Diagnostic Usefulness of the Urinary Na/K Ratio and Serum Chloride in Children with Decompensated Heart Failure

Thesis

Submitted for Partial Fulfillment of Master Degree in Pediatrics

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M.B. B Ch – Ain Shams University (2014)

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2019

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. Alyaa Amal Kotby,*** *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 ***Dr. Nanies Mohamed Salah EL Din,*** *Lecturer of Pediatrics, Faculty of Medicine, Ain Shams University, for her kind care, continuous supervision, valuable instructions, constant help and great assistance throughout this work.*

I am deeply thankful to ***Dr. Menatallah Ali Shabaan,*** *Lecturer of Clinical Pathology, Faculty of Medicine, Ain Shams University, for her great help, active participation and guidance.*

I would like to express my hearty thanks to all ***my family*** *for their support till this work was completed.*

Last but not least my sincere thanks and appreciation to all patients participated in this study.

Esraa Matarawy Eid Kasim

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List of Abbreviations

Abb.	Full term

ACEI.....Angiotensin Converting Enzyme Inhibitor
ACHF…….. Advanced Chronic Heart Failure
ADH .....Anti Diuretic Hormone
ADHF.....Acute Decompensated Heart Failure
AHF.....Acute heart failure
ALCAPA .....Anomalous left coronary artery from the pulmonary artery
ANP .....Atrial Natriuretic Peptide
AQP2……. Aquaporin 2
ARBs…… Angiotensin II Receptor Blockers
AS .....Aortic Stenosis
ASD……..Atrial Septal Defect
ATP .....Adenosine triphosphate
AVP .....Arginine Vasopressin
BMI……..Body Mass Index
BNP .....Brain Natriuretic Peptide
BUN…….Blood Urea Nitrogen
BW……Body Weight
CAVC……..Common Atrioventricular canal
CHD .....Congenital Heart Disease
CHF.....Congestive Heart Failure
CKD.....Chronic kidney disease
CL.....Chloride
COA.....Coarctation of Aorta
COP.....Cardiac output
CRT .....Cardiac Resynchronization Therapy
CTR.....Cardiothoracic ratio
CXR .....Chest X Ray
DCM .....Dilated Cardio Myopathy
ECG.....Electro Cardio Gram

List of Abbreviations (Cont...)

Abb.	Full term

ECMO .....Extra Corporeal Membrane Oxygenation
EF.....Ejection Fraction
EPHESUS…….. Eplerenone Heart Failure Efficacy and Survival Study
EVEREST.....Efficacy of Vasopressin Antagonist in Heart Failure Outcome Study with Tolvaptan
GFR.....Glomerular Filtration Rate
GLDH.....Glutamate Dehydrogenase
h .....Hour
H.....Hydrogen
HF .....Heart Failure
HFNEF.....Heart Failure with Normal Ejection Fraction
HFREF.....Heart Failure with Reduced Ejection Fraction
HIV……Human Immunodeficiency Virus

ICD .....Implantable Cardioverter Defibrillator
ISE…… Ion Specific Electrode
IV.....Intravenous
IVS .....Intact Ventricular Septum
K.....Potassium
LV.....Left Ventricle
LVEDD.....Left Ventricular End Diastolic Diameter
LVESD .....Left Ventricular End Systolic Diameter
MI.....Myocardial infarction
Na.....Sodium
NAD…… Nicotinamide Adenine Dinucleotide
NADH…….. Nicotinamide Adenine Dinucleotide Dehydrogenase
NADPH .....Nicotinamide Adenine Dinucleotide Phosphate
NCC.....Na-Cl Co transporter
NKCC2 .....Sodium-Potassium-Chloride Co transporter
NKKC2 .....Sodium-Potassium-Chloride Co transporter

List of Abbreviations (Cont...)

