

"Symbiotic" Hemofiltration: New System for Chronic Renal Failure Compensation

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Abstract

Widely used nowadays hemodialysis and hemofiltration cannot replace completely the excretory function of human kidneys in natural conditions of physiological regulation. Healthy human kidneys are capable to purify patient's blood from uremic substances better than any artificial device with no doubt. Previously, we proposed a "method of "symbiotic" compensation of chronic renal failure (CRF) in humans", based on the use of healthy human kidneys natural physiological function to purge patient's blood plasma from waste substances subjected to be excreted. In the method, the clearance of blood plasma from metabolites in CRF patients is based on the temporary association of healthy human and patient's circulations. The disadvantage of this method is to mix the blood of a patient and a healthy person. Therefore, this method has certain limitations associated with the necessity of a careful partner's selection with the absolute blood type compatibility.

The aim of our study is to develop and create a new method and apparatus for CRF patients "symbiotic" compensation, based on hemofiltration and healthy humans kidneys natural physiological functions, excluding mixing of partners blood. Method of "symbiotic" hemofiltration is based on mutual exchange of equivalent blood ultrafiltrate volumes between healthy person and CRF patient, needed to be purified from metabolites. During exchange procedure patient's and a healthy person's circulations are separated by hemofilters excluding blood mixing. During CRF patient's blood clearance from metabolic products separate hemofiltration of healthy donor and CRF patient in equal volumes is processed.

Patient's blood ultrafiltrate enters the bloodstream of a healthy person, as a healthy person ultrafiltrate in the same extent (volume) enters the bloodstream of CRF patient. At the same time remaining after filtration blood components of donor and patient are returned in their bloodstream respectively. Fundamentally important advantage of "symbiotic" hemofiltration is that CRF patient's blood is purged from uremic metabolites due to healthy human kidneys natural physiological functions. "Symbiotic" hemofiltration is a highly effective physiological method of CRF patient's blood purification from the uremic substances.

Keywords: Hemofiltration; Kidney; Chronic renal failure

Introduction

Clinically proved methods of chronic renal failure (CRF) compensation based on hemodialysis, hemofiltration, kidney transplantation are widely used in medical practice, but they are sometimes (15-25%) complicated by possible water and electrolyte disbalance in cronicly treated patients [1-5]. Well known nowadays techniques of hemodialysis and hemofiltration (Figure 1) cannot replace completely renal excretory function, which carries out all its activities in natural conditions and is regulated physiologically. Method "Symbiotic" hemofiltration Previously we proposed «Method of chronic renal failure (CRF) symbiotic compensation in humans» [6,7] is based on the use of natural physiological function of healthy human kidney for CRF patient's blood purification from waste substances subjected to be excreted. CRF patient's blood purification from excessive metabolites is based on the periodic temporary association of a healthy person's and CRF patient's circulations. This method has certain limitations associated with the necessity of a careful selection of partners (donor and recipient) with an-absolute blood compatibility.

We have developed a completely new method and apparatus for CRF patient "symbiotic" compensation based on hemofiltration and natural physiological functions of healthy human kidneys, but exclude mixing partners circulating blood [8]. "Symbiotic" hemofiltration is based on mutual exchange of equivalent blood ultrafiltrate of healthy person and CRF patient who need blood purification from metabolites. At the same time donors and recipients blood circulatory systems are divided by hemofilter and therefore there is no blood mixing of the

patient and healthy person. During CRF patient's blood purification from metabolic products separated hemofiltration of the patient's and a healthy person's blood plasma takes place in equal volumes. In this case the patient's blood ultrafiltrate flows into the bloodstream of a healthy person, and also the blood ultrafiltrate from a healthy person in the same extent enters the CRF patient's circulation. Remaining (after hemofiltration) patient's and healthy donor's blood components (formed blood elements) are returning simultaneously in their bloods circulations respectively (Figure 2).

