients as regards laboratory parameters.	81
Table (13):	Comparison between the initial and 3 months evaluations in all patients as regards drugs and costs.	82

List of Tables (Cont...)

Table No.	Title	Page No.
Table (14):	Comparison between different patients' groups as regards clinical parameters at 3 months evaluation.	84
Table (15):	Comparison between different patients' groups as regards clinical parameters at 9 months evaluation.	85
Table (16):	Comparison between different patients' groups as regards clinical parameters at 18 months evaluation.	86
Table (17):	Comparison between different groups as regards percentage change in clinical parameters in between 3 months and 9 months evaluations.	90
Table (18):	Comparison between the 3 and 9 months evaluations in patients' groups as regards frequency of patients in each systolic BP category.	91
Table (19):	Comparison between the 3 and 9 months evaluations in patients' groups as regards frequency of patients in each diastolic BP category.	92
Table (20):	Comparison between different groups as regards percentage change in clinical parameters in between 3 months and 18 months evaluations.	93
Table (21):	Comparison between the 3 and 18 months evaluations in patients' groups as regards frequency of patients in each systolic BP category.	94