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Original Research Article

COMPARISON OF $eGFR_{CG}$ AND mGFR IN CANCER PATIENTS TREATED WITH PLATINUM-BASED DRUGS INCLUDING CISPLATIN, CARBOPLATIN, AND OXALIPLATIN

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ABSTRAC

Background: Platinum-based chemotherapeutic agents—specifically cisplatin, carboplatin, and oxaliplatin—possess distinct nephrotoxic profiles that disrupt paradigms of renal handling. Accurate monitoring of renal function is vital to maximize therapeutic efficacy and mitigate life-threatening toxicities. This study presents a comparative evaluation of estimated Glomerular Filtration Rate ($eGFR_{CG}$) against standardized measured Glomerular Filtration Rate (mGFR) across successive chemotherapy cycles.

Materials and Methods: A comparative study was conducted involving 150 cancer patients, aged 18 to 60 years, divided into three groups (n = 50 each): Group I (Cisplatin), Group II (Carboplatin), and Group III (Oxaliplatin). Renal function was evaluated at baseline, before Cycle I, and before Cycle II of chemotherapy. Estimated GFR was calculated using the Cockcroft-Gault formula (expressed as creatinine clearance in ml/min), and measured GFR was determined directly via standard clearances (expressed in ml/min/1.73sqm) using 99mTc-DTPA radionuclide renography.

Results: A significant diagnostic lag was observed between $eGFR_{CG}$ and mGFR during early chemotherapy cycles. In Group I, Cycle I, mGFR detected an immediate reduction in renal function from a baseline of 85.49±20.83 to 66.66±22.40 mL/min/1.73sqm ($p=0.000$), while $eGFR_{CG}$ masked this sharp decline (92.09±15.49 to 82.52±20.01 mL/min; $p=0.034$). By Cycle II, both metrics recorded significant declines from baseline in Group I ($p=0.000$) and Group II ($p=0.002$ for $eGFR_{CG}$; $p=0.001$ for mGFR). Group III showed no significant changes. In both post-baseline cycles, Group I mGFR values were significantly lower ($p=0.000$) than those of Groups II and III. Across all groups, $eGFR_{CG}$ systematically overestimated baseline renal function across all patients by 5 to 9 mL/min compared to mGFR.

Conclusion: mGFR showed a significantly greater reduction than $eGFR_{CG}$, indicating that creatinine-based estimation systematically overestimates renal function, thereby masking acute, early-stage chemotherapy-induced nephrotoxicity. These findings underscore the clinical necessity of utilizing mGFR rather than serum creatinine measurements for accurate renal monitoring during active platinum-based chemotherapy cycles.

Keywords: Chemotherapy, Platinum drugs, Nephrotoxicity, $eGFR_{CG}$, Creatinine Clearance, mGFR, 99mTc-DTPA.

INTRODUCTION

Renal function assessment is critical in oncology patients receiving nephrotoxic agents such as platinum-based chemotherapy. Accurate estimation of glomerular filtration rate (GFR) is essential for drug dosing, preventing toxicity, and monitoring renal deterioration.[1]

Platinum-derived coordination compounds remain core mainstays within systemic combination regimens against solid malignancies. However, structural variations among individual platinum molecules lead to highly diverse systemic and regional toxicities. Cisplatin is famously associated with cumulative, dose-limiting nephrotoxicity localised within the S3 segment of the proximal straight tubules. Carboplatin relies entirely on passive glomerular filtration for systemic elimination, requiring accurate calculation via the GFR-driven Calvert formula to prevent profound myelosuppressive toxicities. Oxaliplatin replaces the amine groups of cisplatin with a 1,2-diaminocyclohexane carrier ligand, shifting the principal toxicity profile away from the renal parenchyma toward peripheral neurotoxicity.[2-4]

Despite these known traits, monitoring practices continue to debate whether Estimated Glomerular Filtration Rate (eGFR), was calculated using the Creatinine Clearance (CrCl, ml/min) formulas such as the Cockcroft-Gault (CG) equation based on serum creatinine,[5] or calculated mathematical Measured Glomerular Filtration Rate (mGFR) using a gold standard Technetium-99m diethylene-triamine-penta-acetic acid (Tc-99m DTPA) radionuclide renography, the safest window into a patient's true functional filtration status. Total body cachexia, fluid expansion therapy, and altered proximal tubule auto-secretion secondary to active malignancy complicate serum creatinine equilibrium.[6,7]

This paper uses longitudinal clinical data from sequential chemotherapy cycles to characterize clearance discrepancies between $eGFR_{CG}$ and mGFR in patients receiving cisplatin, carboplatin, or oxaliplatin.

