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Research Article

TO EVALUATE THE FORMULAE WITH 24 HOUR URINE CREATININE CLEARANCE IN ESTIMATING GLOMERULAR FILTRATION RATE IN CRITICALLY ILL PATIENTS

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ABSTRACT

Glomerular filtration rate is the most common variable used in the clinical practice for estimating the renal function. In this study, we compared the accuracy of Cockroft Gault formula and MDRD formula with the 24 hour urine creatinine clearance. The study is a cross sectional study conducted on 100 patients admitted to the ICU of Sri Lakshmi Narayana Institute of Medical sciences, Pondicherry. The mean glomerular filtration rate measured by 24 hours urine creatinine clearance was 44.75ml/min/1.73m2 (95% CI: 41.13 to 48.37). The mean glomerular rate calculated by Cockcroft-Gault formula was 56.48ml/min/1.73m2 (95%CI: 52.45 to 60.51) and by MDRD formula was 48.71ml/min/m2 (95% CI: 44.80 to 52.62), with p value <0.0001 for both the formulae. However both the formulas overestimate the GFR which in our study is 11.73ml/min for Cockcroft-Gault equation and 3.961ml/min for MDRD equation.

Keywords:-. GFR, intensive care, Cockcroft Gault formula, MDRD, Creatinine clearance.

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INTRODUCTION

Estimation of the glomerular filtration rate is important in clinical practice that too in intensive care setting. Most of antibiotics and drugs that are used in ICU setting are excreted via the kidney.

Serum creatinine is used to calculate GFR. But serum creatinine is dependent on age, sex, muscle mass and type of food consumed. So GFR based on serum creatinine is not accurate to decide about drug dosage and treatment.

GFR calculation by 24 urine creatinine clearance may correct some of the errors due to muscle mass and creatinine generation. But measurement of 24 hour creatinine clearance is not at all possible in treatment decision, because we have to wait for at least 24 hours to get the results [1].

In the meantime kidney function may change. So lot of formulas was devised to calculate GFR by using serum creatinine, age, sex and body weight. The MDRD formula and Cockcroft Gault equation are most commonly used to calculate GFR.

There are some unique issues with these patients in their hemodynamic instability, rapid change in kidney function, protein catabolic state and battery of medication which will affect the GFR calculation in these patients. So this study is designed to evaluate these formulas in critically ill patients.

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MATERIAL AND METHODS

This study was conducted in 100 adult patients in a medical Intensive Care Unit of Sri Lakshmi Narayana Institute of Medical sciences, Pondicherry.

Patients with ICU stay > 48 hours and <1 week and those with indwelling urinary catheter are included in the study. Patients with age less than 18 years, Pregnant women and those on hemodialysis or peritoneal dialysis, Those on vasoactive drugs, Urine output < 400 ml/day and Patients receiving diuretics are excluded from the study. After obtaining detailed informed consent from the patient detailed history and physical examination was done. Blood and urine was collected from the subjects and the sample was sent to biochemistry lab for analysis. Serum creatinine and urine creatinine were measured by Jaffe's calorimetric method. Urine was collected from 8 Am to next day 8 Am. first sample was discarded.

24 hours urine creatinine clearance was calculated by the following formula,

Creatinine clearance (ml/min) = (U * V)/ (P*1440),

then this was converted into body surface area by the using following formula

CrCl= (U*V*1.73)/P*1440*BSA); here U is urine creatinine, V is urine volume in 24 hours, P is serum creatinine, BSA is body surface area.

Body surface area was calculated by Du Bois formula

Body surface area= $Weight^{0.425}$*$Height^{0.725}$ * 0.20247

Estimated glomerular filtration rates(eGFR) is calculated by MDRD formula and by Cockcroft- Gault formula which is then converted to 1.73 m2 body surface area to compare with other two GFR.

This study is a Prospective cross sectional study conducted on 100 patiets from june 2019 to september 2019.

