

**RENAL FUNCTIONS IN HEALTHY AND CRITICALLY ILL  
NEONATES IN DIFFERENT SOCIOECONOMIC CLASSES**

**THESIS**

Submitted for  
**Ph.D. Degree In Childhood Studies**  
**Medical Department**

By  
**DR. NAYERA ISMAIL ISMAIL ATTIA**  
M.B., B.Ch. – M.Sc. (Pediatrics)

Supervised by

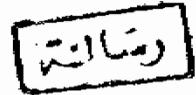
**PROF. DR. ABD EL-KHALEK KHATTAB**  
Professor of Pediatrics  
Faculty of Medicine  
Ain Shams University

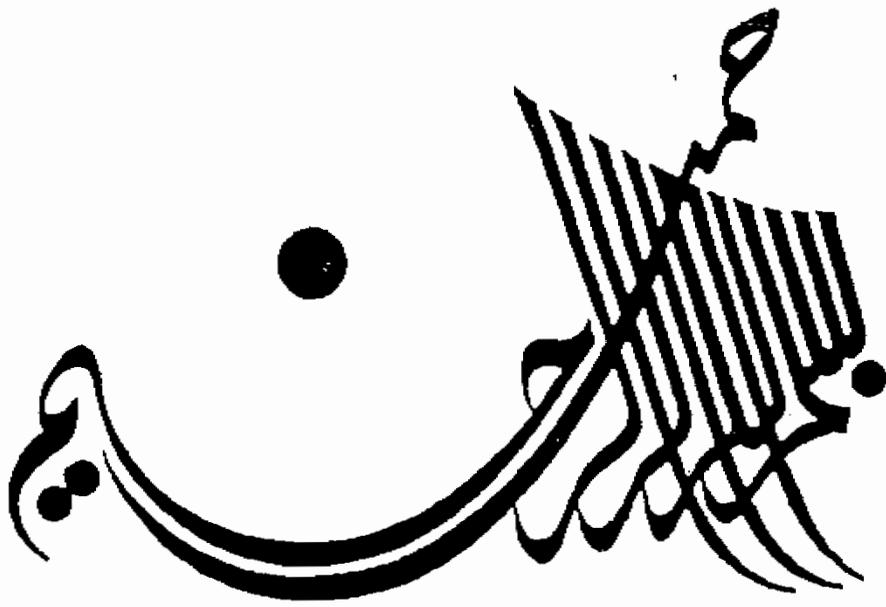
*618.9201*  
*N.I*  
**PROF. DR.**  
**SAWSAN EL-SOKKARY**  
Professor of Pediatrics  
Faculty of Medicine  
Ain Shams University

*u 9184*  
**PROF. DR.**  
**ZEINAB BESHRY**  
Professor of Psychiatry  
Faculty of Medicine  
Ain Shams University

*msan*  
**DR. FARID ADLY FARID**  
Lecturer of Clinical Pathology  
Faculty of Medicine  
Ain Shams University

*Farid*  
Ain Shams University  
1993





قَالُوا

سَجَّادِينَ لِلَّهِ وَمَا كُنَّا  
لِلْآلِهَةِ شُرَكَاءَ وَكُنَّا  
لِأَهْلِ الْبَيْتِ رُحَمَاءَ

مَدِينَةِ الْمَدِينَةِ  
(٢٢٢ / البقرة)



DISCUSSION AND JUDGMENT COMMITTEE

The vice-president for higher studies and research of  
-Shams University has approved to form the following  
committee for the discussion of Mr. Nayera Ismail Ismail Atti

Prof. Dr. Saman El-Sherief. Saman El-Sherief

..... Chairman .....

Prof. Dr. Zeinab Bekry Abdelkhalid. Zeinab Bekry

..... Member .....

Prof. Dr. Saadia <sup>Mohamed</sup> Abd. El-Satah. Saadia Abd. El-Satah

..... Member .....

Prof. Dr. Bethina El-Naggar. Bethina El-Naggar

..... Member .....

*To...*

Poor neonates suffering renal troubles who may benefit from this piece of work.

## ACKNOWLEDGMENT

I would like to express my sincere gratitude and deep appreciation to the spirit of **Professor Dr. Abd El-Khalek Khattab**, Professor of Pediatrics, Faculty of Medicine Ain Shams University, for his valuable help and continuous encouragement. Words of gratitude are not enough, without him, this work would never come into light.

I would like to express unlimited gratitude to **Professor Dr. Sawsan El-Sokkary**, Professor of Pediatrics, Faculty of Medicine Ain Shams University, for her most generous support, eminent help, meticulous supervision and guidance during this work.

I am deeply appreciative and thankful to **Professor Dr. Zeinab Beshry**, Professor of Psychiatry, Faculty of Medicine Ain Shams University, for offering me the opportunity to work in this subject, for her excellent guidance, real assistance and great support.

To **Dr. Farid Adly**, Lecturer of Clinical Pathology, Faculty of Medicine Ain Shams University, I gratefully acknowledge his assistance and his effort in the practical part of the study.