MATERIALS AND METHODS

Study Population and Baseline Characteristics: The research was carried out at the Department of Physiology in close collaboration with the Department of Radiotherapy at Sardar Patel Medical College, Bikaner. Histopathologically confirmed 150 patients with different malignancies who received treatment with cisplatin, carboplatin, and oxaliplatin were examined for their renal function. Institutional ethical clearance was obtained from the ethical committee of S.P. Medical College, Bikaner, before the commencement of the study. Informed consent was obtained beforehand, and the whole procedure and the motive of the study were explained to the patients and their relatives. The oncology cohort was balanced evenly into three arms based on the assigned platinum drugs (n = 50 per group):

Study Group I (Cisplatin): Patients received cisplatin (50–75 mg/m²) plus 5-fluorouracil (1 g in 500 mL of normal saline) via intravenous infusion. Chemotherapy was administered on Days 1, 22, and 44. Pretreatment hydration and standard premedication were given before each cisplatin infusion.

Study Group II (Carboplatin): Patients received carboplatin (400 mg/m²) plus 5-fluorouracil (1 g in 500 mL of normal saline) via intravenous infusion on Days 1, 22, and 44. Antiemetics and supportive care were provided before treatment.

Study Group III (Oxaliplatin): Patients received oxaliplatin (85 mg/m²) in 500 mL of 5% dextrose, followed by leucovorin (50 mg in 500 mL of normal saline) via intravenous infusion. Treatment was administered on Days 1, 15, and 30 at two-week intervals.

Inclusion Criteria

Histopathologically confirmed patients with adequate renal function and haematological values; age limit: 18-60 years; chemotherapy-naive patients; no other serious medical or psychiatric illness. This is in accordance with the institutional and Government of India guidelines. Women/men of the reproductive age group must agree to use effective contraceptive methods.

Exclusion Criteria

Patients with urogenital cancer, systemic diseases, altered renal, not chemotherapy-naive, pregnant and lactating women, inability to eat orally, malabsorption syndrome, patients requiring more than six weeks' time to recover from side effects of drugs were excluded.

Investigations: Relevant routine laboratory investigations like haemoglobin (Hb), total leucocyte count (TLC), platelets, complete blood count (CBC), blood urea, serum creatinine, renogram, liver function tests (LFT), X-ray chest, ultrasonography abdomen, along with renal scanning using technetium-99m-diethyl-triamine-penta-acetic acid (99mTc-DTPA) were done before the start of cycles of treatment.

Renal performance biomarkers were collected across three clear longitudinal timeframes: Baseline (prior to cycle initiation), Cycle I (post-treatment follow-up), and Cycle II (post-treatment follow-up).

1. **Estimated Glomerular Filtration Rate ($eGFR_{CG}$):** Creatinine clearance (CrCl, mL/min) was estimated using the Cockcroft–Gault (CG) equation based on age, body weight, sex, and serum creatinine. The equation used was: CrCl = [(140 − age) × body weight (kg)] ÷ [72 × serum creatinine (mg/dL)] for males, with the calculated value multiplied by 0.85 for females. Serum creatinine was measured from fasting venous blood samples using standard laboratory methods.
2. **Measured Glomerular Filtration Rate (mGFR):** Calculated by using Gate's method. Dynamic kidney renography was performed using a computerized dual-head SPECT and whole-body digital gamma camera (Nuclear Spirit DH-V; MEDISO LIMITED; HQ Budapest, Hungary). After image acquisition, the patient's weight and height were entered into the system, on which all imaging data were recorded, and the

GFR was automatically calculated according to the Gate's method. The Gate's method is most commonly used to compute the GFR in DTPA renogram. In Gate's method, the percentage renal uptake (%RU) of 99mTc DTPA is computed first. In the mGFR method, 99mTc-DTPA is injected into the patient. It emits X-rays, which are picked up by a gamma camera and converted into electronic signals. These signals reflect renal functional status.

Data collection: After obtaining informed written consent, personal particulars such as age, gender, occupation, present and past history were documented. A general and systemic examination was performed, vital signs were recorded, and the outcome was documented.

