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# The Inverse of Serum Creatinine Multiplied by 100 (1/CtS100): The Key to Calculate the Actual Creatinine Clearance and Actual Excreted Creatinine in Renal Failure

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*Abstract*— **In a previous paper it was shown that the inverse of serum creatinine multiplied by 100 very closely correlated with the estimates of the glomerular filtration rate (GFR) by MDRD simplified formula. In past few years and more recently, the inverse of serum creatinine was correlated with GFR values measured by high precision methods. On this basis it was assumed to verify which of the variables measured creatinine clearance and excretion, and creatinine clearance and excretion estimated on the basis of 1/CtS100 and 1/CtS would better correlate with MDRD GFR, CtS, BMI, Protidemia, Serum Urea, .body cellular mass, fat mass, and extracellular water, variables all rationally expected to be somehow linked to the variables above. The variables based on 1/CtS100 had the best correlations, consequently, this method was proposed to measure the actual creatinine clearance and the actual excreted creatinine in the case of substitutive treatment by dialysis and most likely also in the case of decreased renal function.**

*Index Terms*— **Serum Creatinine, Actual Clearances, Estimates**

## I. Introduction

In a previously published paper [1], it was shown that an estimate of actual creatinine clearance calculated on the basis of the inverse of serum creatinine multiplied by 100 (1/CtS100) was very closely correlated with the estimates of glomerular filtration rate according to the MDRD simplified formula [2], although the sizes of the estimated values differed between 1/CtS100 and MDRD, with a larger size for 1/CtS100. This is most likely because 1/CtS100 should estimate the actual total creatinine clearance while MDRD based on data of individuals having renal insufficiency, results in an underestimation of renal function, particularly concerning aged persons. In the quoted paper [1], the regression of the estimated GFR by MDRD on the estimates of the creatinine clearances by 1/CtS100 and on age resulted in R 0,999, R2 0,998, respectively, with a p value of 0,000. The value of the inverse of serum creatinine (1/CtS) has only been used in previous years and very recently [3,4,5,6,7,8], because it resulted in a better approximation of the actual renal function measured by golden standard methods (inulin clearance, isotopes clearance etc.). 1/CtS, according to Selliger et al. [7], resulted in a better approximation of the GFR values measured by 51Cr-EDTA plasma clearance than the measured creatinine clearance. Consequently the possibility of using 1/CtS to estimate actual creatinine clearance was included in this study and 1/CtS values underwent the same computation as 1/CtS100 (see point i in the Methods section). On this basis, the aim of the present study was to verify a) which of the following variables would better correlate with estimated GFR by MDRD, MeasCtCl/min and age, EstimCtCl/min1/CtS100 and age, EstimCtCl/min1/CtS and age. b) which of the following would better correlate with CtS : MeasExcrCt/day, EstimExcrCt/day1/CtS100 and EstimExcrCt/day1/CtS c) which of the variables mentioned in a) and/or b) would better correlate with : BCM kg, BMI, Protidemia/BMI, and serum urea, variables that are possibly related to the variables mentioned above. If the estimates based on 1/CtS100 resulted in better satisfying the above exposed targets, this could demonstrate its usefulness in estimating actual creatinine clearance: consequently estimates by 1/CtS100m could be used to state the degree of approximation of a measured creatinine clearance to the actual clearance in renal insufficiency. The difference between the estimated and measured values would represent added creatinine clearance because of hidden removal of creatinine mass that has been shown by Mitch and Walser [9], Canaud et al. [10] and Huang YC et al in 1982 [11], but it would also confirm their results.