---

Also, I am very grateful to **Dr. Hesham Awad**, Lecturer of Pediatrics, Faculty of Medicine Ain Shams University, for his appreciable advice and explanations throughout this work.

I can't also forget to offer my best thanks to **the staff** working in the lab in the Obstetric and Gynecology Department, Ain Shams University.

Also, I wish to express my heartily thanks to **all my dear colleagues** in the NICU, Ain Shams University, for their cooperation and support.

To my husband, **Dr. Ibrahim Atef**, I'm deeply grateful for his real encouragement and assistance.

I'm very much obliged to **my mother**, for whom no words could ever express my deepest feelings and everlasting gratitude for her eminent support.

Lastly, I would like to thank **my patients** to whom I owe a lot.

Candidate

*Nayera Ismail*

---

## CONTENTS

	<b>Page</b>
Abbreviations	i
List of Tables	ii
List of Figures	iv
<b>Introduction</b>	<b>1</b>
<b>Aim of the Work</b>	<b>3</b>
<b>Review of Literature</b>	<b>4</b>
– Embryology and Functional Maturation of the Kidney	4
– Hormonal Regulation of Renal Function during Development	23
– Assessment of Renal Function in Preterm and Term Neonates	28
– Acute Renal Failure in the Neonate	50
– Renal Functions in High Risk Neonates	85
– $\beta_2$ -Microglobulin	98
– Socioeconomic Factors	104
<b>Subjects and Methods</b>	<b>105</b>
<b>Results and Analysis of Data</b>	<b>118</b>
<b>Discussion</b>	<b>176</b>
<b>Summary and Conclusion</b>	<b>196</b>
<b>Recommendations</b>	<b>200</b>
<b>References</b>	<b>201</b>
<b>Appendix</b>	<b>229</b>
<b>Arabic Summary</b>	

---

## ABBREVIATIONS

AII	Angiotensin II
AAP	Alanine aminopeptidase
ADH	Antidiuretic hormone
ANH	Atrial natriuretic factor
ARF	Acute renal failure
AVP	Arginine vasopressin
$\beta_2$ -M	$\beta_2$ -microglobulin
BUN	Blood urea nitrogen
Cr	Creatinine
Ccr	Creatinine clearance
CPAP	Continuous positive airway pressure
EDTA	Ethylenediamine tetra acetic acid
GFR	Glomerular filtration rate
HIE	Hypoxic-ischemic encephalopathy
IPP	Intermittent positive pressure
IUGR	Intrauterine growth retardation
LBW	Low birth weight
NAG	N-acetyl- $\beta$ -D-glucosaminidase
Pcr	Plasma creatinine
PAH	Para-aminohippurate
PRA	Plasma renin activity
PTH	Parthormone
RBF	Renal blood flow
RDS	Respiratory distress syndrome
RFI	Renal failure index
$^{99}\text{Tc}$ -DTPA	Technetium 99m diethylenetriamine pentaacetic acid
$\text{T}\beta_2\text{M}$	Tubular reabsorption of $\beta_2$ -M
TNa	Tubular reabsorption of Na
TRP	Tubular reabsorption of phosphate
Ucr	Urinary creatinine
VLBW	Very low birth weight

## LIST OF TABLES

	<b>Page</b>
Table (1): Changes in GFR with age.	11
Table (2): Urinalysis in normal newborns.	39
Table (3): Etiology of acute renal failure in newborns.	53
Table (4): Diagnostic indices in neonatal acute renal failure.	71
Table (5): Approach to the infant with suspected renal disease.	73
Table (6): Drugs for treatment of hyperkalemia.	78
Table (7): Sarnat and Sarnat stages of HIE.	107
Table (8): Cases under study.	118
Table (9): Comparison between hyperbilirubinemic neonates with gestational age <34 weeks and those >34 weeks' gestation.	120
Table (10): Comparison between septicemic patients with gestational age <34 weeks and those >34 weeks' gestation.	128
Table (11): Laboratory data in stage I HIE compared to stage II HIE.	137
Table (12): Laboratory data in stage I HIE compared to stage III HIE.	138
Table (13): Laboratory data of cases with HIE stage II compared to stage III.	139
Table (14): Laboratory findings in moderate RDS compared to severe RDS.	143
Table (15): Laboratory data of cases with RDS with gestational age <34 weeks compared to cases >34 weeks' gestation.	144
Table (16): Laboratory data of different groups under study compared to the control group.	147
Table (17): Laboratory data of cases with neonatal septicemia, hypoxic ischemic encephalopathy and respiratory distress syndrome compared to the group of neonatal hyperbilirubinemia	151

