MAYO CLINIC LABORATORIES

Test Definition: CRTS1

Creatinine with Estimated Glomerular Filtration Rate (eGFR), Serum

Overview

Useful For

Diagnosing and monitoring treatment of acute and chronic kidney diseases

Adjusting dosage of renally excreted medications

Monitoring kidney transplant recipients

Estimating glomerular filtration rate for people with chronic kidney disease (CKD) and those with risk factors for CKD (diabetes, hypertension, cardiovascular disease, and family history of kidney disease)

Method Name

Colorimetric

NY State Available

Yes

Specimen

Specimen Type

Serum

Necessary Information

Patient's age and sex are required.

Specimen Required

Collection Container/Tube:

Preferred: Serum gel

Acceptable: Red top

Submission Container/Tube: Plastic vial

Specimen Volume: 0.5 mL

Collection Instructions:

1. Serum gel tubes should be centrifuged within 2 hours of collection.
2. Red-top tubes should be centrifuged and the serum aliquoted into a plastic vial within 2 hours of collection.

Forms

If not ordering electronically, complete, print, and send 1 of the following forms with the specimen:

-Kidney Transplant Test Request

-Renal Diagnostics Test Request (T830)

Specimen Minimum Volume

0.5 mL

Reject Due To

Gross hemolysis	Reject

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Serum	Refrigerated (preferred)	7 days	
	Ambient	24 hours	
	Frozen	90 days	

Clinical & Interpretive

Clinical Information

In muscle metabolism, creatinine is synthesized endogenously from creatine and creatine phosphate. Creatinine is removed from plasma by glomerular filtration into the urine without being reabsorbed by the tubules to any significant extent. Renal tubular secretion also contributes a small quantity of creatinine to the urine. As a result, creatinine clearance often overestimates the true glomerular filtration rate (GFR) by 10% to more than 20%.

Determinations of creatinine and renal clearance of creatinine are of value in the assessment of kidney function. Serum or blood creatinine levels in kidney disease generally do not increase until kidney function is substantially impaired.

Estimated GFR (eGFR) is calculated using the 2021 Chronic Kidney Disease (CKD) Epidemiology Collaboration (EPI) Cr equation:

eGFR =142 x min(standardized Scr/K,1)alpha x max(Scr/K, 1)-1.200 x 0.9938age x 1.012(if patient is female)
-where age is in years
-Scr is serum creatinine
-k is 0.7 for females and 0.9 for males
-alpha is -0.241 for females and -0.302 for males
-min indicates the minimum of Scr/k or 1
-max indicates the maximum of Scr/k or 1
Use of an estimating or prediction equation to estimate GFR from serum creatinine should be employed for people with CKD and those with risk factors for CKD (diabetes, hypertension, cardiovascular disease, and family history of kidney disease). Reasons given for routine reporting of eGFR with every serum creatinine in adult (18 and over) patients include:
-GFR and creatinine clearance are poorly inferred from serum creatinine alone. GFR and creatinine clearance are inversely and nonlinearly related to serum creatinine. The effects of age and sex further cloud interpretation.

-Creatinine is commonly measured in routine clinical practice. Albuminuria (>30 mg/24 hour or urine albumin to creatinine ratio >30 mg/g) may be a more sensitive marker of early kidney disease, especially among patients with diabetic nephropathy. However, there is poor adherence to guidelines that suggest annual urinary albumin testing of patients with known diabetes. Therefore, if a depressed eGFR is calculated from a serum creatinine measurement, it may help providers recognize early CKD and pursue appropriate follow-up testing and therapeutic intervention.
-Monitoring of kidney function (by GFR or creatinine clearance) is essential once albuminuria is discovered. Estimated GFR is a more practical means to closely follow changes in GFR over time, when compared to direct measurement using methods such as iothalamate clearance.
-The CKD-EPI equation does not require weight or height variables. From a serum creatinine measurement, it generates a GFR result normalized to a standard body surface area (1.73 m[2]) using sex and age. Unlike the Cockcroft-Gault equation, height and weight, which are often not available in the laboratory information system, are not required. The 2021 CKD-EPI Cr equation does not require race, so eGFR values for both African Americans and non-African Americans are no longer reported. The new 2021 CKD-EPI eGFR values cannot be directly compared to the previous 2009 CKD-EPI Cr eGFR values that were separately reported for African American and non-African American populations.

The Kidney Disease: Improving Global Outcomes (KDIGO) CKD work group clinical practice guideline,(2) as further defined by the National Kidney Foundation-Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) commentary,(3) provide the following recommendations for reporting and interpretation of serum creatinine and eGFR, which were revised after development of a refit CKD-EPI Creatinine eGFR equation in 2021 that does not require a mathematical adjustment based on race:
-1.4.3: Evaluation of GFR
-1.4.3.1: We recommend using serum creatinine and a GFR estimating equation for initial assessment. (1A)

1.4.3.2: We suggest using additional tests (such as cystatin C or a clearance measurement) for confirmatory testing in specific circumstances when eGFR based on serum creatinine is less accurate. (2B)

1.4.3.3: We recommend that clinicians (1B):
-Use a GFR estimating equation to derive GFR from serum creatinine (eGFRcreat) rather than relying on the serum creatinine concentration alone.
-Understand clinical settings in which eGFRcreat is less accurate.

