Expanded Hemodialysis – Innovative Clinical Approach in Dialysis
Expanded Hemodialysis

Innovative Clinical Approach in Dialysis

Volume Editor

Claudio Ronco  Vicenza

30 figures, 6 in color, and 15 tables, 2017
Contents

VII Introduction
Ronco, C. (Vicenza)

1 The Evolving Patterns of Uremia: Unmet Clinical Needs in Dialysis
Yu, X. (Zhanjiang)

8 Middle-Molecule Uremic Toxins and Outcomes in Chronic Kidney Disease
Massy, Z.A. (Paris/Versailles/Villejuif); Liabeuf, S. (Villejuif/Amiens)

18 Uremia Retention Molecules and Clinical Outcomes
Barreto, F.C.; Barreto, D.V. (Curitiba); Canziani, M.E.F. (São Paulo)

32 End-Stage Renal Disease, Inflammation and Cardiovascular Outcomes
Dai, L. (Stockholm/Tianjin); Golembiewska, E. (Szczecin); Lindholm, B.; Stenvinkel, P. (Stockholm)

44 The Cardiovascular Burden in End-Stage Renal Disease
Cozzolino, M.; Galassi, A.; Pivari, F.; Ciceri, P.; Conte, F. (Milan)

58 Inflammation and Protein-Energy Wasting in the Uremic Milieu
Jankowska, M. (Gdańsk); Cobo, G. (Quito); Lindholm, B.; Stenvinkel, P. (Stockholm)

72 Inflammation: A Key Contributor to the Genesis and Progression of Chronic Kidney Disease
Qian, Q. (Rochester, MN)

84 Solute Transport in Hemodialysis: Advances and Limitations of Current Membrane Technology
Clark, W.R. (West Lafayette, IN); Gao, D. (Seattle, WA); Neri, M.; Ronco, C. (Vicenza)

100 Membrane Innovation in Dialysis
115 Multidimensional Classification of Dialysis Membranes
Ronco, C.; Neri, M.; Lorenzin, A.; Garzotto, F. (Vicenza);
Clark, W.R. (West Lafayette, IN)

127 Modeling of Internal Filtration in Theranova Hemodialyzers
Lorenzin, A.; Neri, M. (Vicenza); Clark, W.R. (West Lafayette, IN); Garzotto, F.;
Brendolan, A.; Nalesso, F.; Marchionna, N.; Zanella, M.; Sartori, M. (Vicenza);
Fiore, G.B. (Milan); Ronco, C. (Vicenza)

142 The Rationale for Expanded Hemodialysis Therapy (HDx)
Hutchison, C.A. (Hastings/Brisbane, QLD); Wolley, M. (Brisbane, QLD)

153 Expanded Hemodialysis Therapy: Prescription and Delivery
Heyne, N. (Tübingen)

158 Effects of Hemodialysis Therapy Using Dialyzers with Medium Cut-Off
Membranes on Middle Molecules
Kirsch, A.H.; Rosenkranz, A.R. (Graz); Lyko, R.; Krieter, D.H. (Würzburg)

168 The Place of Large Pore Membranes in the Treatment Portfolio of
Patients on Hemodialysis
Van Biesen, W.; Vanholder, R.; Schepers, E.; Glorieux, G.; Dhondt, A.;
Eloot, S. (Ghent)

178 Large Middle Molecule and Albumin Removal: Why Should We Not
Rest on Our Laurels?
Florens, N.; Juillard, L. (Lyon/Villeurbanne)