Protocol of sample collection/Blinding: In this study, blinding was not possible, but attempts were made to minimize bias, wherever possible. Blood and urine samples were coded and stored until the final statistical analysis. No midterm analysis of the results was carried out. Care was taken to keep all four groups separate to prevent the exchange of information.

Statistical Analysis: Since the study was conducted in a single location, the geographical and climatic conditions were similar across all cases. Data were managed on Excel spreadsheets. The study variables were summarized by mean and standard deviation. For comparison of means, ANOVA and Student's t-test were employed where applicable, and probabilities were calculated using SPSS version 17.0 with the respective degrees of freedom. (SPSS Inc., Chicago, USA).

RESULTS

Table 1: Age distribution

Age (Years)	Study Group		
	Group I	Group II	Group III
18- 30	1	2	7
31-40	13	1	7
41-50	19	19	17
51-60	17	28	19
Total	50	50	50

[Table 1] shows the age distribution of subjects included in this study. The age distribution comprised 150 cancer patients (n=50 each). The average age of the patients was 32 to 60 years. Their ages ranged from 18 to 60 years, and most were in the 5th and 6th decades of life.

Table 2: Comparative Evaluation of mGFR (ml/min/1.73sqm) vs. $eGFR_{CG}$ (ml/min) level across chemotherapy cycles in study Groups

Group	Method	Baseline (Mean ± SD)	Cycle I (Mean ± SD)	Cycle II (Mean ± SD)	p value (Bl vs CI)	p value (Bl vs CII)
Group I	mGFR	85.49 ± 20.83	66.66 ± 22.40	58.09 ± 21.86	0.000	0.000
	$eGFR_{CG}$	92.09 ± 15.49	82.52 ± 20.01	76.60 ± 20.12	0.034	0.000
Group II	mGFR	84.86 ± 10.33	81.27 ± 9.74	75.55 ± 16.49	0.466	0.001
	$eGFR_{CG}$	92.74 ± 39.11	79.62 ± 29.90	71.00 ± 24.29	0.121	0.002
Group III	mGFR	87.38 ± 13.32	82.05 ± 13.92	81.02 ± 12.98	0.146	0.060
	$eGFR_{CG}$	94.40 ± 39.46	81.69 ± 25.50	79.80 ± 35.32	0.189	0.099

Note: $eGFR_{CG}$: Estimated Glomerular Filtration Rate via Cockcroft-Gault in ml/min; mGFR: Measured Glomerular Filtration Rate in in ml/min/1.73sqm; BL: baseline; CI: Cycle I; CII: Cycle II; SD: standard deviation. p values < 0.05 denote statistical significance.

[Table 2] presents a comparative evaluation of measured glomerular filtration rate (mGFR) and estimated glomerular filtration rate ($eGFR_{CG}$) across chemotherapy cycles. At baseline, $eGFR_{CG}$ systematically overestimated renal function across all cohorts by approximately 5 to 9 ml/min compared to mGFR, yielding baseline differences of 92.09 ± 15.49 ml/min versus 85.49 ± 20.83 ml/min/1.73sqm in Group I, 92.74 ± 39.11 ml/min versus 84.86 ± 10.33 ml/min/1.73sqm in Group II, and 94.40 ± 39.46 ml/min versus 87.38 ± 13.32 ml/min/1.73m² in Group III [Figure 1].

During the transition to Cycle I, a critical diagnostic lag emerged between the two methodologies. In Group I, mGFR showed an immediate, profound reduction in actual filtration capacity, falling sharply to 66.66 ± 22.40 ml/min/1.73sqm ($p = 0.000$). Conversely, $eGFR_{CG}$ masked the severity of this early-stage injury, recording a more modest decline to 82.52 ± 20.01 ml/min ($p = 0.034$). By Cycle II, cumulative renal damage registered significantly on both metrics for Group I ($p = 0.000$ for both) and Group II, where mGFR and $eGFR_{CG}$ dropped to 75.55 ± 16.49 ml/min/1.73sqm ($p = 0.001$) and 71.00 ± 24.29 ml/min ($p = 0.002$), respectively. In Group III, no statistically significant variations from baseline were observed for either mGFR ($p = 0.146$ in Cycle I, $p = 0.060$ in Cycle II) or eGFRCG ($p = 0.189$ in Cycle I, $p = 0.099$ in Cycle II), showing concordance only when acute toxicity was absent.