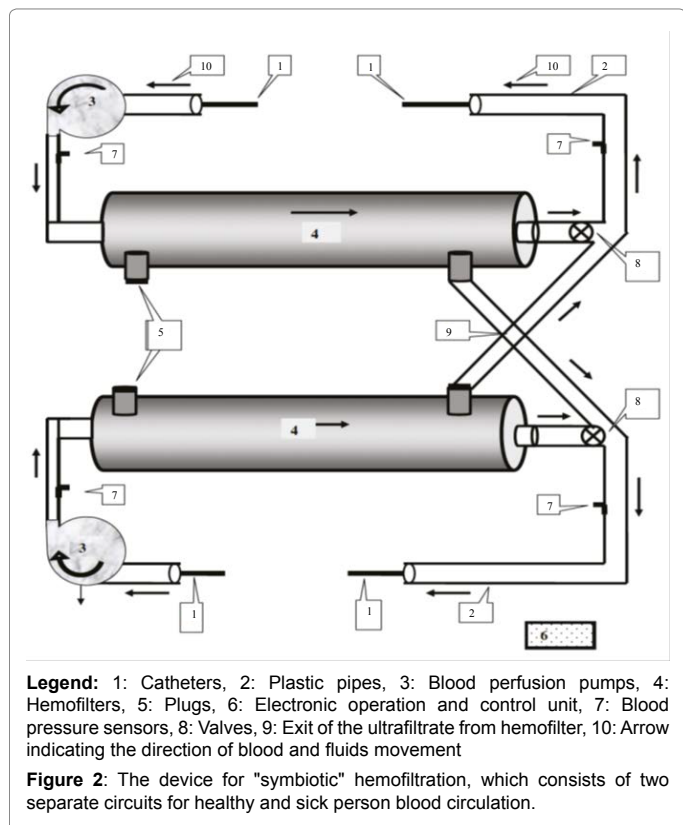
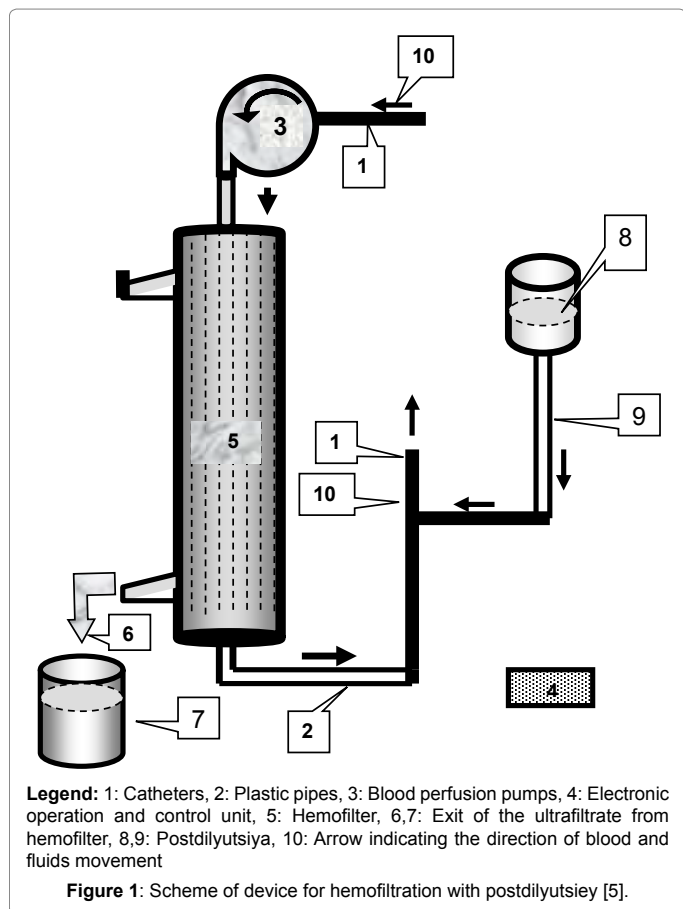
The hardware complex for "symbiotic" hemofiltration includes: blood pumps, which are used in hemodiafiltration [9], hemofilters [10], the electronic operation and control unit, pressure sensors, plastic catheter tube. Currently, many well-known companies produce hemofilters with different characteristics [11]. Filtration characteristics of hemofilter membranes related to «high-flux» droop are very close

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to the parameters of glomerular filtration rate of a healthy person's kidneys. Mentioned hemodiafilters are designed for high-volume hemodiafiltration (HDF) with maximum pressure of 500 mm Hg and replacement volume of more than 15 L per 1 procedure. Based on the manufacturer's data, it is possible to define the hemofilter's functional capacities and to choose the best hemofilter for procedures of "symbiotic" hemofiltration.