## II. Materials and Methods

### A. Materials

This study is based on the registered data of two populations of patients undergoing chronic peritoneal dialysis, 65 males and 82 females, aged 55,96±14,4 and 55,52±12,65 years, respectively, who have the following anthropometric data : males, height 169,6±8,2 cm, weight 74,96±12,4 kg, BMI 26,13±4,4, and BSA 1,85±0,16 square meters; females, height 157,5 cm, weight 63,8±11 kg, BMI 25,7±4, and BSA 1,64±0,16 square meters. Their measured creatinine clearance/liters/week was 47,68±14, with a Coef.Var 0,293, indexed on 1,73 square meters/BSA 44,9±13,8 liters/week for males; and 45,24±14,5 liters/week, with a Coef.Var 0,320, indexed on BSA 47,6±13,6 ml/min for females. Their

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measured creatinine excretion was 738,3±321,14 mg/day, with a Coef.Var 0,435 for males, and 589,9±236,2, with a Coef. Var 0,400 for females. The very high values of coefficient of variation for creatinine clearances and excretions show a wide dispersion of data in males and females, that is, there are high differences within the measured treatments.

*B. Methods*

i) Calculation of Estimated CtCl/min and of the Estimated Excreted Creatinine -The method to estimate the actual creatinine clearance based on 1/CtS100 and the method to calculate by it the estimated creatinine excretion were presented in the paper quoted above [1]. Assuming the value of 1/CtS x 100 to be the value of the actual creatinine clearance, the measured value should be added to its difference versus the value of 1/CtS x 100. However, the value of 1/CtS100 represents an absolute value, because any CtS value results in an undefined number of relationships of creatinine generation rate/creatinine removal, which includes the particular measured clearance that is observed. Consequently, to equalize the two variables to each other and to minimize the errors, the difference was calculated by computing the logarithm in base 10 of (1/CtS100 - MeasCtCl/min), as follows, log10(1/CtS x100/MeasCtCl/min) : the antilog of the result has been assumed to be the difference that should be added to MeasCtCl/min. Estimation of the creatinine excretion resulting from the EstimCtCl/min was computed by applying the formula creatinine excretion mg/dl = (EstimCtCl/min x CtS)/volume/min, assuming the volume/min to be the known value of the measured CtCl/min. This method implicitly acknowledges the existence of a different and hidden way of creatinine removal as assumed by previous publications [9-11]. The estimates of actual CtCl/min and actual ExcrCt using 1/CtS were performed, wth the same considerations and following the same procedure as for 1/CtS100.

ii) The Body impedance Analysis - Sixteen out of 65 males and 27 out of 82 females underwent a Body Impedance Analysis (BIA) by a mono frequency device (50 kHz). Relationships between BIA data and other variables were rationally evaluated and found to be most likely correlated with them, as determined by linear regressions, whose results are reported in Tab.2A and Tab. 2B.

iii) Relationships within all the remaining registered variables concerning CtS, the measured and estimated CtCl/min and excreted creatinine/day, protidemia, serum urea, and BMI have been defined by linear regressions.

iv) The regressions concerning protidemia included the data of 36 out of 65 males and of 31 out of 82 females because of the lack of protidemia values for the remaining males and females.

v) The results of all of the regressions included the computation of the values of the percentage residuals between real and fitted values, computed in their absolute value to avoid an erroneous average value, because a compensation between negative and positive items. The residuals of related regressions attaining significant results were compared each other by T test and by the computation of their percentage similarity. This test was used for a better evaluation of the regressions power, because the more was the effectiveness of the regression the more the similarity between real and fitted values will approximate 100 (100%). The formula to calculate the similarity between the variables A and B Is as follows, similarity = {[(A+B)/2)/A]}*100.

