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(54) **A method and a device for determining the dry weight of a patient with kidney failure**

Verfahren und Gerät zur Bestimmung des Trockengewichts eines Patienten mit Nierenversagen

Procédé et appareil pour déterminer le poids sec d'un patient avec défaillance rénale

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(74) Representative: **Laufhütte, Dieter, Dr.-Ing.**
Lorenz-Seidler-Gossel
Widenmayerstrasse 23
80538 München (DE)

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(73) Proprietor: **Fresenius Medical Care Deutschland**
GmbH
61352 Bad Homburg v.d.H. (DE)

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(72) Inventor: **Chamney, Paul, Dr.**
St. Albans, Herts, AL1 2HS (GB)

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Description

[0001] The invention relates to a method and a device for monitoring the fluid status of a patient according to claims 1 and 12, respectively.

[0002] The kidneys carry out several functions for maintaining the health of a human body. First, they control the fluid balance by separating any excess fluid from the patient's blood volume. Second, they serve to purify the blood from any waste substances like urea or creatinine. Last not least they also control the levels of certain substances in the blood like electrolytes in order to ensure a healthy and necessary concentration level.

[0003] In case of renal failure all forms of ingested fluid accumulate in body tissues causing increased stress on the circulatory system. This surplus fluid has to be removed during a dialysis treatment by ultrafiltration of the blood. If insufficient fluid is removed the long term consequences can be severe, leading to high blood pressure and cardiac failure. Cardiac failure itself is many times more likely to occur in dialysis patients and it is thought that states of fluid overload are one of the major contributing factors. Removal of too much fluid is also dangerous since the dialysis patient becomes dehydrated and this invariably leads to hypotension.

[0004] The dry weight defines the weight of a patient that would be achieved if the kidneys were working normally. In other words this represents the optimal target weight (or fluid status) which should be achieved in order to minimise cardiovascular risk. Dry weight has always been an elusive problem in routine clinical practise due to lack of quantitative methods for its assessment. Currently the dry weight problem is approached using indirect indicators e.g. blood pressure, echocardiographic investigations and subjective information such as X-rays. Furthermore it has been particularly difficult to define a set of conditions which are universally accepted as the dry weight standard.

[0005] A promising method to derive the fluid status of a patient involves the use of bioimpedance measurements. A small alternating current is applied to two or more electrodes which are attached to a patient and the corresponding potential drop is measured. The various fluid compartments of a human body contribute differently to the measured signals. The use of multiple frequencies allows the intracellular water (ICV) and extracellular water (ECV) volumes to be determined. An example of such a device is described in the international patent application WO 92/19153. However, this document discloses no method regarding how the dry weight of the particular patient can be derived.

[0006] Hence there is a need for a non-invasive, accurate and easy to use method for dry weight assessment. This method would be of major benefit to the management of dialysis patients and could significantly reduce hospitalisation costs in the long term. It is hence an object of this invention to provide such a method.

[0007] According to the invention this problem is solved by a method for determining the dry weight $Wgt_{dry}(t)$ of a patient at a time t comprising the steps of determining the extracellular water volume $ECV(t)$ of the patient at the time t , of determining the weight $Wgt(t)$ of the patient at the time t and of deriving the dry weight $Wgt_{dry}(t)$ of the patient as an intersection of a function derived from the determined $ECV(t)$ and $Wgt(t)$ values with a previously established extracellular water volume (ECV) against dry weight (Wgt_{dry}) reference relation representing healthy subjects.

[0008] The inventive method is based on the observation that by looking at the ECV and the weight of a patient both values should approach the ECV and dry weight values of healthy subjects the longer a patient is being treated by renal replacement therapy, i.e. dialysis. Successive measurements therefore directly pinpoint to the intersection with the previously established ECV against Wgt_{dry} reference relation and thus to the dry weight of the patient being treated. In fact it has turned out that a first estimate can be obtained from a single reading for the $ECV(t)$ and $Wgt(t)$ values by deriving a function, most notably a straight line, which can directly be defined by the $ECV(t)$ and $Wgt(t)$ values. The intersection of this function with the ECV against Wgt_{dry} reference relation for healthy subjects can then easily be calculated and thus the dry weight $Wgt_{dry}(t)$ of the patient be derived.

[0009] In a preferred embodiment of the invention $ECV(t)$ is derived by a bioimpedance measurement. The bioimpedance measurement may be a whole body or a segmental measurement.

[0010] In an embodiment of the invention which is particularly easy to apply, the intersection of the function derived from the determined $ECV(t)$ and $Wgt(t)$ values with the previously established ECV against Wgt_{dry} reference relation is determined by using the expression

$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} \quad (1),$$

wherein α_e and β_e are empirically determined coefficients. The coefficient α_e represents the slope of a previously established ECV against Wgt_{dry} reference line, and β_e is the slope of a straight line through the $Wgt(t)/ECV(t)$ data pair.

[0011] An even more advantageous embodiment of the invention involves the storage of several $ECV(t_i)$ and $Wgt(t_i)$ values at times t_i , $i=1\dots j$, preferably between subsequent dialysis treatments. A more accurate estimate of the dry weight $Wgt_{dry}(t_j)$ is thus derived by a linear regression analysis.

[0012] A more refined embodiment of the invention determines a fat mass correction $\Delta f(t)$ in order to take into account

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a variable fat mass for each patient. This fat mass correction $\Delta f(t)$ enables a more accurate comparison with the previously established ECV against Wgt_{dry} reference relation representing healthy subjects which should have been derived from fat mass corrected data as well in order to represent some kind of average fat mass contribution to the dry body weight Wgt_{dry} .

[0013] In a preferred embodiment of the invention the dry body weight $Wgt_{dry}(t)$ is derived by employing a correction term to equation (1) which is dependent on $\Delta f(t)$:

$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} - \frac{\alpha_e \cdot \Delta f(t)}{\beta_e - \alpha_e} \quad (2).$$

The fat mass correction $\Delta f(t)$ is preferably derived with the help of a measurement of the intracellular water volume ICV(t) of the patient at the time t. As indicated above the ICV(t) and ECV(t) values can be determined simultaneously by the same measurement process.

[0014] In a further mode of the invention the fat mass correction $\Delta f(t)$ is determined from the ICV(t) and ECV(t) values according to equation (3):

$$\Delta f(t) = Wgt(t) - \frac{(1 - \rho_e \cdot \alpha_e - \rho_i \cdot \alpha_i) \cdot ICV(t)}{\alpha_i} - \rho_i \cdot ICV(t) - \rho_e \cdot ECV(t) \quad (3),$$

where α_i is a further empirical coefficient, and ρ_e and ρ_i are the densities of the ECV and the ICV compartments, respectively (≈ 1 kg/litre).

[0015] It is also an object of the invention to provide a device for a non-invasive, accurate and easy to use dry weight assessment. The invention therefore also concerns a device comprising a microprocessor unit which in turn comprises a microprocessor program storage unit, an input unit to enable the values of ECV(t) and $Wgt(t)$ to be entered into the device, and a computer storage unit for storing the ECV(t) and $Wgt(t)$ values, wherein the microprocessor program storage unit comprises a program for deriving the dry weight $Wgt_{dry}(t)$ from an intersection of a function derived from the stored ECV(t) and $Wgt(t)$ values with a previously established ECV against Wgt_{dry} reference relation representing healthy subjects.

[0016] In a preferred embodiment of the invention the device further comprises means for determining the ECV(t) value and/or the $Wgt(t)$ value. The means for determining the ECV(t) value may be a bioimpedance device, applied in a whole body or segmental measurement mode.

[0017] The input unit may be a manual user interface such as a keyboard in order to enable the input of the ECV(t) and $Wgt(t)$ values. In a particularly convenient embodiment the means for determining the ECV(t) value and/or the means for determining the $Wgt(t)$ value are directly linked to the input unit which contains a corresponding interface in this case. The manual input of these values is then no longer necessary.

[0018] In further embodiments of the invention the program in the microprocessor storage unit employs equation (1) or a linear regression analysis as outlined above in order to derive the dry weight $Wgt_{dry}(t)$.