188 Effects of Expanded Hemodialysis Therapy on Clinical Outcomes
Mitra, S.; Kharbanda, K. (Manchester)

200 Author Index

201 Subject Index
Introduction

The field of hemodialysis is continuously evolving and this book is a real proof that evolution never stops. Innovation in dialysis is mostly driven by unmet clinical needs and the desire to improve the care of end-stage kidney disease patients. In the history of hemodialysis, we moved through different steps, each one representing a specific challenge. At the beginning, feasibility and reliability were the main objectives for a new blood cleansing modality called hemodialysis. Subsequently, the reliability of machines and equipment represented an important challenge. The possibility to treat all patients who required dialysis, and make with this treatment a real rehabilitation was the next step. With the adoption of a reliable and safe dialysis therapy, the next level of requirement was to increase efficiency and at the same time to improve tolerance. The technological innovation followed these pathways creating new gadgets and new devices for an improved management of the dialysis treatment. In parallel with these advances, dialysis membranes have evolved significantly, allowing new therapies, such as high-flux dialysis and hemodiafiltration. The new convective therapies have partially contributed to an improvement of clinical outcomes in dialysis. Nevertheless, the cardiovascular and general outcomes in dialysis remain unsatisfactory with high rate of hospitalization, complications, and mortality among end-stage kidney disease patients. These in part can be attributed to the current unmet clinical needs and have been correlated with the accumulation of middle-to-high molecular weight uremia retention molecules. To overcome such complications, new membranes with improved performances have been developed. High-flux membranes allow improved middle molecule removal including β-2 microglobulin, but this seems to be insufficient. Further advances in technology allowed better control over the structure and permeability of membranes. Different polymers and improved spinning modalities led to significant advances in solute removal and hemocompatibility. Inner surface modification produced a reduction in membrane thrombogenicity and protein-membrane interaction with less tendency to fouling and permeability decay. Further evolution in tech-
nology led to the development of a new class of membranes, referred to as protein-leaking membranes or high cut-off membranes. These membranes are more permeable than conventional high-flux membranes and allow some passage of larger proteins, including albumin. The rationale for these membranes is the need for increased clearance of low molecular weight proteins and protein-bound solutes. Protein-leaking membranes, however, present the limitation of albumin loss whose effect in patients is still controversial. The last evolution in the field of membranes is the development of innovative high retention onset (HRO) membranes due to the peculiar high sieving value in the middle to high molecular weight range. The introduction of HRO membranes in the clinical routine has allowed developing a new therapy called “expanded hemodialysis” (HDx), which is the content of the present book. Its simple set-up and application offers the possibility to use it even in patients with suboptimal vascular access or even with an indwelling catheter. The system does not require a particular hardware or unusual nursing skill. The quality of dialysis fluid is, however, mandatory to ensure a safe conduction of the dialysis session. This new therapy is likely to modify the outcome of end-stage kidney disease patients thanks to the enhanced removal of molecules traditionally retained by current dialysis techniques.

The aim of this book is to present to the reader a compendium of information that moves from the initial section of solute and water mass transfer across dialysis membranes, to an overarching chapter on dialysis membranes in general. The new multidimensional classification is presented, offering the possibility to consider dialysis membranes from different points of view and using different reference parameters.

In the following section, a complete reappraisal of the current status of clinical conditions in patients with end-stage kidney disease is proposed leading to the description of major unmet clinical needs. Among them, the high cardiovascular morbidity, the malnutrition-inflammation-anemia syndrome, the osteo-metabolic and nutritional disorders are clearly outlined.

A complete analysis of the molecules involved in significant complications and in metabolic disorders due to the inability of current dialysis techniques to effectively remove them is also presented.

A detailed description of the new HRO membrane called Theranova is provided in conjunction with other 2 chapters describing the kinetics of transport of larger molecules inside new dialyzers equipped with this membrane in a new form of therapy called “HDx.” The description of a new prescription modality for this new therapy follows.

Finally, a compendium of clinical results achieved so far with such innovative therapy is provided leading to the discussion on new and more effective clinical
studies to provide the required evidence in support of the clinical and biochemical hypothesis that HDx could solve part of the current unmet clinical needs.

The book is a mixture of consolidated information and fascinating new hypotheses. The book is strongly advised for all physicians who are taking care of dialysis patients, and every day seek for new options and improved care solutions. The book is also a nice tool for students and fellows to incorporate important information and to plan new experiments and new clinical trials on the innovative dialysis technique called HDx, made possible by the advanced HRO membrane and Theranova hemodialyzers.

It is an honor for me to edit and coordinate this book as an important educational tool, and I would like to thank Karger Publishers for the timely publication and the outstanding editing and production quality.

Finally yet importantly, I would like to thank all contributors whose time schedule has been forced due to short production times. Their understanding and dedication have been incredible. They have been forced to work in very short notice devolving their time and commitment to this incredible endeavor.

To everybody goes my sincere appreciation, hoping that the final product of this combined effort encounters the approval and the interest of the scientific community.

Claudio Ronco, Vicenza