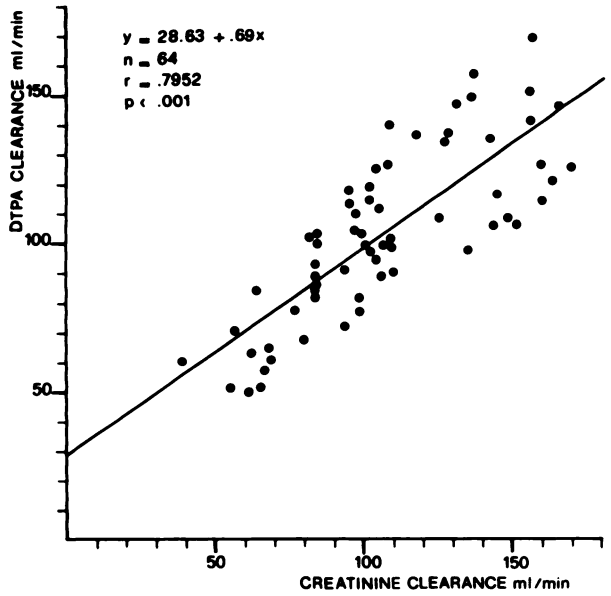

FIGURE 1
Correlation between 24-hr endogenous creatinine clearance and [^{99m}Tc]DTPA clearance (Gates' method) in 64 unselected adults

obtained a correlation of 0.79 (n 64, r 0.79, p <0.001, S x·y 17 ml/min) (Fig. 1).

The standard deviation observed was higher than that reported by Gates (*3*) and more similar to that reported by Russell (*4*) when comparing DTPA-GFR (Gates' method) and eight points plasma clearance of ytterbium-169-DTPA. However, caution must be paid when Cr-Cl is taken as the gold standard of GFR: Improper urine collection especially in the elderly and the children, tubular secretion and intestinal excretion, muscular mass and activity together with day by day variability (*5*) may render this parameter a less accurate reference of GFR.

In this regard, Cachati (*6*) has recently attempted a correlation between GFR determined by Gates' formula and inulin clearance, and obtained good results in both the total group (n 24, r 0.86, p ≤0.001, y = 18.52+ 4.68×) and the unilateral group (n 9, r 0.91, p <0.001, y = 15.89+ .66×), confirming the validity of this method.

In our patients, kidney depth had been previously measured in the lateral position during [^{99m}Tc]Aprotinin Uptake Test (*7*) with the aid of a skin marker. In this regard we agree with Ginjaume's comments: Only in about 50% of our patients, measured and estimated (Tønnesen's method (*8*) organ depth gave similar results, but the error introduced in the attenuation correction does not result in such a remarkable worsening of the correlation.

Although Gates GFR determination seems to provide less accurate results if compared with other methods requiring blood samples (*4*) its advantages in terms of imaging time, reproducibility (*2*), and lower probability of introducing errors in the calculation of blood clearance secure a measurement of glomerular function sufficiently exact for clinical use.

On the basis of these considerations we suggest that GFR determination by Gates' method might be suitably employed in the routine practice while different, more precise approaches should be confined to the research environment only or when a major accuracy is required.

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Measurement of Glomerular Filtration Rate

TO THE EDITOR: There have recently been two articles in the Journal describing methods for calculating glomerular filtration rate (GFR) from the level of tracer activity in one- or two-plasma samples following the injection of technetium-99m diethylenetriaminepentaacetic acid ([^{99m}Tc]DTPA), ytterbium-169 ([^{169}Yb] DTPA) (*1*) and iodine-125 or iodine-131 diatrizoate (DTZ) (*2*). Previous studies of this type have used chromium-51 (^{51}Cr) EDTA (*3,4*) which, although not available for injection in the United States, is available in most western European countries. As a result of such studies, we are confronted by an increasing number of rather similar equations for predicting GFR using a variety of tracers. In order to check whether the tracers are equivalent and to try to establish a "best buy" predictive equation, we have applied several of the equations to data obtained by us using chromium-51 EDTA as tracer. We have measured GFR by the standard technique of multiple blood sampling from 10 min to 3 hr following an i.v. injection of 0.02 mCi (0.75 MBq)