[0019] A further improved mode of the device according to the invention makes use of a fat mass correction $\Delta f(t)$ as described in equation (2). For the determination of $\Delta f(t)$ the device may also comprise means for determining the ICV(t) value, preferably a bioimpedance device which simultaneously measures the ECV(t) and ICV(t) values. In this device the input unit also enables entering the ICV(t) value and the computer storage unit is able to store the ICV(t) value. The program for deriving the dry body weight $Wgt_{dry}(t)$ is then determining the fat mass correction $\Delta f(t)$ by using this ICV(t) value. For this purpose equation (3) may be implemented in the program.

[0020] For an improved understanding of the invention an embodiment will be described purely by way of a non-restrictive example with reference to the appended drawings in which

Figure 1 shows an illustration of typical body composition ratios of the human body;

Figure 2 schematically shows an embodiment of a device for determining the dry weight of a patient according to the invention;

Figure 3a shows a bioimpedance electrode arrangement for whole body bioimpedance measurements;

Figure 3b shows a bioimpedance electrode arrangement for segmental body bioimpedance measurements;

Figure 4 shows an illustration of a bioimpedance measurement for determining the ECV and/or ICV contributions;

Figure 5a shows an ECV against weight diagram graphically illustrating the finding of the dry weight $Wgt_{dry}(t)$ according to the invention;

Figure 5b shows an ECV against weight diagram with subsequent $Wgt(t_i)/ECV(t_i)$ measurements for a dialysis patient (triangles) with a straight line obtained by regression analysis and the corresponding finding of the dry weight $Wgt_{dry}(t)$ according to the invention; and

Figure 6 shows an ECV against weight diagram graphically illustrating the influence of a fat mass correction term $\Delta f(t)$.

[0021] The composition of the human body can be described by a number of compartments which may be expressed as typical fractions of the total body weight as indicated in Figure 1. In patients with kidney failure the ECV becomes expanded due to the ingestion of water. Other compartments are thought to be largely unaffected by changes in a patient's fluid status. Consequently measurement of the ECV is clearly a useful parameter which could help with dry weight management.

[0022] In order to support normal homeostasis a minimum ECV must be required for a given weight. Hence to a good approximation ECV is linearly proportional to weight and may be determined via prediction formulae. According to Guyton physiology (A.C. Guyton: Textbook of Medical Physiology, W.B. Saunders Company, 1991) there is approximately 15 litres of ECV for a weight of 70 kg for a healthy subject with normal fluid and nutrition status. New investigations on healthy subjects revealed the following reference relation between measured ECV_m and measured Wgt_{dry} :

$$ECV_m + ECV_{offset} = \alpha_e \cdot Wgt_{dry} \quad (4),$$

with $\alpha_e = 0,2146$ litres/kg and $ECV_{offset} = -0,93$ litres. The value for α_e expressed as a ratio is $15,002/70$. This is very close to the relationship given by Guyton physiology. The offset ECV_{offset} has been proven to improve the accuracy. As all body compartments shown in Figure 2 should be proportional to Wgt_{dry} it is useful to rewrite equation (4) with a corrected $ECV = ECV_m + ECV_{offset}$. Equation (4a) which is thus obtained represents a straight line passing the origin in a ECV against Wgt_{dry} diagram:

$$ECV = \alpha_e \cdot Wgt_{dry} \quad (4a).$$

[0023] The invention is based on the observation that dialysis patients have an expanded ECV and that therefore the measured ECV must be higher for a given weight than for healthy subjects. If the weight of a fluid overloaded dialysis patient is reduced over many treatments by removal of fluid then the measured ECV should fall, too. Eventually the ECV of the dialysis patient should converge to or close to that of a healthy subject with no renal failure.

[0024] An embodiment of a device for determining the dry weight Wgt_{dry} of a patient according to the invention is shown in Figure 2. The device 10 comprises a microprocessor unit 1 which in turn comprises a microprocessor program storage unit 1a. By means of a link 4 the microprocessor unit 1 is connected to an input unit 2 and a computer storage unit 3. A program for deriving the dry weight $Wgt_{dry}(t)$ of a patient at a time t is stored in the microprocessor program storage unit 1a.

[0025] According to the invention the dry weight $Wgt_{dry}(t)$ is derived as follows: The extracellular water volume ECV (t) of the patient at the time t is determined and entered into the input unit 2 which passes the value to the computer storage unit 3 where it is stored. If equation (4b) is used as reference line, the offset ECV_{offset} as outlined in equation (4) has to be added by the microprocessor program to $ECV(t)$ before the value is stored in order to have comparable data. If equation (4) is used this offset correction is not necessary.

[0026] The weight $Wgt(t)$ of the patient at the time t is also determined and processed similarly. The program for deriving the dry weight $Wgt_{dry}(t)$ is capable of calculating an intersection between a function derived from the stored $ECV(t)$ and $Wgt(t)$ values and the previously established ECV against Wgt_{dry} reference line representing healthy subjects according to equation (4) or (4a), respectively. The function derived from the stored $ECV(t)$ and $Wgt(t)$ values reflects the fact that these values can only change in a particular manner in the predicted progress of dialysis therapy.

[0027] To determine the $ECV(t)$ value means 5 are provided which are connected to the input unit 2 by a link 6. The means 5 is a bioimpedance measurement device. For the bioimpedance measurement various electrode arrangements are possible. In Figure 2 only two electrode elements 5a and 5b are attached to the bioimpedance measurement device 5. Each of the electrode units 5a and 5b consists of a current injection electrode and a potential pick up electrode (not shown). By applying the two electrode units 5a and 5b to the wrist and the ankle of a patient, respectively, as outlined

in Figure 3a, the whole body impedance may be determined. Under this electrode configuration the body is assumed to be a homogenous cylinder. However by use of electrodes on limbs, segmental sections of the body may be isolated allowing localised volume measurements. This has the advantage that localised volume measurements are possible and an improved accuracy in the determination of the whole body fluid status may be achieved. Such a configuration is displayed in Figure 3b. Additional electrode units 5a' and 5b' are attached close to the corresponding shoulder and the hip of the patient enabling a segmental approach to the body elements leg, arm and trunk.

[0028] The ECV(t) value is determined by exploiting the fact that the electrical impedance of body tissue changes as currents of different alternating frequencies are applied to the patient via the electrodes. At low frequencies the cells behave as insulators and the applied current passes only through the ECV spaces. At high frequencies the cells become conductive and thus current passes through both the ICV and ECV spaces. This is illustrated in Figure 4. Measurement of the impedance over at least two frequencies, better over a range of frequencies, allows an impedance locus to be constructed from which the resistance of the ICV and ECV components may be determined. Hence the volumes of the respective compartments can then be calculated from the resistance information, based on compartment resistivity constants available from prior studies for which the volumes were also determined by dilution measurements.

[0029] A bioimpedance device performing such calculations is distributed by Xitron Technologies under the trademark Hydra™. Details about this device are disclosed in the international patent application WO 92/19153.

[0030] An advantage of a first mode of the invention is that only ECV values need to be determined. Therefore only measurements at frequencies being low enough are necessary which have negligible contributions from the ICV compartment. Due to this fact the ECV values can be determined much more accurately than the ICV values for which frequencies are necessary which always lead to contributions from both compartments.

[0031] Other methods proposed in the art address the fluid status of a patient by involving the ICV compartment as well, like analyzing ratios of the kind $ECV/(ECV+ICV)$ or ECV/ICV . Since there is always a discussion how well the impedance locus represents the different compartments such approaches inherently contain deficiencies which are avoided by the claimed invention as no simultaneous analysis of the two compartments remains necessary. (In fact the ICV value may instead be used for a second order correction as will be described below.)

[0032] Returning to the embodiment shown in Figure 2, means 7 are also provided for determining the weight $Wgt(t)$ of the patient which are connected to the input unit 2 by a link 8. The means 7 consist of a scales device which are well known in the art.

[0033] In the embodiment shown in Figure 2 the input unit 2 contains an interface by which the values for ECV(t) and $Wgt(t)$ are directly transferred via the link 4 to the computer storage unit 3. It may also be possible that the determined values for ECV(t) and $Wgt(t)$ are manually entered into the input unit 2 by a user.

