Estimating Creatinine Clearance from Serum Creatinine in Chronically Immobilized Nursing Home Residents

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Dear Sir,
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I am writing to comment on the interesting paper by Durakovic entitled 'Creatinine clearance in the elderly: a comparison of direct measurement and calculation from serum creatinine [1]. I have retrospectively compared directly measured 24-hour creatinine clearance (CrCl) determined with Foley catheter and that simultaneously predicted from the Cockcroft and Gault Equation (CG) in 15 chronically immobilized nursing home residents (age 47-92 years). I would like to share these preliminary data.

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min/

Creatinine clearance

100 ml/min $\times \frac{1.73 \text{ mg}}{A}$

100 ml

$(140 - \text{age, years}) \times \text{weight, kg}$

$= \frac{72 \times P \text{ mg/100 ml}}{1.73 \times A}$ body surface area.

72 $\times$ P mg/100 ml

(1) Drop out serum creatinine (1.73) on both sides leaving units of (mg/100 min)

$\frac{1.73 \text{ mg}}{100 \text{ min}} \times \frac{1.73 (140 - \text{age, years}) \times \text{weight, kg}}{100 \text{ min}} \times A$

(2) Transfer 1.73/A to the right

$\frac{1.73 \text{ mg}}{100 \text{ min}} \times \frac{1.73 (140 - \text{age, years}) \times \text{weight, kg}}{100 \text{ min}} \times A$

$\frac{1.73 \text{ mg}}{100 \text{ min}} \times \frac{1.73 (140 - \text{age, years}) \times \text{weight, kg}}{100 \text{ min}} \times A$

(3) Multiply both sides times 14.4

to calculate mg creatinine per 24 h from $\frac{1.73 \text{ mg}}{100 \text{ min}} \times \frac{1.73 (140 - \text{age, years}) \times \text{weight, kg}}{100 \text{ min}} \times A$

... 100 min

$14.4 \times \frac{1.73 \text{ mg}}{100 \text{ min}} \times \frac{1.73 (140 - \text{age, years}) \times \text{weight, kg}}{100 \text{ min}} \times A$

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$1.73 \text{ mg} \times (140 - \text{age, years}) \times \text{weight, kg} \times \frac{1.73}{100 \text{ min}}$

Using this formula the ratios of measured to predicted 24-hour creatinine excretion are the same as the ratio of measured to predicted creatinine clearance for each patient.

1 The 24-hour creatinine excretion predicted from the formula was calculated by this method: The accuracy of the Cockcroft and Gault equation is based on the assumption that muscle mass and creatinine excretion can be predicted from age, weight and sex [2]. Therefore, residents who appeared to have an abnormal relationship between muscle mass and total body weight were eliminated from the comparison. Four residents were excluded because of excess fluid weight and edema. One resident was excluded because of a lower extremity amputation. In Cockcroft and Gault's original data base from which the equation is derived, patients with instability of serum creatinine (i.e. > 20% recent change) were eliminated. Therefore, 2 residents were excluded because of > 20% variation in serum creatinine in the previous month. Of the 8 remaining residents with characteristics favorable for utilizing the equation, the average absolute difference between CG and CrCl was 46% of the CrCl (table I). In the original Cockcroft and Gault data base the standard error of the estimate was 20% [2]. The two youngest residents (both male) were chronically nonambulatory because of multiple sclerosis and a cervical cord lesion, respectively. I have previously reported that they displayed a striking overestimation of CrCl from CG (78 and 44 ml/min) [3]. The prediction of 24-hour CrCl is directly related to an estimate of 24-hour creatinine excretion. Simple algebra generates the following formula based on the original Cockcroft and Gault equation:

Predicted 24-hour creatinine excretion (mg) =

$$14.4 \times \text{Age} \times \text{Weight} \times \text{Sex} \times \text{Creatinine}^{-1}$$
 where Age = age in years, Weight = weight in kg, Sex = 1 for male, 0 for female, Creatinine = serum creatinine in mg/dl. A = body surface area.

In the case of the 47-year-old resident, the predicted 24-hour creatinine excretion was 1,580 mg while only 685 mg was measured. In the case of the 64-year-old resident, the predicted was 1,150 mg while the measured was 738 mg.

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Table I.

Age, years	Sex	Weight, kg	Height, ft-in	Serum creatinine, mg/dl	Creatinine clearance, ml/min
measured					predicted
47	M	75	5'7"	0.7	138
64	M	70	5'10"	0.6	123
74	M	52	5'10"	0.6	48
75	M	75	5'10"	0.6	68
86	F	63	5'3"	0.3	11
86	M	53	6'0"	0.8	50
88	F	76	5'7"	0.5	31
92	M	69	5'6"	1.2	38

Cockcroft and Gault's formula was based on data from hospitalized men. I suspect that the older group in their data base included greater degrees of chronic immobilization and muscle atrophy than the younger group. Therefore, a younger patient with marked immobility would be expected to be more divergent from this standard data base. Cockcroft and Gault noted the over-estimation of creatinine clearance by their equation in paraplegia and myotonic dystrophy, conditions in which muscle mass and creatinine excretion are predictably low for age, weight and sex [2]. I believe that clinicians should interpret the result of the Cockcroft and Gault equation with caution in chronically immobilized patients with muscle atrophy in whom 24-hour creatinine

excretion can apparently not be accurately predicted from age, weight and sex. More work is certainly needed to confirm this conclusion.

References

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