European Journal of
Nuclear
Medicine

Letter to the editor

A simple method of estimating glomerular filtration rate

Dear Sir,

In a recent contribution to the journal, Picciotto and co-workers concluded that, for chromium-51 ethylene diamine tetra-acetic acid (^{51}Cr-EDTA) plasma clearance rates greater than 30 ml/min in adults, the single sample method of Christensen and Groth provided a good alternative to multi-sample methods for the estimation of glomerular filtration rate (Christensen and Groth 1986; Picciotto et al. 1992). One possible drawback to the widespread use of this method is the apparent need for an iterative computer program to calculate the clearance. This requires access to both a computer and some programming skills in order to take advantage of the method.

On careful study of the above papers, it would appear that it is not necessary to use an iterative method and, in fact, the result can be easily obtained using a pocket calculator. This makes the method much more accessible.

If we consider Eq. (6) from the paper by Picciotto et al. (1992):

$$\mathrm{Cl} = -\ln(\mathrm{ECV}/\mathrm{V}_t)\cdot \mathrm{ECV}/(t\cdot \mathrm{g}(t))$$

where

Cl = Total ^{51}Cr-EDTA plasma clearance in ml/min

ECV = Extracellular volume in ml
= 8116.6 · surface area (m^2) − 28.2

V_t = ^{51}Cr-EDTA distribution volume at time t, in ml

and

$$\mathrm{g}(t) = (0.0000017t - 0.0012)\cdot \mathrm{Cl} - 0.000775t + 1.31$$

If we rewrite Eq. (6) as follows:

$$\mathrm{Cl}\cdot t\cdot \mathrm{g}(t) + \ln(\mathrm{ECV}/\mathrm{V}_t)\cdot \mathrm{ECV} = 0$$

and take $t = 180$ min, for instance, this equation becomes:

$$-0.1609\ \mathrm{Cl}^2 + 210.7\ \mathrm{Cl} + \ln(\mathrm{ECV}/\mathrm{V}_{180})\cdot \mathrm{ECV} = 0$$

This is a simple quadratic equation in Cl and is analogous to the standard form, $ax^2 + bx + c = 0$, with its two solutions

$$x = (-b \pm \sqrt{b^2 - 4ac})/2a = (-b/2a) \pm (\sqrt{b^2 - 4ac}/2a).$$

The values a and b are constants for a given time t, while c is calculated from the measured distribution volume at time t and the predicted ECV.

The following table lists values of a, b and c at different values of t.

t (min)	a	b	c
180	−0.1609	210.7	$\ln(\mathrm{ECV}/\mathrm{V}_{180})\cdot \mathrm{ECV}$
240	−0.1901	269.8	$\ln(\mathrm{ECV}/\mathrm{V}_{240})\cdot \mathrm{ECV}$
300	−0.2070	323.4	$\ln(\mathrm{ECV}/\mathrm{V}_{300})\cdot \mathrm{ECV}$

Therefore, in order to calculate the total plasma clearance, the above values are introduced into the following formula:

$$\mathrm{Cl} = (-b/2a) + (\sqrt{b^2 - 4ac}/2a)$$

(The first term on the right-hand side of the equation is positive and greater than 650 ml/min for $t \geq 180$ min, i.e. unphysiologically high for GFR. Therefore, as a is negative, only the positive value of $\sqrt{b^2 - 4ac}$ need be considered in the second term.)

Therefore, total ^{51}Cr-EDTA plasma clearance values can be easily obtained using a pocket calculator or a very simple computer program without the complication of an iterative procedure.

In line with the findings of Picciotto and co-workers, clearance values obtained using the above formula have been shown to yield results in close agreement with multi-sample estimates.

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References

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Picciotto G, Cacace G, Cesana P, Mosso R, Ropolo R, De Filippi PG (1992) Estimation of chromium-51 ethylene diamine tetra-acetic acid plasma clearance: a comparative assessment of simplified techniques. Eur J Nucl Med 19:30–35