[0034] The procedure according to which the program stored in the microprocessor program storage unit 1a derives the dry weight $Wgt_{dry}(t)$ is illustrated in Figure 5a: In this figure the reference relation between the ECV and Wgt_{dry} for healthy subjects is given as a straight line with slope α_e according to equation (4) or (4a), respectively.

[0035] A single $Wgt(t)$ and ECV(t) measurement of a dialysis patient is denoted by the offline circle. The program for deriving the dry weight $Wgt_{dry}(t)$ of the dialysis patient is now using equation (1) to derive $Wgt_{dry}(t)$. This equation represents the calculation of the intersection IS of a line through the $Wgt(t)/ECV(t)$ data point with the reference line. This line has the slope β_e . This slope is expected to be close to $1/\rho_e$, i.e. in a first estimate the program uses $\beta_e = 1$ litre/kg. The weight coordinate of the intersection directly gives the sought $Wgt_{dry}(t)$ value.

[0036] Figure 5b shows the ECV(t) and $Wgt(t)$ values for a single patient between several subsequent dialysis treatments (triangles), the measurements being made directly before the beginning of a dialysis treatment (pre-dialysis). By successive reduction in post dialysis weight the $Wgt(t)/ECV(t)$ measurement pairs shift increasingly closer to the values predicted for a healthy subject indicating a progressive improvement in the fluid status of the patient. To improve the accuracy of the calculated $Wgt_{dry}(t)$ value a straight line may be fitted to the $Wgt(t)/ECV(t)$ measurement pairs by linear regression analysis. In fact these straight lines turned out to have a slope of approximately 1 litre/1 kg, suggesting that most of the excess fluid accumulated and hence weight gain is really sequestered in the ECV compartment. As in the case of a single measurement pair the intersection IS of the straight line with the ECV against Wgt_{dry} reference for healthy subjects directly identifies the dry weight $Wgt_{dry}(t)$ of the patient. In Figure 5b one obtains a value of $Wgt_{dry}(t) = 81.6$ kg using this method.

[0037] The computer storage unit 3 of the device 10 is hence also able to store $Wgt(t_i)/ECV(t_i)$ data pairs for various times t_i , which are preferably be aquired directly before subsequent dialysis treatments $i=1\dots j$, as represented by the measurements shown in Figure 5b. The program for deriving the dry weight $Wgt_{dry}(t_j)$ at the latest time t_j is then able to retrieve all $Wgt(t_i)/ECV(t_i)$ data pairs from the computer storage unit 3. Depending on the scatter of the data the program performs a linear regression analysis either with the constraint that the slope β_e has a fixed value (e.g. $\beta_e = 1$ litre/kg) or not, or both to offer the user the results of both calculations. Taking an arbitrary Wgt/ECV data pair on the derived straight line function for ECV(t) and $Wgt(t)$ in equation (1), the dry weight $Wgt_{dry}(t_j)$ is determined with the help of equation (1) as well. Further statistical information (e.g., correlation coefficients etc.) as is known in the art of regression analysis may be provided in addition.

[0038] In order to further improve the accuracy of the derived dry weight $Wgt_{dry}(t)$ the program stored in the micro-processor program storage unit 1a has a further section which takes a fat mass correction $\Delta f(t)$ into account. The dry weight $Wgt_{dry}(t)$ is then calculated according to equation (2). The influence of the fat mass correction $\Delta f(t)$ is illustrated by Figure 1: Apart from the ECV and ICV contributions to the total body weight the next most important contribution is attributed to fat mass. Other compartments are an order of magnitude less relevant. For the sake of simplicity, all remaining body mass which is neither ECV nor ICV may be regarded as "the fat mass compartment". The fat mass correction $\Delta f(t)$ originates from this compartment. It is this particular compartment which may vary considerably from subject to subject, for healthy subjects as well as for dialysis patients. This variation will lead to some error in the $Wgt_{dry}(t)$ data if it is not considered. In fact the reference line according to equation (4) has been established by normalizing the weight data in healthy subjects by taking Δf into account.

[0039] Referring to Figure 6 the impact of $\Delta f(t)$ becomes apparent: Taking the reference line of healthy subjects with slope α_e and the middle line of the three lines with slope β_e , one would have the same situation as in Figure 5a. In case the dialysis patient does not have a "normal body fat mass", the weight $Wgt(t)$ of the patient is shifted to the left or to the right by the fat mass correction $\Delta f(t)$, depending on whether the patient has a reduced or an increased body fat mass, respectively. In the latter two cases the intersection IS' and IS" would lead to an inaccurate dry weight $Wgt_{dry}(t)$ value. Instead the dry weight $Wgt_{dry}(t)$ is given by the weight values of the respective circled data points, i.e. an amount e_{DW} has to be added or subtracted from the calculated intersection weight value. This amount e_{DW} is given by the second term in equation (2), by which equation (2) differs from the simplified equation (1).

[0040] In order to derive the fat mass correction $\Delta f(t)$ itself, the program makes use of equation (3). For this purpose the means 5 for determining the ECV(t) value is also a means for determining the ICV(t) value. As has been outlined above there are devices available on the market which measure both values simultaneously.

[0041] Equation (3) is based on the following relations: A relation similar to equations (4) and (4a) can be defined between the ICV and Wgt_{dry} for healthy subjects, i.e.

$$ICV_m + ICV_{offset} = \alpha_i \cdot Wgt_{dry} \quad (5),$$

and

$$ICV = \alpha_i \cdot Wgt_{dry} \quad (5a),$$

where the same comments apply to the offset ICV_{offset} as for the offset ECV_{offset} . A survey has revealed the following values of the coefficients: $\alpha_i = 0,3297$ litres/kg, $ICV_{offset} = 2,63$ litres. Again the slope α_i , - expressed as a ratio: 23,079/70 litres/kg - is not too dissimilar to Guyton physiology (26/70 litres/kg, see Figure 1).

[0042] The values - as in the determination of the values of the coefficients of equation (4) - have been found in an optimization strategy to fit measured weights of healthy subject to a sum of the ECV, the ICV and the fat mass compartments. The latter is in turn divided into an average fat mass and an individual fat mass correction Δf compartment. The volume of the fat mass correction Δf compartment was the only free parameter for a given measured total weight during the optimization calculation which took into account the individuality of the various healthy subjects.

[0043] Furthermore its has been revealed in this study that the ICV volumes do not significantly differ from treatment to treatment for a dialysis patient. In case the patient is neither catabolic or anabolic this volume should even be identical to the ICV volumes of healthy subjects. After having established the coefficients of equation (5) it is therefore possible to divide the total body mass of a dialysis patient into the ICV part which can be determined by the measured ICV(t) value multiplied by the corresponding density ρ_i , into the ECV part which can be determined by the measured ECV(t) value multiplied by the corresponding density ρ_e and which is the sum of a part ECV_N representing the healthy value and a deviation e_{ECV} which accounts for the disturbed fluid balance in a dialysis patient (see Figure 6), the average fat mass contribution and, last not least, the fat mass correction $\Delta f(t)$. The average mass contribution is not a free parameter in the calculation as it can be expressed as dry body weight of average and healthy subjects minus the ICV and ECV contributions of these subjects. The dry body weight of a healthy and average subjects is then substituted by an according arrangement of equation (5a). As a result equation (3) is found where $\Delta f(t)$ remains the only unknown parameter.

[0044] In the derivation of equation (3) the equations (4a) and (5a) were used instead of equations (4) and (5), respectively, i.e. the ECV(t) and ICV(t) values used in equation (3) have to corrected values in view of the offsets ECV_{offset} and ICV_{offset} . For the densities ρ_e and ρ_i the program uses 1 kg/litre as these compartments basically consist of water.

[0045] For patients who just start dialysis therapy show ICV volumes that are slightly increased compared with the

rather steady values found after some dialysis treatments. The outlined procedure to determine the fat mass correction $\Delta f(t)$ is however still a good approximation even in this case.