---

	<b>Page</b>
Table (18): Laboratory data of cases with hypoxic ischemic encephalopathy and respiratory distress syndrome compared to the group of neonatal septicemia	152
Table (19): Laboratory data of respiratory distress syndrome group compared to hypoxic ischemic encephalopathy group.	153
Table (20): Incidence of acute renal failure in different groups of critically-ill neonates under study.	154
Table (21): The blood urea level (mg/dL) in the groups under study in different socioeconomic classes.	169
Table (22): Serum creatinine level (mg/dL) in different socioeconomic classes in the different groups under study.	170
Table (23): Urinary $\beta_2$ -M ( $\mu$ g/L) in different socioeconomic classes in the different groups under study.	171
Table (24): Serum sodium level (mEq/L) in the different groups under study in different socioeconomic classes.	172
Table (25): Serum potassium level (mEq/L) in the different groups under study in different socioeconomic classes.	173
Table (26): Serum calcium level (mg/dL) in the groups under study in different socioeconomic classes.	174
Table (27): Blood glucose level (mg/dL) in the groups under study in different socioeconomic classes.	175

## LIST OF FIGURES

	<b>Page</b>	
Fig. (1a)	Representation of the renal development in the human fetus.	
Fig. (1b):	Embryology of the urogenital system.	
Fig. (2):	Maturation of GFR in relation to conceptional age.	
Fig. (3):	Relationship of pre-dosage gentamicin serum concentration to gestational age.	
Fig. (4):	Renal hemodynamics in acute renal failure.	
Fig. (5):	Nephronal factors in acute renal failure.	
Fig. (6):	The Silverman-Andersen retraction score for assessing the magnitude of respiratory distress.	108
Fig. (7):	Reference curve of b2-Microglobulin.	114
Fig. (8):	Distribution of the studied cases.	119
Fig. (9):	Correlation between total serum bilirubin and blood urea in neonatal hyperbilirubinemic group.	121
Fig. (10):	Correlation between total serum bilirubin and serum creatinine in neonatal hyperbilirubinemic group.	122
Fig. (11):	Correlation between total serum bilirubin and urinary $\beta_2$ M in neonatal hyperbilirubinemic group.	123
Fig. (12):	Correlation between total serum bilirubin and serum sodium in neonatal hyperbilirubinemic group.	124
Fig. (13):	Correlation between total serum bilirubin and serum potassium in neonatal hyperbilirubinemic group.	125
Fig. (14):	Correlation between total serum bilirubin and serum calcium in neonatal hyperbilirubinemic group.	126
Fig. (15):	Correlation between total serum bilirubin and blood glucose in neonatal hyperbilirubinemic group.	127
Fig. (16):	Mean values of renal function tests in both groups of neonatal septicemia with gestational age $\leq 34$ weeks and $>34$ weeks.	129

	<b>Page</b>
Fig. (17): Correlation between sepsis score and serum creatinine in neonatal septicemia group.	130
Fig. (18): Correlation between sepsis score and blood urea in neonatal septicemia group.	131
Fig. (19): Correlation between sepsis score and urinary $\beta_2$ M in neonatal septicemia group.	132
Fig. (20): Correlation between sepsis score and serum sodium in neonatal septicemia group.	133
Fig. (21): Correlation between sepsis score and serum potassium in neonatal septicemia group.	134
Fig. (22): Correlation between sepsis score and calcium in neonatal septicemia group.	135
Fig. (23): Correlation between sepsis score and blood glucose in neonatal septicemia group.	136
Fig. (24): Mean values of serum urea in the three stages of HIE.	140
Fig. (25): Mean values of serum creatinine in the three stages of HIE	141
Fig. (26): Mean values of urinary $\beta_2$ -M in the three stages of HIE	142
Fig. (27): Serum urea levels in the studied groups of neonates.	148
Fig. (28): Serum creatinine levels in the studied groups of neonates	149
Fig. (29): Urinary $\beta_2$ -M levels in the studied groups of neonates	150
Fig. (30): Incidence of renal failure in the studied cases.	155
Fig. (31): Correlation between urinary $\beta_2$ M and blood urea in neonatal hyperbilirubinemic group.	156
Fig. (32): Correlation between urinary $\beta_2$ M and serum creatinine in neonatal hyperbilirubinemic group.	157
Fig. (33): Correlation between urinary $\beta_2$ M and blood urea in neonatal septicemia group.	158
Fig. (34): Correlation between urinary $\beta_2$ M and serum creatinine in neonatal septicemia group.	159

	<b>Page</b>
Fig. (35): Correlation between urinary $\beta_2$ M and blood urea in HIE group.	160
Fig. (36): Correlation between urinary $\beta_2$ M and serum creatinine in HIE group.	161
Fig. (37): Correlation between urinary $\beta_2$ M and blood urea in RDS group.	162
Fig. (38): Correlation between urinary $\beta_2$ M and serum creatinine in RDS group.	163
Fig. (39): Correlation between urinary $\beta_2$ M and blood urea in control group.	164
Fig. (40): Correlation between urinary $\beta_2$ M and serum creatinine in control group.	165
Fig. (41): Serum urea levels in the different socioeconomic classes of the studied groups.	166
Fig. (42): Serum creatinine levels in the different socioeconomic classes of the studied groups.	167
Fig. (43): Urinary $\beta_2$ -M levels in the different socioeconomic classes of the studied groups.	168

# *Introduction*