## III. Result

Tab 1A - 65 males - Regressions of estimates based on 1/CtS and 1/CtS100 versus CtS and MDRD GFR

| regressions | Variables | R ; R² | p | percentage residuals | similarity | T test of residuals |
|---|---|---|---|---|---|---|
| predictor | CtS | 0,144 ; 0,021 | 0,25 | | | |
| responder | EstimCtCl/min by 1/CtS | | | | | |
| predictor | CtS | | | | | |
| responder | EstimCtCl/min by 1/CtS100 | 0,56 ; 0,31 | 0,000 | n.e | n.e | n.e. |
| predictor | CtS | | | | | |
| responder | EstimExcrCt/day by 1/CtS | 0,74;0,54 | 0,000 | 28,04±30,8 | 105,3±20,2 | |
| predictor | CtS | | | | | |
| responder | EstimExcrCt/day by 1/CtS100 | 0,86 ; 0,75 | 0,000 | 8,08±5,43 | | 5,15 p 0,000 |
| predictor | EstimCtCl by 1/CtS, age | | | | | |
| responder | MDRD | 0,25;0,06 | 0,13 | n.e. | n.e | |
| predictor | EstimCtCl by 1/CtS100,age | | | | | |
| responder | MDRD | 0,55 ; 0,30 | 0,000 | 21,2±20,14 | 103,2±14,3 | n.e. |

Tab 1B - 82 females - Regressions of estimates based on 1/CtS and 1/CtS100 versus CtS and MDRD GFR

| regressions | Variables | R ; R² | p | percentage residuals | similarity | T test of residuals |
|---|---|---|---|---|---|---|
| predictor | CtS | | | | | |
| responder | EstimCtCl/min by 1/CtS | 0,6 ; 0,004 | 0,58 | n.e. | n.e. | |
| predictor | CtS | | | | | |
| responder | EstimCtCl/min by 1/CtS100 | 0,75 ; 0,56 | 0,000 | 7,53±6,23 | 100,5±4,88 | n.e. |
| predictor | CtS | | | | | |
| responder | EstimExcrCt/day by 1/CtS | 0,54 ; 0,29 | 0,000 | 26,7±26,5 | 105,6±18 | |
| predictor | CtS | | | | | |
| responder | EstimExcrCt/day by 1/CtS100 | 0,78 ; 0,6 | 0,000 | 7,14±6,34 | 100,6±4,76 | 6,38 p 0,000 |
| predictor | EstimCtCl by 1/CtS, age | | | | | |
| responder | MDRD | 0,33 ; 0,107 | 0,013 | 26,7±22,14 | 104,6±11,8 | |
| predictor | EstimCtCl by 1/CtS100,age | | | | | |
| responder | MDRD | 0,76 ; 0,58 | 0,000 | 16,5±15,2 | 102±11 | 3,38 p 0,001 |

The obtained results are shown in the Tables 1A-1B, 2A- 2B, 3A – 3B, 3C- 3D, 4A – 4B, and 5A – 5B. - The following Tab. 1A and 1B display the relationships between the Estimates of CtCl/min and ExcrCt/day versus CtS and versus MDRD estimated GFR, for males and females

In the tables above the estimates based on 1/CtS100 had a better correlation with the predictor variables than those based on 1/CtS; this was also confirmed by the significant difference of the percentage residuals of the regressions and the lower values of percentage similarities.

**Tab 2A - 16 males - Relationships Concerning Monofrequency Body Impedance data**

| Regressions | Variables | R ; $R^2$ | p | percentage residuals | similarity | T test of residuals |
|---|---|---|---|---|---|---|
| Predictor | Meas ExcrCt | | | | | |
| Responder | BCM kg | 0,48 ; 0,23 | 0,059 | 13,6±13,2 | 101,5±9,5 | |
| Predictor | EstimExcrCt 1/CtS100 | | | | | |
| Responder | BCM kg | 0,59 ; 0,34 | 0,017 | 12,95±11,9 | 101,3±8,8 | 0,16; p 0,876 |
| Predictor | EstimExcrCt 1/CtS | | | | | |
| Responder | BCM kg | 0,48 ; 0,23 | 0,058 | n.e | n.e. | n.e. |
| Predictor | BCM+FM as % of body weight | | | | | |
| Responder | Protidemia | 0,68; 0,46 | 0,007 | 5,85 ±4,04 | 100,2±3,64 | |
| Predictor | BCM+FM -ExtraCellW | | | | | |
| Responder | Protidemia | 0,7 ; 0,5 | 0,005 | 5,4±4,04 | 100,2±3,46 | |
| Predictor | BMI | | | | | |
| Responder | BCM | 0,52 ; 0,27 | 0,04 | 13,4±10,4 | 101,4±8,6 | |

