Clinical Applications of Biofeedback Systems in Hemodialysis

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CHAPTER OUTLINES

- Introduction.
- Dialysis hypotension.
- Biofeedback apparatus
- Conclusions and future directions

CHAPTER OBJECTIVES

- Basic understanding of the pathophysiology of dialysis hypotension.
- Knowledge of functioning, clinical results and limitations of currently available biofeedback systems for hemodialysis.

KEY TERMS

- Hemodialysis.
- Dialysis hypotension.
- Blood volume.
- Blood pressure.
- Ultrafiltration.
- Dialysate sodium concentration.
- Biofeedback systems.
- Dialysate temperature.

ABSTRACT

Despite the tremendous progress in hemodialysis technology over the past decades, hemodynamic instability during hemodialysis is still a frequent complication. This is caused by the fact that in most patients large amounts of fluid are being removed over a short period of time, in combination with an increasingly higher proportion of (elderly) patients with significant cardiovascular co-morbidity. In recent years various closed-loop techniques have been developed to prevent hemodynamic instability during hemodialysis. These techniques differ with respect to the input and output parameters but have in common that they are based on current concepts of the pathophysiology of dialysis hypotension. In this chapter we will outline the pathophysiology of dialysis hypotension and discuss the various closed-loop techniques for hemodialysis that are currently available.
21.1 INTRODUCTION

In 1943 the first human hemodialysis (HD) treatment was performed by Willem J. Kolff in Kampen, the Netherlands (Kolff 1946). In the early years, HD was only feasible as a short-term life-saving procedure for patients with acute renal failure pending recovery of renal function. In the following decades, HD also evolved as a life-sustaining long-term therapy for patients with chronic renal failure (Kloppenburg 2002) (see Fig. 21.1).

The major goals of HD treatment are the regulation of the extracellular volume by the removal of excess fluid and sodium and the clearance of uremic waste products. The removal of a large volume of fluid (usually 2 to 4 liters per session) and solutes over a short period of time (usually 3 to 5 hours) is not physiological and has a major impact on the cardiovascular system. Moreover, the HD procedure induces a bioincompatibility reaction as a result of the interaction between the blood and the material of blood lines and dialyser (Grooteman and Nubé 1998; Friedrich et al. 2006). The resulting systemic inflammatory reaction can cause symptoms such as fever and can negatively affect organ function (Mårtensson et al. 1990; van Teijlingen et al. 2003).

![Fig. 21.1](image-url) Evolution in dialysis techniques over time

Progress in HD equipment, dialysate composition (bicarbonate), and dialysis access, as well as the development of more biocompatible blood lines and dialysers, has helped enormously in improving the tolerance to HD since the early days of dialysis. Nevertheless, hemodynamic instability is still one of the most frequent complications occurring during the HD procedure. This is largely explained by the change in the characteristics of the dialysis population over time. In the past decades the proportion of