RESULTS

In this study mean age group of patients were 43.14 with standard deviation of 14.67; minimum age of the patient was 19 years and maximum age of the patient was 71 years. Out of 100 patients male patients were 62 and female patients were 38. (95% confidence interval for age was 40.23- 46.05). The mean glomerular filtration rate measured by 24 hours urine creatinine clearance was 44.75ml/min/1.73m2 (95% CI: 41.13 to 48.37).

The mean glomerular rate calculated by Cockcroft-Gault formula was 56.48ml/min/1.73m2 (95%CI: 52.45 to 60.51) and by MDRD formula was 48.71ml/min/m2 (95% CI: 44.80 to 52.62).Table1. Correlation coefficient for comparison of Cockcroft-Gault formula and 24 hour urine creatinine clearance is 0.90956 with p value of <0.0001. Correlation coefficient for comparison between GFR calculated by MDRD formula with 24 hour urine creatinine clearance is 0.9303 with p value of <0.0001(Table2). However application of these formulas to calculate GFR, leads to overestimation of GFR as shown by positive Bias. In our study which is 11.73ml/min for Cockcroft-Gault equation and 3.961ml/min for MDRD equation (Table 2).

DISCUSSION

Glomerular filtration rate is defined as volume of fluid filtered by the glomerular capillaries per unit time. It is expressed as ml/min/1.73m2 body surface area. Glomerular filtration rate is equal to clearance rate of the particular substance, when that particular substance is neither secreted nor absorbed from the tubular fluid.[2] In men approximate level of glomerular filtration rate is 125 to 135 ml/min/1.73m2 and in women the level is 115 to 125 ml/min/1.73m2**[1]**. There is inter individual variability due to exercise, diurnal variation and protein intake.

In humans, GFR can be determined exactly by measuring the clearance of an ideal filtration marker, such as inulin. Unlike inulin, creatinine is not a perfect filtration marker. This is because the substance is not only eliminated by glomerular filtration but also by tubular secretion. The extent of tubular creatinine secretion is not constant in various individuals.[3]

Methods using exogenous substances to assess renal function are expensive, time-consuming, risky and cannot be easily implemented in clinical practice. Additionally, creatinine clearance (CL_{cr}) has some limitations.[4]

Creatinine is hypersecreted progressively by remnant renal tubules as the disease worsens. Accordingly, attempts to use creatinine as a marker with which to evaluate or monitor glomerulopathic patients will result in gross and unpredictable overestimates of the GFR. Situations where accurate estimation of glomerular filtration rate needed are chronic illness (because of reduced muscle mass), drug dose adjustment, usage of iodinated contrast material, monitoring kidney transplant recipients, timing of access placement, pre-emptive transplantation and initiation of dialysis.[5]

Due to the limitations of the clearance tests, they are frequently replaced by estimation equations such as Cockcroft-Gault (C-G) and the modification of diet in renal disease (MDRD) formulas.

Cockcroft- Gault formula

EGFR = [(140-age) x (weight in Kg)] / [serum creatinine (mg/dl) x72]

Multiplied by 0.85 if patient is female; GFR calculated by CG formula was converted to 1.73 m2 body surface area to compare with other two GFR. [6]

Refitting the Cockcroft-Gault data to body surface area gave superior results compared to the original Cockcroft-Gault formula with an overall accuracy in the general and subgroup analysis above 70% agreement within 30% estimate of the measured creatinine clearance.[7]

MDRD estimated creatinine clearance (ml/min/1.73m2)

EGFR = 186 x [serum creatinine (mg/dl)] ^-1.154 x (age in years) ^-0.203

If the subject or patient is female the GFR is multiplied by 0.742.[8]

