Artificial Organs for Metabolic Support.
The most challenging problems in severe kidney injury when dialysis is necessary.
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Abstract
This paper refers to one of three lectures scheduled for the European Society for Artificial Organs (ESAO) mini-symposium that took place during the IEEE Congress 2013.

Introduction
Chronic kidney disease is a progressive problem that includes more than 2 million dialysis patients worldwide. Hemodialysis is the most common treatment modality while peritoneal dialysis is less common. The first human hemodialysis was performed by Haas in 1934. Another pioneer in this field was Willem Kolff, who in 1940 successfully achieved the first recovery of an acute renal failure patient treated with hemodialysis, opening in clinical practice artificial renal substitution therapy.

The major developments over the past four decades related to improvements in membrane biocompatibility and dialyzer design, volumetric control, sophisticated monitoring systems that provide online clearances, isothermal dialysis, high flux membranes and convective modalities such as hemodiafiltration and hemodiafiltration, leading to significant improvement of the overall mortality rates of hemodialysis (HD).

Despite this fact the total life expectancy of an individual with end stage renal disease (ESRD) is only one-fourth to one-fifth that of the general population. This difference in survival can be attributed to the higher rates of cardiovascular and infectious complications associated with ESRD.

The most challenging problems in severe kidney injury when dialysis is necessary
This presentation focused on various topics that concern about the optimization of artificial organs for metabolic support for kidney impairment that result in uremia including multi organ failure. Uremic toxins are substances that retain in the body during severe kidney disease. Defined are a growing number of more than 140 substances that are divided into small water soluble, middle molecule size and protein bound solutions. The latter are only to a limited extent removed from the body by conventional hemodialysis (1-3). The removal of protein bound toxins is difficult to predict using conventional hemodialysis techniques (4). Other options that could be considered especially for protein bound solutions is using adsorption devices. The development of adsorption devices that are added to basic dialysis is such option (5). Under way are also developed combined matrix membranes (6).

In hemodialysis the metabolic energy recovery by the lipoprotein lipase is disturbed during each regular dialysis session using conventional anticoagulation. The dysfunction lasts up to 7 hours and results in disturbance to degrade triglycerides (7). This part of the session will deal with the pathophysiology and clinical options to try to reduce the disadvantage. Is there a difference in the LPL baseline function in hemodialysis versus peritoneal dialysis? Does the LPL system get exhausted over time in hemodialysis? What other option for dialysis could be considered to avoid such ‘metabolic starvation’?

A problem arises during hemodialysis when microbubbles of air are dispersed into the tubing system (8-15). Where do they develop? What happens with them? Are they eliminated by the tubing system? Can the extent be reduced? Is it harmful? What about inter dialytic weight gain (IDWG) between hemodialyses. Is it harmful to retain water between dialyses or to remove the water by the dialysis process? Is IDWG a potential risk factor? Report from a prospective study indicates that IDWG constitutes an important risk (16, 17) that adds on to the risk of intensive removal of fluid (18). By using more sophisticated dialysis devices the removal of fluid can be performed more smoothly (19). Multi organ failure including acute kidney injury. Death by other reasons that uremia is the main obstacle for kidney survival. What are the therapeutic options using artificial organ support? The use of various approaches of apheresis was reported (20).

References