**Tab 2B - 27 females - Relationships Concerning Mono frequency Body Impedance Data**

| Regressions | Variables | R ; $R^2$ | p | percentage residuals | similarity | T test of residuals |
|---|---|---|---|---|---|---|
| Predictor | Meas ExcrCt | | | | | |
| Responder | BCM kg | 0,55 ; 0,3 | 0,003 | 16,3±16,2 | 102±11,4 | |
| Predictor | EstimExcrCt 1/CtS100 | | | | | |
| Responder | BCM kg | 0,55 ; 0,31 | 0,003 | 16,6±15,4 | 101,9±11,2 | -0,07 0,945 |
| Predictor | EstimExcrCt 1/CtS | | | | | |
| Responder | BCM kg | 0,04;0,001 | 0,85 | n.e. | n.e. | n.e. |
| Predictor | BCM+FM % body weight/BMI | | | | | |
| Responder | Protidemia/BMI | 0,66; 0,43 | 0,02 | 11,1 ±12,3 | 101±8,4 | |
| Predictor | BCM+FM -ExtraCellW | | | | | |
| Responder | Protidemia | 0,8; 0,082 | 0,798 | n.e. | n.e | |
| Predictor | BMI | | | | | |
| Responder | BCM | 0,46 ; 0,21 | 0,016 | 16,7±15,9 | 102,1±11,5 | |

The Tabs. 2A and 2B display the relationships of MeasExcrCt and EstimExcrCt/day by 1/CtS100 and 1Cts with BCM kg, and the relationships of other variables with protidemia and BMI with BCM kg. Tab. 2A shows the same results in males as in previous tables concerning MeasExcrCt/day and EstimExcrCt/day by 1/CtS100 and 1/CtS versus BCM kg, with the best correlation attained by the estimates according to 1/CtS100, however, In Tab. 2B, MeasExcrCt and EstimExcrCt1/CtS100 attained the same degree of correlation in females. The estimates by 1/CtS, as in previous tables, result in worse correlations. In the remaining regressions, protidemia indexed on BMI result well correlated with the body mass represented by BCM + FM that was equally indexed. More interestingly, protidemia strongly correlates with BCM+FM subtracted from ExtraCellW, this most likely shows the uncertain exactness of the relationship extracellular/ intracellular water as defined by the monofrequency BIA, because the measurement of BCM is based on a correct measurement of intracellular water.

In the following Tabs. 3A - 3B (males) and Tabs. 3C – 3D (females) the results of the regressions concerning the relationships of the measured and estimated CtCl/min and measured and estimated excreted Ct/day versus CtS, CtS and age, BMI are shown.

**Tab 3A- 65 males - Relationships of measured and estimated CtCl and ExcrCt versus CtS**

| regressions | Variables | R ; $R^2$ | p | percentage residuals | similarity | T test of residuals |
|---|---|---|---|---|---|---|
| predictor | CtS | | | | | |
| responder | MeasCtCl/min | 0,15 ; 0,012 | 0,238 | n.e. | n.e. | |
| predictor | CtS | | | | | |
| responder | EstimCtCl/min 1/CtS100 | 0,56 ; 0,31 | 0,000 | 8,45± 5,4 | 100,5±5 | n.e. |
| predictor | CtS | | | | | |
| responder | EstimCtCl/min 1/CtS | 0,14 ;0,021 | 0,25 | n.e. | n.e. | n.e. |
| predictor | CtS | | | | | |
| responder | MeasExcrCt/day | 0,738;0,54 | 0,000 | 28,5±31,9 | 105,5±20,8 | |
| predictor | CtS | | | | | |
| responder | EstimExcrCt/day1/CtS100 | 0,867;0,75 | 0,000 | 8,01±5,4 | 100,5±4,9 | 4,19 p 0,000 |
| predictor | CtS | | | | | |
| responder | EstimExcrCt/day 1/CtS | 0,74;0,55 | 0,000 | 28,04±30,9 | 105,3±20,2 | -5,15 p 0,000 |

