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Artificial Kidney: Status of the Art and New Perspectives

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ABSTRACT

Extracorporeal dialysis was first performed in 1943 and has become a routine for End Stage Renal Patients from the early sixties. In the last 30 years researchers have focused on biocompatibility of artificial materials and optimisation of removal of uremic toxins by the membrane as in the long term treatment many complications like amylodosis heart and bone lesions, accelerated amyloidosis and immune system failure can occur. From this point of view high flux dialytic membranes are currently considered more biocompatible therefore being able to prevent such diseases.

Key Words: Dialysis; Biocompatibility; High flux membranes; Accelerated atherosclerosis; Cytokines.

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Dialysis by artificial kidneys is an extracorporeal technique of depuration, performed by means of solute and water exchange between blood and a polysaline solution, the dialytic fluid, separated by a semipermeable pore membrane, the dialytic membrane. This membrane is contained within the dialytic filtre, the functional unit of the artificial kidney. In 1943, Willelm Kholff performed the first extracorporeal hemodialysis session in one patient affected with obstructive nephropathy. The first successful results of hemodialysis were achieved in patients suffering from Acute Renal Failure but, owing to the need of surgical preparation of an arterial vessel for every dialytic session, uremic patients requiring a continuative treatment were barred from this kind of therapy. In 1962, Brescia and Cimino performed the first arterovenous anastomosis between the radial artery and the cephalic vein, which, after arterialization, allowed the connection between the patient and the extracorporeal circuit. Since then, artificial kidney could be systematically used for treating patients suffering from End Stage Renal Disease (ESRD). In 1997, according to the United States Data System, more than 200000 patients were undergoing dialytic treatment. ESRD main causes in the USA in 1997 were diabetes mellitus (35%), nephroangiosclerosis (30%) and glomerulonephritis (14%). Artificial replacement therapy makes it possible in a cyclic (Hemodialysis, Hemofiltration and Hemodiafiltration) or continuous way (Continuous Artero Venous Hemofiltration, Continuous Veno-Venous Hemofiltration) to decrease uremic toxins blood concentration, to control hydroelectrolytic balance, to correct acid-base balance alterations. Anyway, there are some disadvantages linked to the use of artificial kidney: Only partial removal of uremic toxins; bioincompatibility of artificial materials; impossible replacement of renal endocrine functions. First of all, dialytic treatment is not able to remove adequately high weightened molecules, such as β2-michroglobulin, parathormone and AGEs. Furthermore, the contact between blood and dialytic membrane and between blood and dialytic fluid gives origin to bioincompatibility phenomenons, like platelet and coagulative activation and the release of growing factors, activation of leucocytes and monocytes and activation of the complement and kynines systems. Therefore, owing to these biological reactions, during a single dialytic session clinical events could happen, such as: iperthermia due to cytokine release, transitory hypoxia due to leucocytes withdrawal in the lung, hypotension due to eccessive activation of kinines, vascular access thrombosis or extracorporeal circuit clotting. In the long period, the effects of the insufficient depuration and of the bioincompatibility of the treatment can lead to complications, such as systemic amyloidosis, heart and bones alterations, accelerated atherosclerosis, immune system failure. This is the main reason for the actual trend to use high-flux dialytic techniques and more biocompatible dialytic membranes.