1.4.3.4: We recommend that clinical laboratories should (1B):
-Measure serum creatinine using a specific assay with calibration traceable to the international standard reference materials and minimal bias compared to isotope-dilution mass spectrometry (IDMS) reference methodology.
-Report eGFRcreat in addition to the serum creatinine concentration in adults and specify the equation used whenever reporting eGFRcreat.
-Report eGFRcreat in adults using the 2021 CKD-EPI creatinine equation.

When reporting serum creatinine:
-We recommend that serum creatinine concentration be reported and rounded to the nearest whole number when expressed as standard international units (mmol/l) and rounded to the nearest 100th of a whole number when expressed as conventional units (mg/dL).

When reporting eGFRcreat:

-We recommend that eGFRcreat should be reported and rounded to the nearest whole number and relative to a body surface area of 1.73 m2 in adults using the units mL/min/1.73 m2.
-We recommend eGFRcreat levels less than 60 mL/min/1.73 m2 should be reported as "decreased."

1.4.3.8: We suggest measuring GFR using an exogenous filtration marker under circumstances where more accurate ascertainment of GFR will impact treatment decisions (2B)

Reference Values

CREATININE
Males(1)
0-11 months: 0.17-0.42 mg/dL
1-5 years: 0.19-0.49 mg/dL
6-10 years: 0.26-0.61 mg/dL
11-14 years: 0.35-0.86 mg/dL
> or =15 years: 0.74-1.35 mg/dL

Females(1)
0-11 months: 0.17-0.42 mg/dL
1-5 years: 0.19-0.49 mg/dL
6-10 years: 0.26-0.61 mg/dL
11-15 years: 0.35-0.86 mg/dL
> or =16 years: 0.59-1.04 mg/dL

ESTIMATED Glomerular Filtration Rate (eGFR)
> or =18 years old: > or =60 mL/min/BSA (body surface area)

Note: eGFR results will not be calculated for patients younger than 18 years old.
Estimated GFR calculated using the 2021 CKD-EPI creatinine equation
2021 CKD-EPI creatinine eGFR not valid for patients younger than 18 years old.

Interpretation

Because serum creatinine is inversely correlated with glomerular filtration rate (GFR), when kidney function is near normal, absolute changes in serum creatinine reflect larger changes than do similar absolute changes when kidney function is poor. For example, an increase in serum creatinine from 1 to 2 mg/dL may indicate a decrease in GFR of 50 mL/min (from 100 to 50 mL/min), whereas an increase in serum creatinine level from 4 to 5 mg/dL may indicate a decrease of only 5 mL/min (from 25 to 20 mL/min).

Because of the imprecision of serum creatinine as an assessment of GFR, there may be clinical situations where a more accurate GFR assessment must be performed, iothalamate or inulin clearance are superior to serum creatinine and eGFR.

Several factors may influence serum creatinine independent of changes in GFR. For instance, creatinine generation is dependent upon muscle mass. Thus, young, muscular male patients may have significantly higher serum creatinine levels than older adult female patients, despite having similar GFRs. Also, because some renal clearance of creatinine is

due to tubular secretion, drugs that inhibit this secretory component (eg, cimetidine and trimethoprim) may cause small increases in serum creatinine without an actual decrease in GFR.

According to the Kidney Disease: Improving Global Outcomes (KDIGO) CKD work group, chronic kidney disease (CKD) is defined as the abnormalities of kidney structure or function, present for more than 3 months, with implications for health.(3) CKD should be classified by cause, GFR category, and albuminuria category.(3)

Table. KDIGO guidelines provide the following GFR categories(2,3):

Stage	Terms	GFR mL/min/1.73 m(4)
G1*	Normal or high	90
G2*	Mildly decreased	60 to 89
G3a	Mildly to moderately decreased	45 to 59
G3b	Moderately to severely decreased	30-44
G4	Severely decreased	15-29
G5	Kidney failure	<15

*In the absence of evidence of kidney damage, neither G1 nor G2 fulfill criteria for CKD.