[0046] Independent of whether a fat mass correction $\Delta f(t)$ is taken into account or not, the result for $Wgt_{dry}(t)$ is finally passed on to an output unit 9 which is a display device and which displays the result to a user. Further intermediate results like the measurement values or the fat mass correction $\Delta f(t)$ might add to the informative character of the display.

[0047] The disclosed device and method according to the invention is hence able to provide for a powerful technique for the management of dry weight. It is obvious that the scope of the claimed invention is not limited to the equation (4) as far as the previously established ECV against Wgt_{dry} reference relation for healthy subjects is concerned. Any other established relation can be used instead.

[0048] Management of any patient is possible, independent of the treatment modality, i.e. the invention is applicable for hemodialysis, hemofiltration, hemodiafiltration or any forms of peritoneal dialysis (all these treatment modalities are summarized throughout this patent application by the terminology "a dialysis treatment"). Furthermore, measurement in virtually any setting would be practical including the home, clinic, dialysis unit, ward or intensive care environment.

Claims

1. A method for determining the dry weight $Wgt_{dry}(t)$ of a patient at a time t comprising the steps of:

determining the extracellular water volume $ECV(t)$ of the patient at the time t ,

determining the weight $Wgt(t)$ of the patient at the time t ,

deriving the dry weight $Wgt_{dry}(t)$ of the patient as an intersection of a function derived from the determined $ECV(t)$ and $Wgt(t)$ values with a previously established extracellular water volume (ECV) against dry weight (Wgt_{dry}) reference relation representing healthy subjects.

2. The method according to claim 1 **characterized in that** $ECV(t)$ is derived from a bioimpedance measurement.

3. The method according to claim 2 **characterized in that** the bioimpedance measurement is a whole body measurement.

4. The method according to claim 2 **characterized in that** the bioimpedance measurement is a segmental measurement.

5. The method according to any of the preceding claims **characterized in that** $Wgt_{dry}(t)$ is determined using the following expression:

$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e},$$

where α_e and β_e are empirically determined coefficients.

6. The method according to any of the preceding claims **characterized in that** the $ECV(t_i)$ and $Wgt(t_i)$ values of a patient at times t_i , $i=1 \dots j$, are stored and that the dry body weight $Wgt_{dry}(t_j)$ is derived by a linear regression analysis.

7. The method according to any of the preceding claims **characterized in that** a fat mass correction $\Delta f(t)$ is determined in order to derive the dry body weight $Wgt_{dry}(t)$ from the determined weight $Wgt(t)$.

8. The method according to claim 7 **characterized in that** the dry weight $Wgt_{dry}(t)$ is derived by the following expression:

$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} - \frac{\alpha_e \cdot \Delta f(t)}{\beta_e - \alpha_e},$$

where α_e and β_e are empirically determined coefficients.

9. The method according to claims 5 or 8 **characterized in that** α_e equals 0,2146 litres/kg and β_e equals 1 litre/kg.
10. The method according to any of the claim 7 to 8 **characterized in that** the intracellular water volume ICV(t) is determined for the patient at the time t and that the determined ICV(t) is used to derive the fat mass correction $\Delta f(t)$.

- 5 11. The method according to claim 10 **characterized in that** the fat mass correction $\Delta f(t)$ is derived by the following expression:

$$10 \quad \Delta f(t) = Wgt(t) - \frac{(1 - \rho_e \cdot \alpha_e - \rho_i \cdot \alpha_i) \cdot ICV(t)}{\alpha_i} - \rho_i \cdot ICV(t) - \rho_e \cdot ECV(t),$$

where ρ_e and ρ_i are the densities of the ECV(t) and ICV(t) volumes, respectively, and α_e is an empirically determined coefficients as in claim 8 and α_i is a further empirically determined coefficient.

- 15 12. A device (10) for carrying out the method according to claim 1 comprising
- a microprocessor unit (1) which in turn comprises a microprocessor program storage unit (1a),
- 20 a input unit (2) to enable entering the values of ECV(t) and Wgt(t),
- a computer storage unit (3) for storing the ECV(t) and Wgt(t) values,
- wherein the microprocessor program storage unit (1a) comprises a program for deriving the dry weight $Wgt_{dry}(t)$ as an intersection (IS) of a function derived from the stored ECV(t) and Wgt(t) values with a previously established ECV against Wgt_{dry} reference relation representing healthy subjects.

- 25 13. The device according to claim 12 **characterized in that** it further comprises means (5) for determining the ECV (t) value.
- 30 14. The device according to claims 12 or 13 **characterized in that** it further comprises means (7) for determining the Wgt(t) value.
- 35 15. The device according to claim 13 **characterized in that** the means (5) for determining the ECV(t) value is a bio-impedance measurement device.
- 40 16. The device according to claim 12 **characterized in that** the input unit (2) is a manual user interface, preferably a keyboard.
- 45 17. The device according to any of the claims 12 to 16 **characterized in that** the input unit (2) comprises an interface to the means (5) for determining the ECV(t) value and/or the means (7) for determining the Wgt(t) value.
18. The device according to any of the claims 12 to 17 **characterized in that** the program for deriving the dry body weight $Wgt_{dry}(t)$ uses the following expression:

$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e},$$

- 50 where α_e and β_e are empirically determined coefficients.
- 55 19. The device according to any of the claims 12 to 18 **characterized in that** the computer storage unit (3) is capable of storing the ECV(t_i) and Wgt(t_i) values of a patient at times t_i , $i=1...j$, and that the program for deriving the dry weight $Wgt_{dry}(t_j)$ uses a linear regression analysis.
20. The device according to any of the claims 12 to 19 further comprising an output unit (9) that is linked to the micro-processor unit for outputting, preferably displaying the derived $Wgt_{dry}(t)$ value.

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21. The device according to any of the claims 12 to 20 **characterized in that** the program stored in the microprocessor program storage unit (1a) is suitable to determine a fat mass correction $\Delta f(t)$ in order to derive the dry body weight $Wgt_{dry}(t)$ from the determined weight $Wgt(t)$.

5 22. The device according to claim 21 **characterized in that** the program for deriving the dry body weight $Wgt_{dry}(t)$ uses the following expression:

$$10 \quad Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} - \frac{\alpha_e \cdot \Delta f(t)}{\beta_e - \alpha_e}$$

where α_e , and β_e are empirically determined coefficients.

15 23. The device according to claims 18 or 22 **characterized in that** α_e equals 0,2146 litres/kg and β_e equals 1 litre/1 kg.

20 24. The device according to any of the claims 21 to 23 **characterized in that** the input unit (2) is also suitable to enable entering a value for the intracellular water volume $ICV(t)$ of the patient at the time t, the computer storage unit (3) is able to store the $ICV(t)$ value and that the program for deriving the dry body weight $Wgt_{dry}(t)$ uses the $ICV(t)$ value in order to determine the fat mass correction $\Delta f(t)$.

25 25. The device according to claim 24 **characterized in that** the program uses the following expression for determining the fat mass correction $\Delta f(t)$:

$$\Delta f(t) = Wgt(t) - \frac{(1 - \rho_e \cdot \alpha_e - \rho_i \cdot \alpha_i) \cdot ICV(t)}{\alpha_i} - \rho_i \cdot ICV(t) - \rho_e \cdot ECV(t),$$

where ρ_e and ρ_i are the densities of the $ECV(t)$ and $ICV(t)$ volumes, respectively, and α_e is an empirically determined coefficients as in claim 22 and α_i is a further empirically determined coefficient.

30 26. The device according to claims 24 or 26 **characterized in that** the device further comprises means for determining the $ICV(t)$ value, preferably a bioimpedance device.