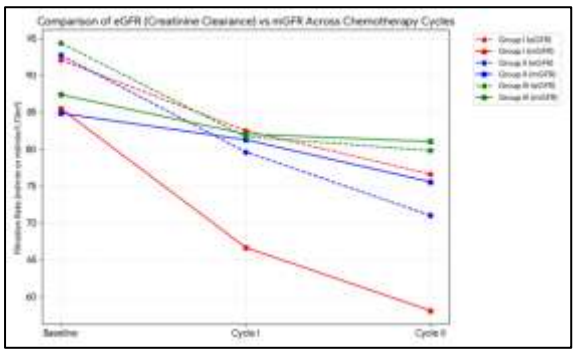


Figure 1: Comparative longitudinal analysis of renal clearance between radionuclide mGFR and $eGFR_{CG}$ across successive chemotherapy cycles.

DISCUSSION

The findings of this study demonstrate a critical clinical discrepancy between the estimated glomerular filtration rate (eGFR) calculated using the Cockcroft-Gault formula and the measured glomerular filtration rate (mGFR) in patients undergoing chemotherapy. Most notably, $eGFR_{CG}$ exhibits a significant diagnostic lag in detecting acute declines in renal function during early treatment cycles, thereby introducing an immediate risk of underestimating chemotherapy-induced nephrotoxicity in clinical practice.[6,8]

The pathophysiological mechanism underlying this lag stems from $eGFR_{CG}$'s reliance on serum creatinine. Serum creatinine is a structural byproduct of muscle metabolism that is excreted via glomerular filtration. When chemotherapy agents induce acute tubular injury or sudden glomerular damage, the actual filtration rate (mGFR) drops instantaneously.[9] However, serum creatinine does not rise instantly; it takes days to accumulate in the bloodstream to a level that noticeably alters mathematical estimation equations. Furthermore, cancer patients frequently experience muscle wasting (sarcopenia), malnutrition, and weight loss during chemotherapy cycles. Because the Cockcroft-Gault formula incorporates body weight and assumes a stable muscle mass for steady-state creatinine production, progressive cachexia artificially lowers serum creatinine levels. This physiological shift falsely elevates the calculated $eGFR_{CG}$, masking true renal impairment and obscuring severe, real-time declines in glomerular filtration.[10,11]

The clinical implications of this diagnostic lag are profound, particularly concerning patient safety and oncological drug dosing:[6]

Subtherapeutic or Toxic Chemotherapy Dosing: Many critical chemotherapeutic agents—especially nephrotoxic agents such as cisplatin, carboplatin, and methotrexate—require strict renal threshold cutoffs for dose calculations or treatment eligibility. Because $eGFR_{CG}$ overestimates true renal function during early cycles (e.g., assessing Group I at 82.52 mL/min instead of the true mGFR of 66.66 mL/min/1.73m²), patients are at an elevated risk of receiving full, toxic doses of chemotherapy when a dose reduction or regimen switch is clinically indicated.

Delayed Nephroprotective Interventions: In clinical practice, early detection of renal injury triggers immediate interventions, such as aggressive intravenous hydration, extending intervals between cycles, or administering nephroprotective agents. The lag in creatinine-based equations delays these protective protocols until Cycle II or later, allowing cumulative, preventable parenchymal damage to occur.

Flawed Monitoring in Sarcopenic Patients: Cancer-induced cachexia and malnutrition alter creatinine production, rendering serum creatinine an unfaithful biomarker. Overreliance on $eGFR_{CG}$ in an oncology population introduces a systematic blind spot where progressive muscle wasting actively masks worsening renal failure.

Consequently, $eGFR_{CG}$ is not a reliable surrogate for mGFR in this clinical setting. Substituting mGFR with creatinine-based equations risks delaying necessary chemotherapy dose adjustments, cycle deferrals, or aggressive hydration protocols, thereby exposing vulnerable oncology patients to cumulative, irreversible renal damage. For high-risk, nephrotoxic chemotherapy regimens, relying solely on eGFRCG is insufficient for real-time monitoring. In centers where direct mGFR (such as DTPA, or EDTA clearance) is unavailable, clinicians should complement creatinine-based estimates with alternative biomarkers that do not depend on muscle mass, such as Cystatin C, or implement mandatory, heightened monitoring protocols during the initial treatment cycles.[12]

CONCLUSION

In conclusion, this study demonstrates that the Cockcroft-Gault formula eGFRCG cannot reliably replace measured glomerular filtration rate (mGFR) for monitoring renal function in cancer patients undergoing active chemotherapy. Due to its systemic reliance on serum creatinine, eGFRCG exhibits a dangerous diagnostic lag that masks acute, early-stage chemotherapy-induced nephrotoxicity and overestimates initial baseline capacity. This limitation is compounded by chemotherapy-associated muscle wasting, which artificially inflates estimated filtration rates despite declining physical kidney function. To ensure patient safety, prevent toxic drug overdosing, and permit timely nephroprotective interventions, direct mGFR assessment or alternative biomass-independent markers should be utilized as the standard of care during nephrotoxic oncology regimens.