**Tab 3B - 65 males - Relationships of measured and estimated CtCl and ExcrCt versus CtS and age, BMI**

| | | | | | | |
|---|---|---|---|---|---|---|
| predictor | CtS, age | | | | | |
| responder | MeasExcrCt/day | 0,75;0,56 | 0,000 | 27,07±28,4 | 105,12±19,4 | |
| predictor | CtS, age | | | | | |
| responder | EstimExcrCt/day 1/CtS100 | 0,867;0,75 | 0,000 | 7,9±5,5 | 100,5±4,8 | 5,34 p 0,000 |
| Predictor | CtS, age | | | | | |
| responder | EstimExcrCt/day 1/CtS | 0,75 ;0,57 | 0,000 | 26,6±28,4 | 104,9±18,9 | -5,21 p 0,000 |
| Predictor | BMI | | | | | |
| responder | MeasExcrCt/day | 0,28;0,08 | 0,025 | 40,8±46,9 | 110,3±29,4 | |
| Predictor | BMI | | | | | |
| responder | EstimExcrCt/day 1/CtS100 | 0,30;0,09 | 0,013 | 17,15±11,9 | 102,2±11,3 | 3,94 p 0,000 |
| Predictor | BMI | | | | | |
| responder | EstimExcrCt/day 1/CtS | 0,28 ; 0,08 | 0,025 | 38,47±45,3 | 101±58,2 | -3,68 p 0,000 |

| Tab 3C - 82 females - Relationships of measured and estimated CtCl and ExcrCt versus CtS | | | | | | |
|---|---|---|---|---|---|---|
| regressions | Variables | R ; R² | p | percentage residuals | similarity | T test of residuals |
| Predictor | CtS | | | | | |
| Responder | MeasCtCl/min | 0,06;0,003 | 0,627 | n.e. | n.e. | |
| Predictor | CtS | | | | | |
| Responder | EstimCtCl/min 1/CtS100 | 0,75;0,76 | 0,000 | 7,53±6,2 | 100.5±4.9 | n.e. |
| Predictor | CtS | | | | | |
| Responder | EstimCtCl/min 1/CtS | 0.062 ; 0,004 | 0,59 | n.e. | n.e. | n.e. |
| Predictor | CtS | | | | | |
| Responder | MeasExcrCt/day | 0,54;0.29 | 0.000 | 27.2±27,4 | 105,8±18,5 | |
| Predictor | CtS | | | | | |
| Responder | EstimExcrCt/day 1/CtS100 | 0,778;0,60 | 0.000 | 7,14±6.34 | 100,6±4,76 | 6,34 p 0,000 |
| Predictor | CtS | | | | | |
| Responder | EstimExcrCt/day 1/CtS | 0,54; 0,29 | 0.000 | 26.7±26,5 | 105,6±18 | -6,38 p 0,000 |

Tables 3A and 3B show that estimated variables according to 1/CtS100 have the best correlation with the predicting variables. In tables 3C and 3D, the results for females are the same that in above tables, with the exception of the regression versus BMI, where the EstimExcrCt/day with 1/CtS has better correlation statistics R and $R^2$ than the regression of EstimExcrCt/day with 1/CTS100.

However, it is strongly emphasized that the percentage residuals of the fitted values versus the real values are significantly greater in the former regression than those in the regression concerning EstimExcrCt/day with 1/CTS100, that is, this last regression has a better power of prediction.