All subjects were analysed for SCr and subjected to 24-hour urine collection to estimate urine volume (V) and urine creatinine (UCr). The CL_{cr} was calculated by the following equation

$$\textbf{CCLcr (ml/min)=(UCr} \times \textbf{V)}$$

$$\textbf{SCrCCLcr (ml/min)=(UCr} \times \textbf{V)SCr}$$

The CL_{cr} was then adjusted to BSA to get CCL_{cr} in ml/min per 1.73 m² by the following formula, where BSA equals the square root ([height in cm x weight in Kg]/3600)

$$\textbf{CCLcr=(CLcr} \times \textbf{1.73)BSA}$$ [9]

Irrespective of the formula used [i.e. Cockcroft–Gault, or modified MDRD (Modified Diet in Renal Disease)], Nankivell or Schwartz formulae, the important issue is that any calculation is a better estimate of kidney function that serum creatinine alone. The purpose of the guidelines emphasis on estimated GFR is to improve the identification of kidney disease by transforming serum creatinine into a more meaningful measure.[10-11]

In critically ill patients there are several factors like hemodynamic instability, rapid change in kidney function, protein catabolic state and nephrotoxic drugs which will affect the GFR.[11] Hence in this study, the Cockcroft-Gault formula and MDRD formula are evaluated in critically ill patients and compared with 24hour creatinine clearance. Our study has revealed that these formulas to calculate GFR, leads to overestimation of GFR which is 11.73ml/min for Cockcroft-Gault equation and 3.961ml/min for MDRD equation.

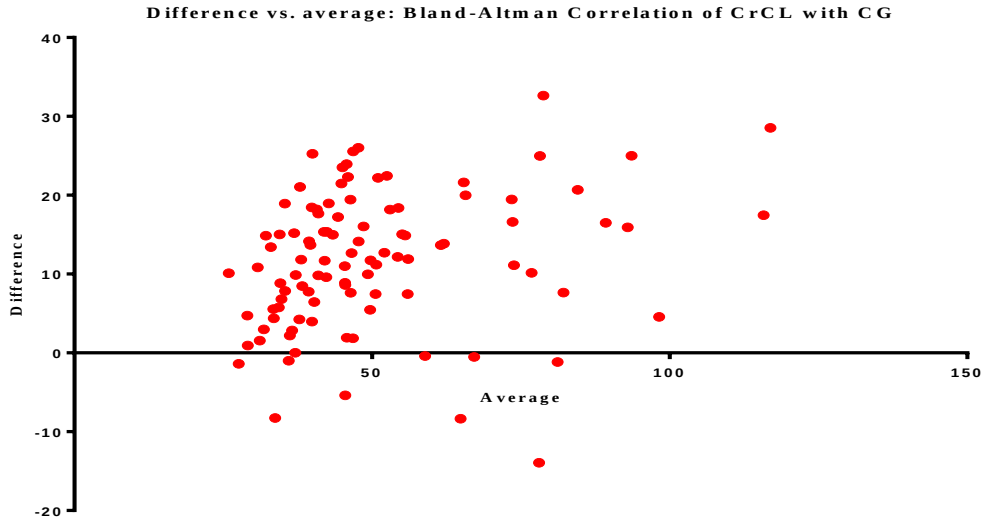
Table 1: Mean and standard deviation comparison

METHOD	MEAN±SD	MINIMUM	MAXIMUM
24 Hr Urine CrCl	44.75±18.22	20.89	107.05
CG FORMULA	56.48±20.30	26.89	131.16
MDRD	48.71±19.69	23.16	115.54