35 Patentansprüche

1. Verfahren zur Bestimmung des Trockengewichts $Wgt_{dry}(t)$ eines Patienten zum Zeitpunkt t, umfassend die folgenden Schritte:

40 Bestimmen des extrazellulären Wasservolumens $ECV(t)$ des Patienten zum Zeitpunkt t,

Bestimmen des Gewichts $Wgt(t)$ des Patienten zum Zeitpunkt t,

45 Ableiten des Trockengewichts $Wgt_{dry}(t)$ des Patienten als Schnittpunkt einer Funktion, abgeleitet von den bestimmten $ECV(t)$ - und $Wgt(t)$ -Werten, mit einer zuvor ermittelten Referenzbeziehung aus extrazellulärem Wasservolumen (ECV) gegenüber einem Trockengewicht- (Wgt_{dry}), welche gesunde Personen repräsentiert.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** $ECV(t)$ von einer Bioimpedanz-Messung abgeleitet ist.

50 3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** die Bioimpedanz-Messung eine Ganzkörpermessung ist.

4. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** die Bioimpedanz-Messung eine segmentale Messung ist.

55 5. Verfahren nach mindestens einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** $Wgt_{dry}(t)$ mit Hilfe des nachstehenden Ausdrucks bestimmt wird:

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$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e},$$

5 worin α_e und β_e empirisch ermittelte Koeffizienten sind.

6. Verfahren nach mindestens einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die $ECV(t_i)$ - und $Wgt(t_i)$ -Werte eines Patienten zu den Zeitpunkten t_j , $i=1..j$ gespeichert werden und dass das Trockenkörpergewicht $Wgt_{dry}(t_j)$ durch eine lineare Regressionsanalyse abgeleitet wird.

10 7. Verfahren nach mindestens einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** eine Fettmassekorrektur $\Delta f(t)$ bestimmt wird, um das Trockenkörpergewicht $Wgt_{dry}(t)$ von dem bestimmten Gewicht $Wgt(t)$ abzuleiten.

15 8. Verfahren nach Anspruch 7, **dadurch gekennzeichnet, dass** das Trockengewicht $Wgt_{dry}(t)$ durch den nachstehenden Ausdruck abgeleitet wird:

$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} - \frac{\alpha_e \cdot \Delta f(t)}{\beta_e - \alpha_e},$$

20 worin α_e und β_e empirisch ermittelte Koeffizienten sind.

25 9. Verfahren nach Anspruch 5 oder 8, **dadurch gekennzeichnet, dass** α_e 0,2146 Liter/kg entspricht und β_e 1 Liter/kg entspricht.

30 10. Verfahren nach mindestens einem der Ansprüche 7 bis 8, **dadurch gekennzeichnet, dass** das intrazelluläre Wasservolumen $ICV(t)$ für den Patienten zum Zeitpunkt t bestimmt wird und dass der ermittelte $ICV(t)$ zur Ableitung der Fettmassenkorrektur $\Delta f(t)$ verwendet wird.

35 11. Verfahren nach Anspruch 10, **dadurch gekennzeichnet, dass** die Fettmassenkorrektur $\Delta f(t)$ durch den nachstehenden Ausdruck abgeleitet wird:

$$\Delta f(t) = Wgt(t) - \frac{(1 - \rho_e \cdot \alpha_e - \rho_i \cdot \alpha_i) \cdot ICV(t)}{\alpha_i} - \rho_i \cdot ICV(t) - \rho_e \cdot ECV(t),$$

40 worin ρ_e und ρ_i die Dichten der $ECV(t)$ - bzw. $ICV(t)$ -Volumina sind und α_e ein empirisch ermittelter Koeffizient wie in Anspruch 8 ist und α_i ein weiterer empirisch ermittelter Koeffizient ist.

45 12. Vorrichtung (10) zur Durchführung des Verfahrens nach Anspruch 1, umfassend:

 eine Mikroprozessoreinheit (1), die ihrerseits eine Mikroprozessor-Programmspeichereinheit (1a) umfasst,

 eine Eingabeeinheit (2), um die Eingabe der Werte für $ECV(t)$ und $Wgt(t)$ zu ermöglichen,

 eine Computerspeichereinheit (3) zum Speichern der $ECV(t)$ - und $Wgt(t)$ -Werte,

50 wobei die Mikroprozessor-Programmspeichereinheit (1a) ein Programm zur Ableitung des Trockengewichts $Wgt_{dry}(t)$ als Schnittpunkt (IS) einer Funktion, abgeleitet von den gespeicherten $ECV(t)$ - und $Wgt(t)$ -Werten, mit einer zuvor ermittelten Referenzbeziehung von ECV gegenüber einem Wgt_{dry} , welche gesunde Personen repräsentiert, umfasst.

55 13. Vorrichtung nach Anspruch 12, **dadurch gekennzeichnet, dass** diese weiterhin eine Einrichtung (5) zur Bestimmung des $ECV(t)$ -Wertes umfasst.

14. Vorrichtung nach Anspruch 12 oder 13, **dadurch gekennzeichnet, dass** diese weiterhin die Einrichtung (7) zur Bestimmung des $Wgt(t)$ -Wertes umfasst.

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15. Vorrichtung nach Anspruch 13, **dadurch gekennzeichnet, dass** die Einrichtung (5) zur Bestimmung des ECV(t)-Wertes ein Bioimpedanz-Messgerät ist.

5 16. Vorrichtung nach Anspruch 12, **dadurch gekennzeichnet, dass** die Eingabeeinheit (2) eine manuelle Benutzerschnittstelle, vorzugsweise eine Tastatur ist.

10 17. Vorrichtung nach mindestens einem der Ansprüche 12 bis 16, **dadurch gekennzeichnet, dass** die Eingabeeinheit (2) eine Schnittstelle mit der Einrichtung (5) zur Bestimmung des ECV(t)-Wertes und/oder die Einrichtung (7) zur Bestimmung des Wgt(t)-Wertes umfasst.

18. Vorrichtung nach mindestens einem der Ansprüche 12 bis 17, **dadurch gekennzeichnet, dass** das Programm zur Ableitung des Trockenkörpergewichts $Wgt_{dry}(t)$ den nachstehenden Ausdruck verwendet:

$$15 \quad Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e},$$

worin α_e und β_e empirisch ermittelte Koeffizienten sind.

20 19. Vorrichtung nach mindestens einem der Ansprüche 12 bis 18, **dadurch gekennzeichnet, dass** die Computerspeichereinheit (3) zum Speichern der ECV(t_i)- und Wgt(t_i)-Werte eines Patienten zu den Zeitpunkten t_i , $i=1\dots j$ fähig ist und dass das Programm zur Ableitung des Trockengewichts $Wgt_{dry}(t_i)$ eine lineare Regressionsanalyse verwendet.

25 20. Vorrichtung nach mindestens einem der Ansprüche 12 bis 19, weiterhin umfassend eine Ausgabereinheit (9), die mit der Mikroprozessoreinheit für die Ausgabe, vorzugsweise die Anzeige des abgeleiteten $Wgt_{dry}(t)$ -Wertes verbunden ist.

30 21. Vorrichtung nach mindestens einem der Ansprüche 12 bis 20, **dadurch gekennzeichnet, dass** das in der Mikroprozessor-Programmspeichereinheit (1a) gespeicherte Programm geeignet ist, eine Fettmassenkorrektur $\Delta f(t)$ zu bestimmen, um das Trockenkörpergewicht $Wgt_{dry}(t)$ aus dem ermittelten Gewicht $Wgt(t)$ abzuleiten.

35 22. Vorrichtung nach Anspruch 21, **dadurch gekennzeichnet, dass** das Programm zum Ableiten des Körpertrockengewichts $Wgt_{dry}(t)$ den nachstehenden Ausdruck verwendet:

$$40 \quad Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} - \frac{\alpha_e \cdot \Delta f(t)}{\beta_e - \alpha_e}$$

worin α_e und β_e empirisch ermittelte Koeffizienten sind.

23. Vorrichtung nach Anspruch 18 oder 22, **dadurch gekennzeichnet, dass** α_e 0,2146 Liter/kg entspricht und β_e 1 Liter/kg entspricht.

45 24. Vorrichtung nach mindestens einem der Ansprüche 21 bis 23, **dadurch gekennzeichnet, dass** die Eingabeeinheit (2) ebenfalls geeignet ist, die Eingabe eines Wertes für das intrazelluläre Wasservolumen ICV(t) des Patienten zum Zeitpunkt t zu ermöglichen, die Computerspeichereinheit (3) dazu fähig ist, den ICV(t)-Wert zu speichern, und das Programm zum Ableiten des Trockenkörpergewichts $Wgt_{dry}(t)$ den ICV(t)-Wert verwendet, um die Fettmassenkorrektur $\Delta f(t)$ zu bestimmen.