The following Tabs. 4A and 4B display the relationships of the variables above with protidemia In the tables above, the predictive and responding variables have been indexed on BMI to obtain their correct relationships. The numerousness of the subjects is lower than that in previous tables because only these subjects had registered data of protidemia. It is possible to observe that, as in previous tables, the estimates based on 1/CtS100 attained the best correlations in males as well in females.

| Tab 4A - 37 males - Relationships with Protidemia | | | | | | |
|---|---|---|---|---|---|---|
| regressions | Variables | R ; R² | p | percentage residuals | similarity | T test of residuals |
| predictor | MeasExcrCt/BMI | | | | | |
| responder | Protidemia/BMI | 0,04 , 0,02 | 0,8 | n.e. | n.e. | |
| predictor | EstimExcrCt 1/CtS100 /BMI | | | | | |
| responder | Protidemia /BMI | 0,42 ; 0,18 | 0,009 | 12±9,24 | 101±7.6 | n.e. |
| predictor | EstimExcrCt 1/CtS /BMI | | | | | |
| responder | Protidemia/BMI | 0,039;0,0016 | 0,819 | n.e. | n.e. | n.e. |
| predictor | MeasCtCl/BMI | | | | | |
| responder | Protidemia/BMI | 0,06 ; 0,004 | 0,71 | n.e. | n.e. | |
| predictor | EstimCtCl 1/CtS100/BMI | | | | | |
| responder | Protidemia/BMI | 0,62 ; 0,39 | 0,000 | 9,94±7,5 | 100,5±5,14 | n.e. |
| predictor | EstimCtCl 1/CtS/BMI | | | | | |
| responder | Protidemia/BMI | 0,07 ; 0,005 | 0,689 | n.e | n.e. | n.e. |

| Tab 4B - 31 females - Relationships with Protidemia | | | | | | |
|---|---|---|---|---|---|---|
| regressions | Variables | R ; R² | p | percentage residuals | similarity | T test of residuals |
| predictor | MeasExcrCt/BMI | | | | | |
| responder | Protidemia/BMI | 0,43;0,18 | 0,016 | 14,9±11,3 | 101,6±9,3 | |
| predictor | EstimExcrCt 1/CtS100/BMI | | | | | |
| responder | Protidemia/BMI | 0,654;0,427 | 0,000 | 11,5±14,2 | 101,2±9,1 | 1,04 p 0,301 |
| predictor | EstimExcrCt 1/CtS /BMI | | | | | |
| responder | Protidemia/BMI | 0,435;0,189 | 0,014 | 14,88±11,3 | 101,6±9,3 | -1,04 p 0,304 |
| predictor | MeasCtCl/BMI | | | | | |
| responder | Protidemia/BMI | 0,325;0,106 | 0,07 | 15,4±11,2 | 101,7±9,5 | |
| predictor | EstimCtCl 1/CtS100/BMI | | | | | |
| responder | Protidemia/BMI | 0,467;0,218 | 0,008 | 13,5±12,7 | 101,5±9,2 | 0,67 p 0,503 |
| predictor | EstimCtCl 1/CtS/BMI | | | | | |
| responder | Protidemia/BMI | 0,329;0,108 | 0,07 | n.e. | n.e. | n.e. |

| Tab 5A - 65 males - Relationships of Variables concerning Serum Urea | | | | | | |
|---|---|---|---|---|---|---|
| regressions | Variables | R ; R² | p | percentage residuals | similarity | T test of residuals |
| predictor | MeasCtCl/min | | | | | |
| responder | serum urea | 0,21 ; 0,04 | 0,088 | 27,8±36,4 | 105,4±22,3 | |
| predictor | EstimCtCl/min 1/CtS100 | | | | | |
| responder | serum urea | 0,44 ; 0,19 | 0,0002 | 24,8±31,26 | 104,6±19,5 | 0,5 p 0.615 |
| predictor | EstimCtCl/min 1/CtS | | | | | |
| responder | serum urea | 0,215;0,046 | 0,086 | n.e. | n.e. | n.e. |
| predictor | MeasExcrCt/day | | | | | |
| responder | serum urea | 0,22 ; 0,05 | 0,07 | 28,8±38 | 105,6±23,3 | |
| predictor | EstimExcrCt/day 1/CtS100 | | | | | |
| responder | serum urea | 0,37 ; 0,14 | 0,0024 | 27,5±34,3 | 105±21,5 | 0,2 p 0.838 |
| predictor | EstimExcrCt/day 1/CtS | | | | | |
| responder | serum urea | 0,223;0,05 | 0,074 | n.e. | n.e. | n.e. |

