Differences between High Flux Dialysis versus High Efficiency Online Hemodiafilteration in Diffusive and Convective Reduction Ratio

Thesis

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بسم الله الرحمن الرحيم

قالوا

سبحانك لا علم لنا إلا ما علمتنا إنك أنت العليم الحكيم

صدق الله العظيم

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May Abd Elaziz Abd Elaziz Elhashash

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List of Abbreviations

Abbrev.	Full-term
AGE	: Advanced glycation end-products
B2M	: Beta-2 microglobulin
BFRs	: Blood flow rates
Ca	: Calcium
CAVH	: Continuous arteriovenous hemofiltration
CAVHDF	: Continuous hemodiafiltration
CBC	: Complete blood count
CKD	: Chronic kidney disease
CRRT	: Contentious renal replacement therapy
CVVH	: Continuous venovenous hemofiltration
CVVHD	: Continuous venovenous hemodialysis
CVVHDF	: Continuous venovenous hemodiafiltration
DM	: Diabetes mellitus
DOPPS	: Dialysis Outcomes and Practice Patterns Study
EPO	: Erythropoetin
ESHOL	: On-line Haemodiafiltration Survival Study
ESKD	: End-stage kidney disease
ESRD	: End-stage renal disease
GFR	: Glomerular filtration rate
HD	: Hemodialysis
HEMO	: Hemodialysis

HE-OL HDF	: High-efficiency online hemodiafiltration
HPM	: High performance membrane
HTN	: Hypertension
IHD	: Ischemic heart disease
JSDT	: Japanese Society of Dialysis Therapy
K	: Potassium
KDIGO	: Kidney Disease Improving Global Outcomes
LF	: Low-flux
LVH	: Left ventricular hypertrophy
Na	: Sodium
PCR	: Protein catabolic rate
Qb	: Blood flow rate
Qd	: Dialysate flow rate
SCUF	: Slow continuous ultrafiltration
SCUF	: Slow Continuous Ultrafiltration
SD	: Standard deviation
SLED	: Slow low-efficiency diffusion hemodialysis
SPSS	: Statistical package for social science
TMP	: Transmembrane pressure
TNF-α	: Tumor necrosis factor-α
UF	: Ultrafiltration
UFR	: Ultrafiltration rate
URR	: Urea Reduction Ratio

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Abstract

Background: Several epidemiological studies performed in recent decades based on large databases suggest that convective treatments may be superior at reducing morbidity and mortality in dialysis patients. HDF has also been reported to improve beta2- microglobulin (ß2-m), phosphate and urea removal. Some others studies have reported better anaemia correction and lower inflammation when using HDF. The main disadvantages of HDF are its cost and the loss of albumin. **Aim of the Work:** The objective of the study is to compare between efficiency of dialysis sessions of high flux dialysis and HE-OL HDF in diffusive and convective reduction ratio of urea and ß2 microglobulin by using them as an indicators. **Patients and methods:** This observational cross sectional study was conducted on 22 prevalent hemodialysis patients attending at hemodialysis unit of Ain Shams University specialized hospital. The included patients are clinically stable on thrice weekly hemodialysis sessions for 4 hours per session, performing both high flux hemodialysis sessions alternating with high efficiency online hemodiafilteration sessions. **Results:** The study showed that There was more significant reduction ratio in serum β2 microglobulin in HDF session (82.2±3.4%) than in HF session (67.4±6.5%) with (p value <0.001). Also, there was more significant reduction ratio in blood urea in HDF session (82.2±5.0 %) than in HF session (76.0±5.9%) with p value <0.001 **Conclusion:** The results of this study confirm the experience of other investigators that routine on-line hemodiafiltration can be performed safely in a large group of patients. Our results also show that hemodiafiltration provides superior solute removal to high-flux hemodialysis over a wide range of solute sizes for blood flow rates in the range of 250 to 400 ml/min. **Recommendations:** Further studies on a larger scale of patients are needed to confirm the results obtained by this work.