50 25. Vorrichtung nach Anspruch 24, **dadurch gekennzeichnet, dass** das Programm den nachstehenden Ausdruck zur Bestimmung der Fettmassenkorrektur $\Delta f(t)$ verwendet:

$$55 \quad \Delta f(t) = Wgt(t) - \frac{(1 - \rho_e \cdot \alpha_e - \rho_i \cdot \alpha_i) \cdot ICV(t)}{\alpha_i} - \rho_i \cdot ICV(t) - \rho_e \cdot ECV(t),$$

worin ρ_e und ρ_i die Dichten der ECV(t)- bzw. ICV(t)-Volumina sind und α_e ein empirisch ermittelter Koeffizient wie

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in Anspruch 22 ist und α_i ein weiterer empirisch ermittelter Koeffizient ist.

26. Vorrichtung nach den Ansprüchen 24 oder 26, **dadurch gekennzeichnet, dass** die Vorrichtung weiterhin eine Einrichtung zur Bestimmung des ICV(t)-Wertes, vorzugsweise eine Bioimpedanz-Vorrichtung umfasst.

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Revendications

1. Une méthode pour déterminer le poids sec $Wgt_{sec}(t)$ d'un patient à un temps t, comprenant les étapes de :

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déterminer le volume d'eau extracellulaire ECV(t) du patient au temps t,
déterminer le poids $Wgt(t)$ du patient au temps t,
dériver le poids sec $Wgt_{sec}(t)$ du patient comme une intersection d'une fonction dérivée des valeurs déterminées de ECV(t) et $Wgt(t)$ avec un volume d'eau extracellulaire précédemment établi (ECV) en fonction de la relation de référence de poids sec (Wgt_{sec}) représentant des sujets sains.

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2. Méthode selon la revendication 1, **caractérisée en ce qu'on** dérive ECV(t) d'une mesure de bio-impédance.
3. Méthode selon la revendication 2, **caractérisée en ce que** la mesure de bio-impédance est une mesure du corps entier .
4. Méthode selon la revendication 2, **caractérisée en ce que** la mesure de bio-impédance est une mesure segmentaire.
5. Méthode selon l'une quelconque des revendications précédentes, **caractérisée en ce qu'est** déterminé $Wgt_{sec}(t)$ en utilisant l'expression suivante :

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$$Wgt_{Sec}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e}$$

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où α_e et β_e sont des coefficient déterminés empiriquement.

6. Méthode selon l'une quelconque des revendications précédentes, **caractérisée en ce que** les valeurs de ECV(t_i) et $Wgt(t_i)$ d'un patient aux temps t_i , $i=1\dots j$, sont stockées et que le poids du corps sec $Wgt_{sec}(t_i)$ est dérivé par une analyse de régression linéaire.
7. Méthode selon l'uns quelconque des revendications précédentes, **caractérisée en ce qu'une** correction de masse de graisse $\Delta f(t)$ est déterminée afin de dériver le poids du corps sec $Wgt_{sec}(t)$ du poids déterminé $Wgt(t)$.
8. Méthode selon la revendication 7, **caractérisé en ce que** le poids sec $Wgt_{sec}(t)$ est dérivé par l'expression suivante :

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$$Wgt_{Sec}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} - \frac{\alpha_e \cdot \Delta f(t)}{\beta_e - \alpha_e}$$

où α_e et β_e sont des coefficient déterminés empiriquement.

9. Méthode selon la revendication 5 ou 8, **caractérisée en ce que** α_e est égal à 0,2146 litre/kg et β_e est égal à 1 litre/kg.
10. Méthode selon l'une quelconque des revendications 7 à 8, **caractérisée en ce que** le volume d'eau intracellulaire ICV(t) est déterminé pour le patient au temps t et **en ce que** ICV(t) déterminé est utilisé pour dériver la correction de masse de graisse $\Delta f(t)$.
11. Méthode selon la revendication 10, **caractérisée en ce que** la correction de masse de graisse $\Delta f(t)$ est dérivée par l'expression suivante :

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$$\Delta f(t) = Wgt(t) - \frac{(1 - \rho_e \cdot \alpha_e - \rho_j \cdot \alpha_j) \cdot ICV(t)}{\alpha_j} - \rho_j \cdot ICV(t) - \rho_e \cdot ECV(t),$$

5 où ρ_e et ρ_j sont les densités des volumes ECV(t) et ICV(t), respectivement, et α_e est un coefficient empiriquement déterminé selon la revendication 8 et α_j est un autre coefficient empiriquement déterminé.

12. Dispositif (10) pour effectuer la méthode selon la revendication 1, comprenant

10 une unité de microprocesseur (1) qui à son tour comprend une unité de stockage de programme de micro-processeur (1a),
une unité d'entrée (2) pour permettre l'entrée des valeurs de ECV(t) et Wgt(t),
une unité de stockage d'ordinateur (3) pour stocker les valeurs de ECV(t) et Wgt(t),

15 où l'unité de stockage de programme de microprocesseur (1a) comprend un programme pour dériver le poids sec $Wgt_{sec}(t)$ en tant qu'une intersection (IS) d'une fonction dérivée des valeurs stockées de ECV(t) et Wgt(t) avec ECV précédemment établi en fonction de la relation de référence Wgt_{sec} représentant des sujets sains.

20 13. Dispositif selon la revendication 12, **caractérisé en ce qu'il** comprend de plus un moyen (5) pour déterminer la valeur de ECV(t).

14. Dispositif selon les revendications 12 ou 13, **caractérisé en ce qu'il** comprend de plus un moyen (7) pour déterminer la valeur de Wgt(t).

25 15. Dispositif selon la revendication 13, **caractérisé en ce que** le moyen (5) pour déterminer la valeur de ECV(t) est un dispositif de mesure de bio-impédance.

16. Dispositif selon la revendication 12, **caractérisé en ce que** l'unité d'entrée (2) est une interface manuelle pour l'utilisateur, de préférence un clavier.

30 17. Dispositif selon l'une quelconque des revendications 12 à 16, **caractérisé en ce que** l'unité d'entrée (2) comprend une interface vers le moyen (5) pour déterminer la valeur de ECV(t) et/ou le moyen (7) pour déterminer la valeur de Wgt(t).

35 18. Dispositif selon l'une quelconque des revendications 12 à 17, **caractérisé en ce que** le programme pour dériver le poids du corps sec $Wgt_{sec}(t)$ utilise l'expression suivante :

40
$$Wgt_{Sec(t)} = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e}$$

où α_e et β_e sont des coefficients empiriquement déterminés.

45 19. Dispositif selon l'une quelconque des revendications 12 à 18, **caractérisé en ce que** l'unité de stockage d'ordinateur (3) est capable de stocker les valeurs de ECV(t_i) et Wgt(t_i) d'un patient aux temps t_i , $i=1\dots j$, et **en ce que** le programme pour dériver le poids sec $Wgt_{sec}(t_j)$ utilise une analyse de régression linéaire.

20. Dispositif selon l'une quelconque des revendications 12 à 19, comprenant de plus une unité de sortie (9) qui est liée à l'unité de microprocesseur pour émettre et, de préférence, visualiser la valeur dérivée de $Wgt_{sec}(t)$.

50 21. Dispositif selon l'une quelconque des revendications 12 à 20, **caractérisé en ce que** le programme stocké dans l'unité de stockage du programme de microprocesseur (1a) est approprié pour déterminer une correction de masse de graisse $\Delta f(t)$, afin de dériver le poids du corps sec $Wgt_{sec}(t)$ à partir du poids déterminé Wgt(t).