TABLE 1

Ref.	Tracer	Sample(s)	Slope —	Y intercept (ml/min)	r —	s.e.e. (ml/min)
(3)	[^{51}Cr]EDTA	2 hr, 3 hr	1.023 ± 0.023	−3.41 ± 1.84	0.989	4.2
(3)	[^{51}Cr]EDTA	1 hr, 3 hr	0.999 ± 0.023	−1.57 ± 1.90	0.988	4.3
(1)	[^{169}Yb]DTPA	1 hr, 3 hr	1.044 ± 0.029	−2.11 ± 2.32	0.984	5.3
(3)	[^{51}Cr]EDTA	3 hr	0.992 ± 0.029	−2.57 ± 2.33	0.982	5.3
(1)	[^{99m}Tc]DTPA	1 hr, 3 hr	1.042 ± 0.029	−2.33 ± 2.38	0.983	5.4
(4)	[^{51}Cr]EDTA	3 hr	1.176 ± 0.035	−10.21 ± 2.82	0.981	6.4
(1)	[^{169}Yb]DTPA	3 hr	1.059 ± 0.039	−4.22 ± 3.12	0.972	7.1
(1)	[^{99m}Tc]DTPA	3 hr	1.127 ± 0.041	−11.30 ± 3.31	0.972	7.5
(2)	[^{125}I/^{131}I]DTZ	2 hr	1.154 ± 0.065	−5.86 ± 5.23	0.936	11.9
(1)	[^{169}Yb]DTPA	2 hr	1.139 ± 0.069	−8.71 ± 5.56	0.927	12.7
(1)	[^{99m}Tc]DTPA	2 hr	1.172 ± 0.071	−18.42 ± 5.76	0.927	13.1

[^{51}Cr]EDTA and then fitting a double exponential function to the tracer disappearance curve. A total of 47 GFR results ranging in value from 20 to 140 ml/min in 37 patients were obtained with a maximum of three determinations for any one subject. Correlations have been sought between these "standard" GFR values (X axis) and values predicted from formulae in the references quoted above using one or two samples only (Y axis). If the various tracers are equivalent and if the one or two sample methods are acceptably accurate, then we would expect the linear correlation regression lines to have unit slope and a zero Y intercept while the correlation coefficients would be close to unity and the standard errors in the estimates, s.e.e., would be small. The results are shown in Table 1 in order of increasing standard error in the estimate.

From the table, it is apparent that [^{51}Cr]EDTA, [^{99m}Tc]DTPA and [^{169}Yb]DTPA are essentially equivalent as evidenced by the slope and Y intercept information for the first five entries. It is also apparent that, as indicated by Russell et al. (*1*), the two sample methods are generally superior while the 3-hr single-sample method gives an acceptable level of accuracy for most purposes. Unfortunately, we have been unable to apply a 3-hr single-sample formula obtained from the DTZ tracer data (*3*) because, although the author states that "for general use the 180-min sampling time may suffice", the necessary coefficients to be incorporated into his general prediction formula are not quoted for this sampling time. We have, however, incorporated our [^{51}Cr]EDTA data into the generally less satisfactory 2-hr prediction equation from the same reference which yields results very similar to those calculated using the 2-hr prediction formulae obtained with [^{99m}Tc] and [^{169}Yb]DTPA (*1*). Therefore, it is likely that all four tracers are equivalent when used for GFR determination.

From our study, it appears that if the added accuracy of a two-sample method is required, there is little to choose between the predictive equations of Refs. *1* and *3*. However, the predictive equations of Morgan et al. (*3*) using 1- and 3-hr and 2- and 3-hr samples are marginally superior to the alternatives; they came at the top of our league table based on lowest s.e.e. when using [^{51}Cr]EDTA tracer and the 1- and 3-hr equation was again marginally superior when used by Russell and associates to predict GFR from [^{99m}Tc] or [^{169}Yb]DTPA data (*1*). An additional advantage of this equation, and those of Ref. *1*, is that the sample time appears in the equation as a continuous variable so that minor variations about the correct sampling times are automatically accounted for without having to alter the "constants" in the equation as is required in some methods (*2*). Where a single-sample method is preferable, then, here again, the 3-hr predictive equation of Morgan et al. (*3*) appeared to be best, although in this case there is no automatic correction for minor variations in sampling time.

The criticism may be made that our data set is too small and that perhaps it would be more practical to perform the analysis on data from a larger number of patients with GFR values in the more clinically relevant range below 60 ml/min. To this end, we would be happy to provide our detailed data to anyone wishing to repeat the analysis with a larger database.

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REPLY: It is interesting that our glomerular filtration rate (GFR) formulas worked so well with chromium-51 EDTA, which is probably better than the agents for which our formulas were derived. Though technetium-99m diethylenetriaminepentaacetic acid ([^{99m}Tc]DTPA) permits imaging and split function measurements (which explains the dose we used), there are quality control problems with this agent (*1–3*). Ytterbium-169 DTPA has not been extensively studied as a GFR agent, and we have noticed some decomposition after