REFERENCES

1. Malyszko J, Lee MW, Capasso G, Kulicki P, Matuszkiewicz-Rowinska J, Ronco P, Stevens P, Tesarova P, Viggiano D, Capasso A. How to assess kidney function in oncology

patients. Kidney Int. 2020;97(5):894-903. doi:10.1016/j.kint.2019.12.023.
2. Zhang C, Xu C, Gao X, Yao Q. Platinum-based drugs for cancer therapy and anti-tumor strategies. Theranostics. 2022 Feb 7;12(5):2115-2132. doi: 10.7150/thno.69424.
3. Van Warmerdam LJ, Rodenhuis S, ten Bokkel Huinink WW, Maes RA, Beijnen JH. The use of the Calvert formula to determine the optimal carboplatin dosage. J Cancer Res Clin Oncol. 1995; 121(8):478-86. doi: 10.1007/BF01218365.
4. Watanabe D, Fujii H, Matsuhashi N, Iihara H, Yamada Y, Ishihara T, Takahashi T, Yoshida K, Suzuki A. Dose adjustment of oxaliplatin based on renal function in patients with metastatic colorectal cancer. Anticancer Res. 2020; 40(4):2379-2386. doi:10.21873/anticanres.14207.
5. Cockcroft DW, Gault MH. Prediction of creatinine clearance from serum creatinine. Nephron. 1976;16(1):31-41. doi:10.1159/000180580.
6. Arora A, Shukla P, Srinivasan V, Oteiza LZ, LeMense Z, Vang G, Hanna PE. GFR evaluation among patients with cancer: insights and clinical implications. Cancers (Basel). 2026;18(3):351. doi:10.3390/cancers18030351.
7. Chiewvit S, Larpparisuth N. A comparison of the renal function between GFR from Tc-99m DTPA renography and serum creatinine, serum BUN, eGFR by CKD-EPI equation, and 24-hour urine creatinine clearance in Thai living related kidney donors. J Med Assoc Thai. 2022;105:729-733. doi:10.35755/jmedassocthai.2022.08.10778.
8. McMahon BA, Rosner MH. GFR Measurement and Chemotherapy Dosing in Patients with Kidney Disease and Cancer. Kidney360. 2020 Jan 13;1(2):141-150. doi: 10.34067/KID.0000952019.
9. Choudhary R, Bundela M K, Bharang K. Comparison of Renal Functions Evaluated by Measured Glomerular Filtration Rate in Patients Treated With Cisplatin, Carboplatin, and Oxaliplatin. Cureus, March2023; 15(3): e36549. doi 10.7759/cureus.36549.
10. Claudel SE, Gandhi M, Patel AB, Verma A. Estimating kidney function in patients with cancer: A narrative review. Acta Physiol (Oxf). 2023 Jun;238(2):e13977. doi: 10.1111/apha.13977.
11. Chancharoenthana W, Wattanatorn S, Vadcharavivad S, Eiam-Ong S, Leelahavanichkul A. Agreement and precision analyses of various estimated glomerular filtration rate formulae in cancer patients. Sci Rep. 2019;9:19356. doi:10.1038/s41598-019-55833-0.
12. Kitchlu A, Silva VTCE, Anand S, Kala J, Abudayyeh A, Inker LA, Rosner MH, Karam S, Gudsoorkar P, Gupta S, Chen S, Klomjit N, Leung N, Milanez T, Motwani SS, Khalid SB, Srinivasan V, Wanchoo R, Beumer JH, Liu G, Tannir NM, Orchanian-Cheff A, Geng Y, Herrmann SM. Assessment of GFR in Patients with Cancer: A Statement from the American Society of Onco-Nephrology. Clin J Am Soc Nephrol. 2024 Aug 1;19(8):1061-1072. doi: 10.2215/CJN.0000000000000508.