Abb.	Full term

NO .....Nitric Oxide
NT BNP.....N- Terminal Brain Natriuretic Peptide
NYHA .....New York Heart Association
PCT .....Proximal Convoluted Tubule
PCWP .....Pulmonary capillary wedge pressure
PDA .....Patent Ductus Arteriosus
PVC……. Poly Vinyl Chloride
RAAS.....Renin Angiotensin Aldosterone System
Sa O2.....Oxygen saturation
SCD .....Sudden Cardiac Death
Sig…….Significance
SNS .....Sympathetic Nervous System
SPSS……. Statistical package for social science
TAPVC .....Total Anomalous Pulmonary Venous Connection
TAPVR…… Total Anomalous Pulmonary Venous Return
TGA .....Transposition of Great Arteries
UOP……...Urine output
WRF……..Worsened Renal Function
V2R…… vasopressin type 2 receptor
VAD .....Ventricular Assist Device
VEC .....Extracellular volume
VSD .....Ventricular Septal Defect
WNKs .....With No Lysine Kinases
Wt……..Weight

ABSTRACT

Objective: Comparing diuretic efficacy between high dose furosemide as a continuous infusion and bolus injections in children with congenital left to right shunts presenting with decompensated chronic heart failure**.**

Outcome measures*:* Diuretic efficacy of furosemide therapy assessed by net fluid output /40mg furosemide, change in Na/K ratio and change in body weight/40 mg furosemide in children with acute on top of chronic heart failure.

Patients and methods: The study included twenty six (26) patients, median age 0.75 years (range 0.42-1.2 years) with congenital left to right shunts presenting with normal ejection fraction heart failure. Two urine samples were collected from patients on admission and at day 3 of admission for immediate assay of urinaryNa and K.

Results: Thirteen patients (50%) were on continuous furosemide infusion versus thirteen (50%) that were kept on furosemide bolus injections. Patients on Furosemide infusion had significantly prolonged Capillary refill time and worse ROSS classification on admission and on follow up. On assessment of the diuretic response in the two groups we have found that patients on furosemide infusion had decreased Na/K ratio (P=0.017), increased furosemide dose (P=0.018), had less change in body weight(P=0.000) in relation to the diuretic dose and less fluid output (p=0.081).

Conclusion: Augmentation of furosemide therapy in the form of infusion rather than interval dosing in patients with heart failure is not always associated with an equivalent increase in diuresis and may not benefit the patient.

Key wards: Pediatric, heart failure, diuretic resistance, furosemide infusion

Abbreviations: ADHF: Acute Decompensated Heart Failure, CHF: Chronic Heart Failure, CTR: Cardiothoracic Ratio, CXR: Chest x ray, HF: Heart Failure, K: Potassium, Na: Sodium, NYHA: New York Heart Association, SSPS: Statistical package for social science, UOP: Urine output.

INTRODUCTION

Heart failure (HF) is a major clinical issue, which imposes a heavy social and economic burden on health care systems. In fact, it directly causes approximately 1 million hospital admissions every year in Adults in the United States ***(Roger et al., 2013).***

Fluid overload, clinically evident as systemic and/or pulmonary congestion, represents the most frequent cause of hospitalization in this clinical setting, plays a central role in the progression of HF and has a major negative prognostic impact ***(Dupont et al., 2011).***

Adequate control of systemic congestion along with maintenance and improvement of renal function represents a key target of patient management in HF ***(Greene et al., 2013).*** On these grounds, current guidelines suggest that decongestion should be attempted through diuretic therapy. Diuretics, essentially loop diuretics, are utilized in more than 90% of patients with HF to obtain an increase in urinary output, dyspnea relief and weight loss ***(Ponikowski et al., 2016).***

Diuretic treatment of systemic and pulmonary congestion can be ineffective in some patients with HF – a condition commonly referred to as diuretic resistance or refractoriness. However, the lack of an operational definition makes it difficult to define the exact incidence of this problem. It is thought that

about one third of patients with HF, especially in the phase of acute decompensation, may present with apparent diuretic refractoriness ***(Voors et al., 2014).***

Lower chloride (CL) levels are linked to reduced loop diuretic response. Hypochloremic patients have a greater relative wasting of chloride compared with sodium(Na), whereas renal free water clearance does not seem to be impaired, suggesting that depletion rather than dilution may be the responsible mechanism ***(Hanberg et al., 2016).***

Adult studies have demonstrated that hypochloremia is associated with neurohormonal activation and diuretic resistance with chloride depletion as a candidate mechanism. Sodium-free chloride supplementation can be associated with increases in serum chloride and changes in several cardiorenal parameters as aminoterminal pro B-type natriuretic peptide which decreases with chloride supplementation and the blood urea nitrogen to creatinine ratio which increases with chloride supplementation ***(Hanberg et al., 2016).***