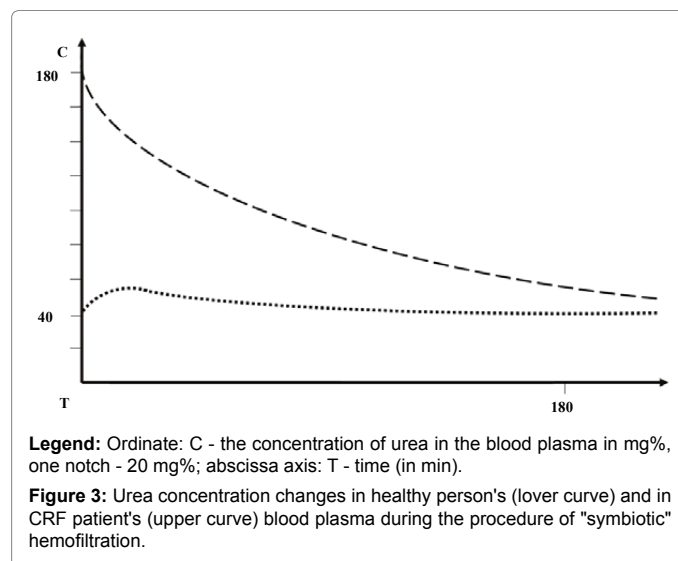
Calculated data for blood plasma clearance from urea and creatinine show high efficiency of "symbiotic" hemofiltration. Figure 3 shows calculated in model dynamics of urea concentrations changes in the blood of CRF patient and healthy person during a "symbiotic" hemofiltration. At the initial period of "symbiotic" hemofiltration procedure the concentration of uremic substances in healthy human blood, due to the receipt of metabolites from the patient's blood slightly increases. Kidneys of a healthy person will «respond» by increasing of their functional capacities to remove excessive wastes. With the increase of uremic metabolites in healthy person's blood plasma due to more intense glomerular clearance their concentrations will increase in primary urine and there will be an increase of their excretion with the final urine. Subsequently, fewer all uremic substances enter into healthy person's blood due to lowering of their concentration in CRF patient's blood (Figure 3).

Entering into healthy person's blood of patient's urea and other nitrogenous metabolic products will not lead to an increase in their content in blood plasma and the procedure of partners filtered blood plasma interchange does not cause any complications in healthy person. Applied result of "symbiotic" blood plasma clearance is to reduce the level of nitrogen-containing metabolites in CRF patient's blood plasma due to more intensive physiological function of healthy partner's kidneys.

Advantages of "Symbiotic" Hemofiltration Over Hemodialysis and Hemofiltration

Fundamentally important advantage of "symbiotic" hemofiltration is that the CRF patient's blood plasma clearance from uremic metabolites is produced due to the natural physiological functions of healthy human kidneys.

1. The method is more physiological than hemodiafiltration. As a



result of continuous mutual hemofiltration procedure kidneys of healthy person effectively purify CRF patient's blood plasma from uremic substances.

2. The method is less expensive, does not require expensive equipment and complex schemes of hemofiltration. There is no need to prepare and obtain a special dialysis fluid, in performing of pre-dilution and post-dilution (common practice in hemodialysis).
3. In contrast to hemofiltration, whereby it is difficult to provide an equivalent ultra-filtrate volume replacement, the method of "symbiotic" hemofiltration provides equal "cross-" ultra-filtrate exchange that maintains a constant circulating blood volume in partner's circulation.
4. Due to the natural physiological function of healthy person's kidneys, used as a basis for patient's blood plasma clearance, the potential for complications development arising from hemodiafiltration, such as acid-base disbalance, dehydration and so forth, is reduced.

Thus, "Symbiotic" hemofiltration is highly effective method of CRF patient's blood plasma physiological purification from uremic metabolites. Nevertheless each patient and doctor has a choice- what to prefer under specific clinical settings and individual patient's comorbidities and conditions: hemodiafiltration or "symbiotic"

hemofiltration for blood plasma purging from metabolites in case of decompensated chronic renal failure.

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