Key words: high flux dialysis, high efficiency online hemodiafileration, diffusive, convective reduction ratio

Introduction

Although it was not until 1960s that long term dialysis in a clinical setting become a reality, dialysis as a treatment for renal failure had been the focus of interest for some time, it is difficult now to imagine that less than 50 years ago patients with ESRD had only one prognosis, death. Dialysis Involves bidirectional movement of molecules across a semipermeable membrane ***(Ahmad, 2009).***

Hemodialysis (HD) is a dynamic process, which occurs during movement of low molecular weight water soluble substances through a semipermeable membrane, Transport across the membranes of low-flux (LF) dialyzers is based mainly on diffusion and through the membranes of high-flux (HF) dialyzers, diffusion and convection ***(Sobaszek-Pitas et al., 2014).***

The mortality rate of patients on maintenance dialysis remains alarmingly high, at approximately 15-20 % per year. Increasing dialyzer urea clearance has not been shown to improve survival and hence interest has shifted towards convective therapies, such as hemodiafiltration (HDF) which can remove middle molecular weight uremic toxins, which have been suggested to increase mortality in patients with end-stage kidney disease ***(Basile et al., 2017).***

Because of incomplete removal of uremic toxins, 90% of hemodialysis patients reveal symptoms of pathologic amyloidosis caused by ß2 microglobulin after five years of dialysis ***(Oshvandi et al., 2014).***

HDF combines diffusion and convection. The large convective volumes that are generated using high-flux membranes are replaced with substitution fluid, from either commercially available bags or using ultrapure dialysis fluid in a technique known as online HD ***(Vilar et al., 2009).***

HDF is a treatment designed to remove accumulated metabolic products from blood by a combination of diffusive and convective transport through a semi-permeable membrane of high-flux type. Fluid is removed by ultrafiltration and the volume of filtered fluid exceeding the desired weight loss is replaced by sterile, pyrogen-free infusion solution. HDF provides a solute elimination of high molecular weight molecules better than HD ***(Tattersall & Ward, 2013).***

Aim of the Work

The objective of the study is to compare between efficiency of dialysis sessions of high flux dialysis and HE-OL HDF in diffusive and convective reduction ratio of urea and ß2 microglobulin by using them as an indicators.

End Stage Renal Disease (ESRD)

Chronic kidney disease (CKD) is a global health problem. CKD patients are widely prevalent, and the number of end-stage kidney disease (ESKD) patients is still increasing ***(Kimura, 2016).***

ESKD patients require cost-prohibitive kidney replacement therapy. Moreover, CKD patients are highly vulnerable, and the risk of cardiovascular events and death increases with the progression of CKD stages. Thus, it is critical to predict their risk for the progression to ESKD in CKD patients to avoid these unfavorable situations ***(Kimura, 2016).***

DEFINITION

CKD is defined as abnormalities of kidney structure or function, present for >3 months, with implications for health.

The addition of 'with implications for health' is intended to reflect the notion that a variety of abnormalities of kidney structure or function may exist, but not all have implications for health of individuals, and therefore need to be contextualized ***(KDIGO, 2012).***

Mechanism (pathophysiology)

Nephrons are generated in weeks 12–36 of gestation in humans, with a mean of 950,000 nephrons per kidney (with a range of ~200,000 to >2.5 million) ***(Bertram et al., 2011).***

No new nephrons can be generated after this period. During growth, the available nephrons increase in size to accommodate increased renal demands. Furthermore, GFR decreases with age ***(Brenner et al., 1982)***.

Nephron loss, for example owing to injury or donation of one of the kidneys, can have hypertrophic effect on the remaining nephrons ***(Brenner et al., 1982).***

This nephron adaptability allows for continued normal clearance of plasma solutes. Plasma levels of substances such as urea and creatinine start to show measurable increases only after total GFR has decreased to 50% ***(Schnaper, 2014).***

The plasma creatinine value will approximately double with a 50% reduction in GFR. For example, a rise in plasma creatinine from a baseline value of 0.6 mg/dL to 1.2 mg/dL in a patient, although still within the adult reference range, actually represents a loss of 50% of functioning nephron mass ***(Schnaper, 2014).***

Aging and renal function

The GFR peaks during the third decade of life at approximately 120 mL/min/1.73 m2; it then undergoes an annual mean decline of approximately 1 mL/min/y/1.73 m2, reaching a mean value of 70 mL/min/1.73 m2 at age 70 years ***(Hallan, 2012).***