Tables 5A and 5B display the relationships of the same variables with serum urea.

| Tab 5B - 79 females - Relationships of Variables concerning Serum Urea | | | | | | |
|---|---|---|---|---|---|---|
| regressions | Variables | R ; R² | p | percentage residuals | similarity | T test of residuals |
| predictor | MeasCtCl/min | | | | | |
| responder | serum urea | 0,11;0,013 | 0,322 | n.e | n.e. | |
| predictor | EstimCtCl/min 1/CtS100 | | | | | |
| responder | serum urea | 0,336;0,113 | 0,0026 | 21,0616,7 | 103±13,1 | n.e. |
| predictor | EstimCtCl/min 1/CtS | | | | | |
| responder | serum urea | 0,112 ; 0,012 | 0,322 | n.e | n.e. | n.e. |
| predictor | MeasExcrCt/day | | | | | |
| responder | serum urea | 0,145;0,02 | 0,203 | n.e | n.e. | |
| predictor | EstimExcrCt/day 1/CtS100 | | | | | |
| responder | serum urea | 0,28;0,08 | 0,014 | 21,5±16,4 | 103,3±16,7 | n.e. |
| predictor | EstimExcrCt/day 1/CtS | | | | | |
| responder | serum urea | 0,146; 0,021 | 0,2 | n.e. | n.e. | n.e. |

Tabs. 5A and 5B show the same observation as in practically all of the tables, the best, if not the only, significant correlation is attained by the estimated variables based on 1/CtS100.

## IV. Discussion

The fundamental aim of this elaboration was to verify which variable within MeasCtCl/min, EstimCtCl1/CtSD100, and EstimCtCl1/CtS and the corresponding MeasExcrCt, EstimExcrCt1/CtS100 and EstimExcrCT1/CtS would have the best correlation with MDRD GFR and with other variables defined in Premise section. The obtained results, as shown in the tables, can be summarized in a very simple observation : in 64 out of 66 regressions, the best correlation was attained by the estimates that were based on 1/CtS100, with only two exceptions. The first in Tab 2B with females, where MeasExcrCt and EstimExcrCt had the same degree of correlation versus BCM kg. The second exception shown in Tab. 3D with females concerning the regression of EstimExcrCt1/CtS versus BMI, with R 0,39 $R^2$ 0,15, and p 0,004 versus the result of EstimExcrCt1/CtS100, with R 0,25 R2 0,06, and p 0,028. The comment on the table notes that the percentage residuals of the fitted values were significantly lower that the regression of EstimExcrCt1/CtS100, evidently showing a more correct power of prediction by EstimExcrCt1/CtS100. Furthermore, It has to be emphasized that the estimates based on 1/CtS100 attained the only significant correlations with two variables, protidemia and serum urea, whereas the measured variables and the estimates based on 1/CtS did not attain significant results. The related data shown in Tabs. 4A,4B and 5A,5B, are reported as follows:1)males:Protidemia/BMI versus Estim ExcrCt1 /CtS100 /BMI , R 0,42 R2 0,18 p 0,009 – Protidemia/BMI versus EstimCtCl/min1/CtS100/BMI R 0,62 R2 0,39 p 0,000 –females:Protidemia/BMI versus Estim ExcrCt1 /CtS100/ BMI, R 0,654 R2 0,427 p 0,000 – Protidemia/BMI versus EstimCtCl/min1/CtS100/BMI R 0,467 R2 0,218 p 0,008 - 2) males - serum urea versus EstimExcrCt1/CtS100 R 0,37 R2 0,14 p 0,024 ; serum urea versus EstimCtCl/min1/CtS100 R 0,44 R2 0,19 p 0,0002 and females : serum urea versus EstimExcrCt1/CtS100 R 0,28 R2 0,08 p 0,014 - Serum urea versus EstimCtCl/min1/CtS100 R 0,336 R2 0,113 p 0,0026. Similarly, EstimExcrCt1/CtS100 with BCM kg was significantly correlated in males as well as in females; this correlation was absent with MeasExcrCt and EstimExcr1/CtS.