55 22. Dispositif selon la revendication 21, **caractérisé en ce que** le programme pour dériver le poids du corps sec $Wgt_{sec}(t)$ utilise l'expression suivante :

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$$Wgt_{sec}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{\alpha_e - \beta_e} - \frac{\alpha_e \cdot \Delta f(t)}{\beta_e - \alpha_e}$$

5 où α_e et β_e sont des coefficients déterminés empiriquement.

23. Dispositif selon les revendications 18 ou 22, **caractérisé en ce que** α_e est égal à 0,2146 litre/kg et β_e est égal à 1 litre/kg.

10 24. Dispositif selon l'une quelconque des revendications 21 à 23, **caractérisé en ce que** l'unité d'entrée (2) est également appropriée pour permettre l'entrée d'une valeur pour le volume d'eau intracellulaire ICV(t) du patient au temps t, l'unité de stockage d'ordinateur (3) est capable de stocker la valeur de ICV(t), et **en ce que** le programme pour dériver le poids du corps sec $Wgt_{sec}(t)$ utilise la valeur de ICV(t) afin de déterminer la correction pour masse de graisse $\Delta f(t)$.

15 25. Dispositif selon la revendication 24, **caractérisé en ce que** le programme utilise l'expression suivante pour déterminer la correction pour la masse grasse $\Delta f(t)$:

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$$\Delta f(t) = Wgt(t) - \frac{(1 - \rho_e \cdot \alpha_e - \rho_i \cdot \alpha_i) \cdot ICV(t)}{\alpha_i} - \rho_i \cdot ICV(t) - \rho_e \cdot ECV(t),$$

25 où ρ_e et ρ_i sont les densités des volumes ECV(t) et ICV(t), respectivement et α_e est un coefficient déterminé empiriquement selon la revendication 22 et α_i est un autre coefficient déterminé empiriquement.

26. Dispositif selon les revendications 24 ou 26, **caractérisé en ce que** le dispositif comprend de plus un moyen pour déterminer la valeur de ICV(t), de préférence un dispositif à bio-impédance.

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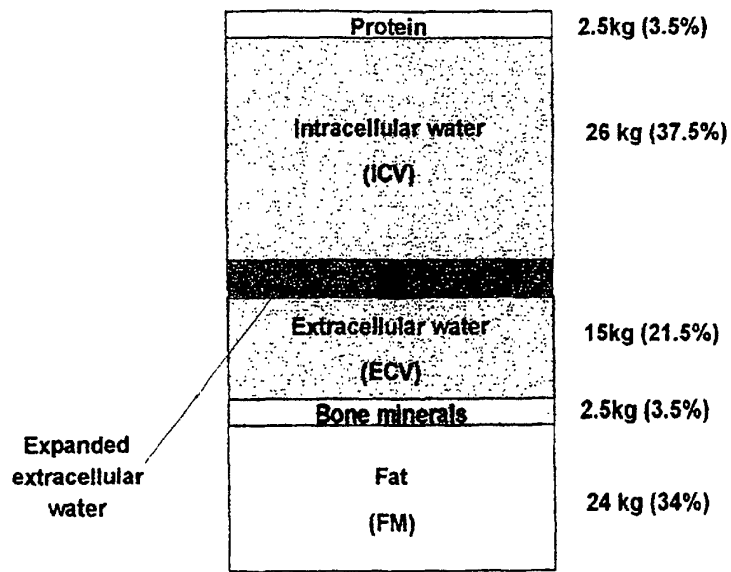


