HEMODIAFILTRATION- BASIC CONCEPTS, PRACTICAL ASPECTS, AND COST CONSEQUENCES

MEDigest

ISSUE #20: MARCH 2022

INTRODUCTION TO HEMODIAFILTRATION (HDF)

In this section we will provide an introduction to HDF, discuss the requirements for performing HDF such as sterile and non-pyrogenic substitution fluids, dialyzers and vascular access. We will also review the different HDF modalities namely, pre-dilution, post-dilution, mixed-dilution and mid-dilution; global trends of its use and the benefits and challenges with the use of HDF in terms of survival outcomes, cardioprotection and dampening of the inflammatory responses.

PRACTICAL ASPECTS AND COST CONSEQUENCES OF HDF

In this section, we will highlight the practical aspects of performing HDF, and various factors to be considered to optimize performance of the procedure including convective dose, dialyzers, management of transmembrane pressure, etc. Lastly, we will address the cost consequences of performing HDF: its value to the provider, the payers and the ESKD patients.

ADVANCED RENAL EDUCATION PROGRAM
Asia Pacific

DISCLOSURE:

CONTACT US:

For suggestions and comments email us at: medical_information_education@fmc-asia.com. Global Medical Education and Information, Fresenius Medical Care Asia Pacific, 51/F Sun Hung Kai Centre, 30 Harbour Road, Wan Chai, Hong Kong

FRESENIUS MEDICAL CARE

INTRODUCTION TO HEMODIAFILTRATION

Hemodiafiltration is a kidney replacement modality developed in the 1980s that combines diffusion and convection processes to improve solute removal over a wide range of molecular weights. Apart from removing urea, HDF is also efficient in removing middle molecular weight solutes such as beta-2 microglobulin (B2M). [1] Requirements for the performance of HDF include machines capable of performing the procedure, a hemodialyzer with surface area between 1.6–2.2 m^2, online production of sterile and non-pyrogenic substitution fluid and a patent vascular access either an arteriovenous fistula or graft or central vein catheter. [2] There are four different modes of HDF, with pre–dilution (fluid substitution before the dialyzer) and post–dilution modes (fluid substitution after the dialyzer) more commonly used in practice compared to mixed dilution and mid–dilution modes. The advantages and disadvantages comparing pre– and post–dilution modes are illustrated in Table 1. [1]

	Post-dilution HDF	Pre-dilution HDF
PROS	High solute clearance and removal; Reduced consumption of substitution volume	Decreased viscosity and oncotic pressure; Reduced fibers and membrane fouling; Reduced membrane stress
CONS	Increased viscosity and oncotic pressure; Fiber and membrane fouling; Clotting; Alarms; Albumin leakage?	Reduced solute clearance and removal; Increased consumption of substitution volume

Table 1. Adapted from Imamović G et al, 2016. doi: 10.5772/63067.

Direct factors	Indirect factors
Hemodynamic stability	Anemia correction
Cardiac remodeling	Nutritional status
Arrhythmogenicity	Physical activity
Inflammation	Patient perception (QoL)
Oxidative stress	Residual kidney function
Endothelial and vascular function and stress	
Sympathetic tone activity	
Circulating uremic toxins	

Table 2. Adapted from Canuad B et al, Semin Dial 2021, doi: 10.1111/sdi.13039.

Pre–dilution mode is the HDF mode most commonly used in Japan whereas the post–dilution mode is employed by most centers internationally including in Europe, Canada and Australia and New Zealand. Globally, the use of on–line HDF accounts for 10% of all hemodialysis (HD) treatments with 26% of all HD patients receiving the modality in Europe. The usage of on–line HDF increased by 17% from 2009–2017. [3,4] The reason for the increase in usage is most likely due to robust evidence in terms of its clinical benefits as demonstrated by four large randomized controlled studies (CONTRAST, FRENCHIE, ESHOL and Turkish HDF studies). Significant survival outcome benefits are associated with higher substitution volumes (>21L/session). [5–8] There were also reported direct and indirect mechanisms of cardioprotection that further strengthens evidence that HDF is a truly beneficial treatment option for ESKD patients. (Table 2) [9] There are also some challenges associated with HDF therapy which include (1) the need for standardization of convection volume across patient groups; (2) the backtransport phenomenon and; (3) and protein deposition and reduced membrane permeability, both of which could result from high convective volumes.

PRACTICAL ASPECTS AND COST CONSEQUENCES OF HDF

HDF benefits require sufficient delivery of an optimal substitution fluid dose (>21 L/session). Individualization of therapies has also proven beneficial via standardization with body surface area (1.73 m^2) and total body water (35 L) as demonstrated by two individual pooled analysis of data from the four large RCTs. [10, 11] Other aspects that could help to optimize the HDF prescription include the use of a highly permeable dialyzers, effective anticoagulation, adequate blood (≥ 350 mL/min) and dialysate flow rates (≥ 600 mL/min). Transmembrane pressure can also be managed through pressure or volume–controlled modes where a maximum of 350 mmHg is usually set. Treatment time is also a crucial factor and extended treatment times may help to improve clinical outcomes. One to three months from the initial prescription, patients should undergo adjustments in the treatment schedule in order to achieve an optimal maintenance prescription. [12]

A recent analysis also showed the healthcare value-based case for HDF vs. high-flux HD with regards to patient, provider and payer perspectives. For the **patients and providers**, HDF was shown to improve survival rates and patients' general well–being. For the **payers**, taking the UK NICE initiative into consideration, HDF has been shown to be cost-effective in terms of improvement of survival, fewer dialysis-related complications, and reduction of medication requirements (e.g., erythropoietin stimulating agents). The authors of the study commented that despite the rapid rise in HDF use worldwide (especially in high-income countries), the reasons that prevent greater application of HDF must be examined. [13]



References:

(1) Imamović G et al., Advances in Hemodiafiltration, edited by Ayman Karkar, IntechOpen, 2016. doi: 10.5772/63067.
(2) Schiffl H, Int Urol Nephrol 2020 Aug;52(8):1501–1506.
(3) Canaud B et al., Nephrol Dial Transplant, 2020; 35(3):398–407.
(4) Canaud B, et al., Nephrol. Dial Transplant, 2019.
(5) Grooteman et al., J Am Soc Nephrol 2012;23:1087–1096.
(6) Morena, M et al., Kidney Int 2017;91:1495–1509.
(7) Maduell et al., JASN 2013;24 (3):487–497.
(8) Ok E et al. NDT 2013; 28:192–202.
(9) Canaud B et al., Semin Dial 2021, doi: 10.1111/sdi.13039.
(10) Peters S et al., Nephrol Dial Transplant 2016; 31:978–984.
(11) Davenport A et al., Kidney International. 2016; 89: 193–199
(12) Canaud B and Davenport A, Semin Dial 2022, doi: 10.1111/sdi.13069.
(13) Horning C et al., Semin Dial 2022, doi: 10.1111/sdi.13075.