The correlation of BCM kg with Protidemia has to be considered an obvious relationship, taking into account that representing BCM kg the muscle mass, the greater will be this variable, the greater has to be the protein serum concentration and obviously the same considerations can be assumed on the correlation with serum urea in presence of renal insufficiency. The serum urea concentration results from its clearance but also from the protein input and is therefore indirectly related to the serum proteins concentration. Consequently, a parallelism necessarily exists with the creatinine pool, and the creatinine concentration is related to the creatinine excretion regarding the function of its clearance but also regarding the existing muscle mass. This leads to the conclusion that a direct relationship does exist between all the above mentioned variables, but it should be emphasized that of the three possible measures of excreted creatinine, measured excretion. estimated excretion by 1/CtS and estimated excretion by 1/CtS100, only the last and Estim/CtCl/min1/CtS100 attain significant correlation with all the above variables concerning muscle mass and, indirectly, the nutrition. The final consideration is that all the observations above strongly support the consistency that EstimCtCl/min1/CtS100 represents the measurement of actual creatinine clearance or a measurement very close to its actual size and that EstimExcrCt1/CtS100 is the correct measure of generated creatinine mass in condition of renal insufficiency or, in any case, an estimate very close to its real size.

## V. Conclusions

EstimCtCl1/CtS100 and EstimExcrCt1/CtS100, with two exceptions, consistently presented the best correlations with the variables in comparison with the results attained by MeasCtCl, MeasExcrCt and by EstimCtCl1/CtS and EstimExcrCt1/CtS, this verifying the fundamental aim of this work.The particular effectiveness of the estimates based on 1/CtS100 versus the correlated protidemia and serum urea and all of the considerations drawn above regarding the correlations within serum protein, serum urea, BCM and creatinine excretion demonstrate that the estimates based on 1/CtS100 most likely represent the values of actual creatinine clearance and of actual creatinine generated pool.

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LIST OF ABBREVIATIONS

| | |
|---|---|
| CtS | Serum creatinine mg/dl |
| 1/CtS | Inverse of serum creatinine mg/dl |
| 1/CtS100 | Inverse of serum creatinine mg/dl multiplied by 100 |
| MeasCtCl | Measured creatinine clearance ml/min |
| EstimCtCl1/CtS100 | Estimated creatinine clearance ml/min calculated by 1/CtS100 |
| EstimCtCl1/CtS | Estimated creatinine clearance ml/min calculated by 1/CtS |
| MeasExcrCt | Measured excreted creatinine mg/day |
| EstimExcrCt1/CtS100 | Estimated excreted creatinine mg/day calculated by1/CtS100 |
| EstimExcrCt1/CtS | Estimated excreted creatinine mg/day calculated by1/CtS |
| BMI | Body Mass Index |
| MeasCtCl/BMI | Measured creatinine clearance/min normalized on BMI |
| EstimCtCl1/CtS100/BMI | Estimated creatinine clearance/min by 1/CtS100 normalized on BMI |
| Protidemia | Total serum proteins g/dl |
| Protidemia/BMI | Total serum proteins normalized on BMI |
| BCM/BMI | Body Cellular Mass normalized on BMI |
| BCM%/BMI | Body Cellular Mass as percentage of body Weight normalized on BMI |
| ExtraCellW/BMI | Extra Cellular Water kg normalized on BMI n.e difference not evaluable. |