Table 2: Pearson correlation coefficient

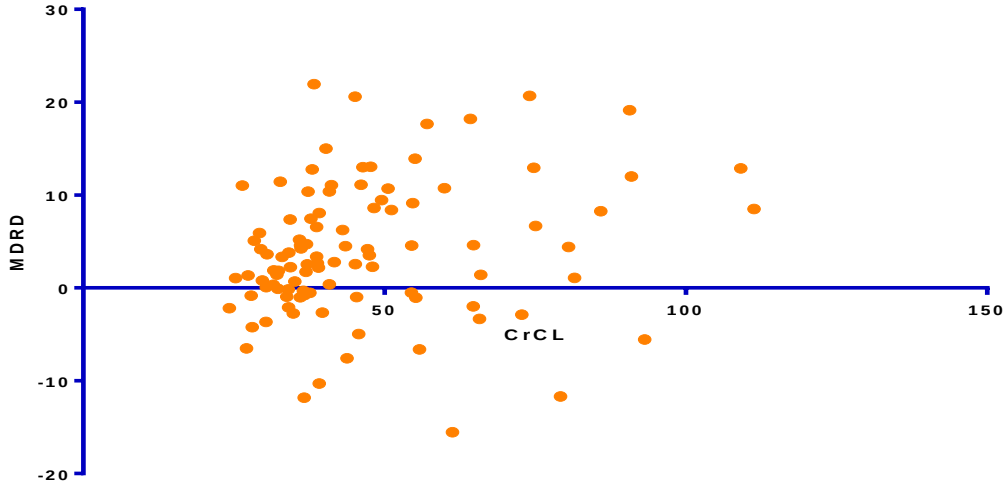
METHOD	BIAS	CORRELATION COEFFICIENT	P VALUE
CG/ 24 Hr Urine CrCl	11.73	0.9056	<0.0001
MDRD/ 24 Hr Urine CrCl	3.961	0.9303	<0.0001

Figure 1: Bland analysis correlation



Bias = 11.73, SD of bias 8.612

Figure 2: Bland Altman analysis



Bias = 3.961, SD of bias 7.225

CONCLUSION

In this study both CG and MDRD formulas have good correlation with 24 hour urine creatinine clearance. Because of convenience and cost, they can be used to assess the progression of disease. In clinical practice they have to interpret carefully because they tend to overestimate the actual glomerular filtration rate.

REFERENCES

1. Kharbanda M, Majumdar A, Basu S, Todi S. (2013). Assessment of accuracy of Cockcroft-Gault and MDRD formulae in critically ill Indian patients. Indian J Crit Care Med. 17, 71-5.
2. Stevens LA, Levey AS. (2005). Measurement of kidney function. Med Clin North Am. 89, 457–73.
3. Rahn KH, Heidenreich S, Brückner D. (1999). How to assess glomerular function and damage in humans. J Hypertens. 17, 309–17.
4. Magdi E. Al-Osali, Salim S. Al-Qassabi, Saud M. Al-Harthi. (2014). Assessment of Glomerular Filtration Rates by Cockcroft-Gault and Modification of Diet in Renal Disease Equations in a Cohort of Omani Patients. Sultan Qaboos University Med J. Vol. 14, Iss. 1, pp. e72- 79.
5. Shemesh O, Golbetz H, Kriss JP, Myers BD. (1985). Limitations of creatinine as a filtration marker in glomerulopathic patients. Kidney Int. 28, 830–8.
6. Cockcroft DW, Gault MH. (1976). Prediction of creatinine clearance from serum creatinine. Nephron. 16, 31–41.
7. Shoker A, Hossain MA, Koru-Sengul T, Raju DL, Cockcroft D. (2006). Performance of creatinine clearance equations on the original Cockcroft-Gault population. Clin Nephrol. 66, 89–97.
8. Levey AS, Bosch JP, Lewis JB, Greene T, Rogers N, Roth D. (1999). A more accurate method to estimate glomerular filtration rate from serum creatinine: A new prediction equation. Modification of Diet in Renal Disease Study Group. Ann Intern Med. 130, 461–70.
9. Inker LA, Perrone RD. (2012). Assessment of kidney function. From: www.uptodate.com/contents/assessment-of-kidney-function Accessed.
10. Levin A. (2003). The advantage of a uniform terminology and staging system for chronic kidney disease (CKD) Nephrol Dial Transplant. 18, 1446–51.
11. 11) Wilson RF, Soulilier G. (1980). The validity of two hour creatinine clearance studies in critically ill patients. Crit Care Med. 8, 281‑4.

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