Cautions

Creatinine:
-Ascorbic acid: less than 1.70 mmol/L or less than 300 mg/dL does not interfere.
-No interference was found at therapeutic concentrations using common drug panels. Exceptions: rifampicin, levodopa, and calcium dobesilate (Dexium) cause artificially low creatinine results. Dicynone (Etamsylate) at therapeutic concentrations may lead to falsely low results.
-N-Ethylglycine at therapeutic concentrations and DL-proline at concentrations greater than or equal to 1 mmol/L give falsely high results.
-No significant interference up to creatine level of 4 mmol/L (524 mg/L).
-Hemolyzed specimens from patients with hemoglobin F values of 600 mg/dL and higher interfere with the test.
-2-Phenyl-1,3-indandion (phenindione) at therapeutic concentrations interferes with the assay.
-In patients receiving catecholamines (dopamine, dobutamine, epinephrine, and norepinephrine) falsely low results might be observed.(4)
-Acetaminophen intoxications are frequently treated with N-acetylcysteine. N-Acetylcysteine at the therapeutic concentration of 3.4 mmol/L and the acetaminophen metabolite N-acetyl-p-benzoquinone imine independently may cause falsely low creatinine results.
-Venipuncture should be performed prior to the administration of metamizole. Venipuncture immediately after or during the administration of metamizole may lead to falsely low results. A significant interference may occur at any plasma metamizole concentration.
-In very rare cases of gammopathy, in particular Waldenstrom macroglobulinemia (type IgM), may cause unreliable results.
The following do not interfere with this assay:
-Ketone bodies

-Cephalosporin antibiotics

Clinical Reference

1. Kulasingam V, Jung BP, Blasutig IM, et al: Pediatric reference intervals for 28 chemistries and immunoassays on the Roche cobas 6000 analyzer--a CALIPER pilot study. Clin Biochem. 2010 Sep;43(13-14):1045-1050
2. Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group: KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl. 2013;3:1-150
3. Inker LA, Astor BC, Fox CH, et al: KDOQI US commentary on the 2012 KDIGO clinical practice guideline for the evaluation and management of CKD. Am J Kidney Dis. 2014 May;63(5):713-735
4. Saenger AK, Lockwood C, Snozek CL, et al: Catecholamine interference in enzymatic creatinine assays. Clin Chem. 2009 Sep;55(9):1732-1736
5. Rifai N, Horvath AR, Wittwer CT, eds: Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics. 8th ed. Elsevier; 2018
6. Miller WG, Kaufman HW, Levey AS, et al: National Kidney Foundation Laboratory Engagement
Working Group recommendations for implementing the CKD-EPI 2021 race-free equations for estimated glomerular filtration rate: Practical guidance for clinical laboratories. Clin Chem. 2022 Mar 31;68(4):511-520. doi: 10.1093/clinchem/hvab278
7. Inker LA, Eneanya ND, Coresh J, et al: Chronic Kidney Disease Epidemiology Collaboration. New creatinine- and cystatin C-Based equations to estimate GFR without race. N Engl J Med. 2021 Nov 4;385(19):1737-1749. doi: 10.1056/NEJMoa2102953

Performance

Method Description

Creatinine:
This enzymatic method is based on the conversion of creatinine with the aid of creatininase, creatinase and sarcosine oxidase to form glycine, formaldehyde and hydrogen peroxide. Catalyzed by peroxidase the liberated hydrogen peroxide reacts with 4-aminophenazone and HTIB (2,4,6-triiodo03-hydroxybenzoic acid) to form a quinone imine chromogen. The color intensity of the quinone imine chromogen formed is directly proportional to the creatinine concentration in the reaction mixture.(Package insert: Creatinine plus ver.2. Roche Diagnostics; 07/2024)

Estimated Glomerular Filtration Rate:
Estimated GFR (eGFR) is calculated using the 2021 Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation:
Females:
If creatinine < or =0.7 mg/dL: 142 x (Scr/0.7)(-0.241) x 0.9938age x 1.012
If creatinine >0.7 mg/dL: 142 x (Scr/0.7)(-1.200) x 0.9938age x 1.012

Males:
If creatinine < or =0.9 mg/dL: 142 x (Scr/0.9)(-0.302) x 0.9938age
If creatinine >0.9 mg/dL: 142 x (Scr/0.9)(-1.200) x 0.9938age
Values are reported for calculated glomerular filtration rate (GFR) estimates between 15-90 mL/min/1.73 m(4).

Estimated GFR values outside of this range are reported as "<15 mL/min/1.73 m(2)" or ">90 mL/min/1.73 m(4)" and not as an exact number.

PDF Report
No

Day(s) Performed
Monday through Sunday

Report Available
Same day/1 to 2 days

Specimen Retention Time
1 week

Performing Laboratory Location
Mayo Clinic Laboratories - Rochester Main Campus

Fees & Codes

Fees
- Authorized users can sign in to Test Prices for detailed fee information.
- Clients without access to Test Prices can contact Customer Service 24 hours a day, seven days a week.
- Prospective clients should contact their account representative. For assistance, contact Customer Service.

Test Classification
This test has been cleared, approved, or is exempt by the US Food and Drug Administration and is used per manufacturer's instructions. Performance characteristics were verified by Mayo Clinic in a manner consistent with CLIA requirements.

CPT Code Information
82565

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
CRTS1	Creatinine with eGFR, S	45066-8

Result ID	Test Result Name	Result LOINC® Value
CRTSA	Creatinine, S	2160-0
EGFR1	Estimated GFR (eGFR)	98979-8