Figure 1

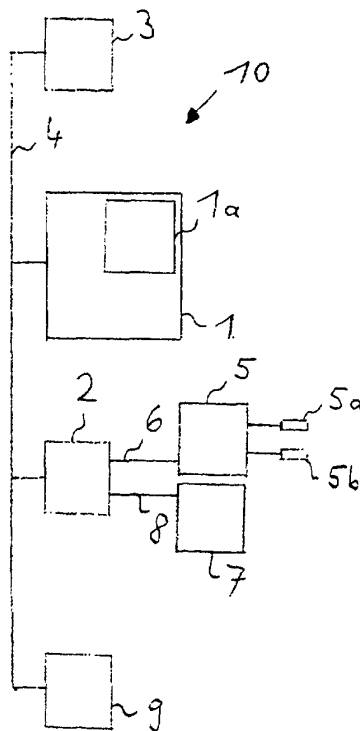


Figure 2

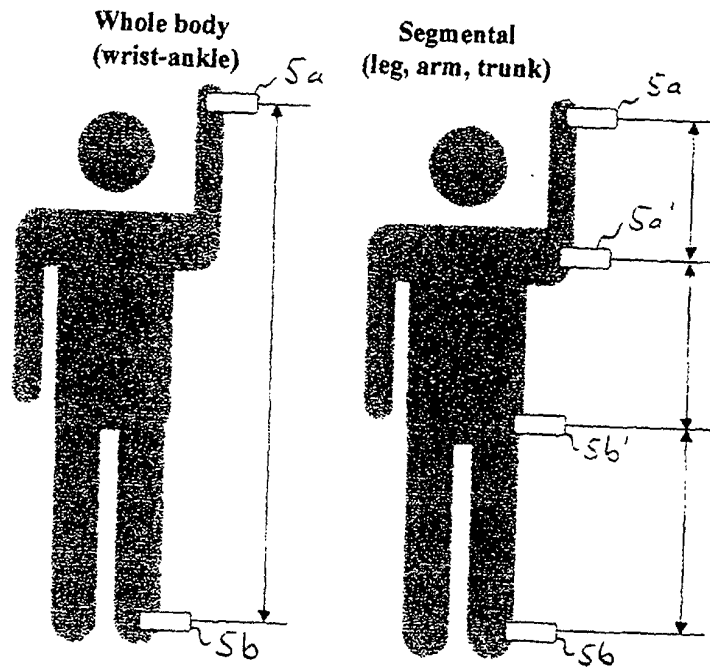


Figure 3a

Figure 3b

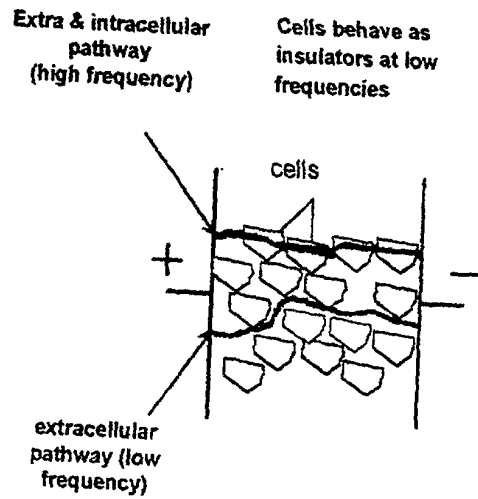


Figure 4

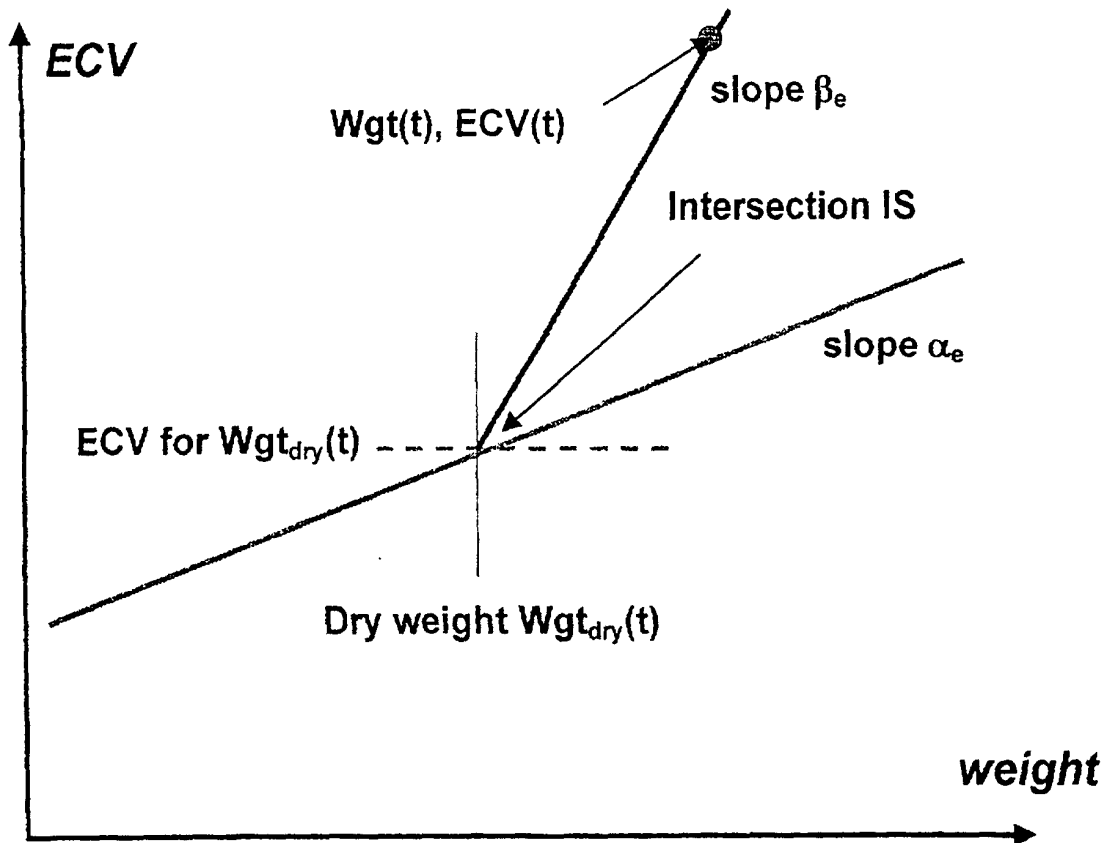


Figure 5a

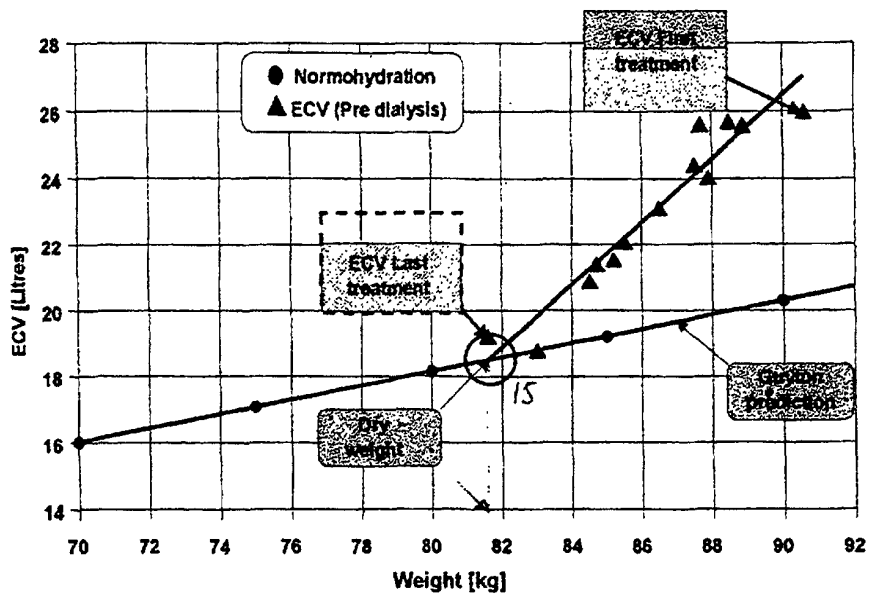


Figure 5b

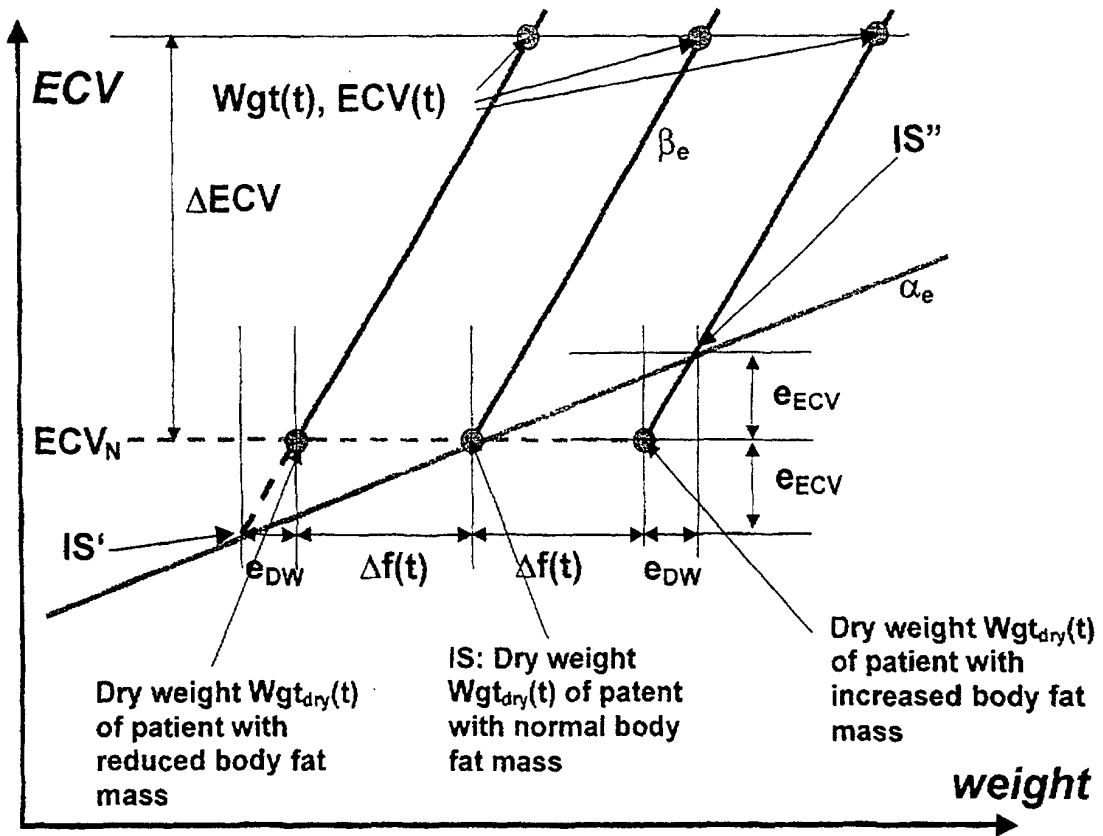


Figure 6

专利名称(译)	一种用于确定患有肾衰竭的患者的干重的方法和装置		
公开(公告)号	EP1205144B1	公开(公告)日	2002-10-02
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[标]申请(专利权)人(译)	弗雷森纽斯医疗护理德国有限责任公司		
申请(专利权)人(译)	费森尤斯医药DEUTSCHLAND GMBH		
当前申请(专利权)人(译)	费森尤斯医药DEUTSCHLAND GMBH		
[标]发明人	CHAMNEY PAUL DR		
发明人	CHAMNEY, PAUL, DR.		
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外部链接	Espacenet		

摘要(译)

本发明涉及一种用于监测患有肾衰竭的患者的流体状态的方法和装置。在肾功能衰竭的情况下，所有形式的摄入液体积聚在身体组织中，导致循环系统上的压力增加。在透析治疗期间，必须通过血液的超滤除去这种多余的液体。该剩余流体的量或针对该剩余流体校正的重量，即干重，是用于管理透析患者的流体状态的重要参数。根据本发明，患者在时间t的干重Wgtdry(t)通过确定患者在时间t的细胞外水量ECV(t)，通过确定患者的体重Wgt(t)来确定。时间t并通过导出患者的干重Wgtdry(t)作为从确定的ECV(t)和Wgt(t)值得到的函数与先前建立的细胞外水体积(ECV)对干重的函数的交集(Wgtdry)代表健康受试者的参考关系。为了获得更准确的结果，还建议考虑脂肪质量校正Δf(t)。本发明还涉及一种用于获得干重Wgtdry(t)的装置。

$$Wgt_{Dry}(t) = \frac{ECV(t) - \beta_e \cdot Wgt(t)}{a_e - \beta_e}$$