MAYO CLINIC LABORATORIES

Test Definition: CRCL

Creatinine Clearance, Serum and 24-Hour Urine

Overview

Useful For
Estimation of glomerular filtration rate

Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
CRTS1	Creatinine with eGFR, S	Yes	Yes
CRCU	Creatinine, U	No	Yes

Special Instructions
- Urine Preservatives-Collection and Transportation for 24-Hour Urine Specimens

Method Name
Enzymatic Colorimetric Assay

NY State Available
Yes

Specimen

Specimen Type
Serum
Urine

Necessary Information
1. 24-Hour volume is required.
2. Patient's height in centimeters and weight in kilograms are required.

Specimen Required
Both serum and urine are required. Serum must be collected no earlier than 72 hours before start of urine collection and no later than 72 hours after urine collection is completed.

Specimen Type: Serum
Collection Container/Tube:
Preferred: Serum gel
Acceptable: Red top
Submission Container/Tube: Plastic vial

Specimen Volume: 1 mL
Collection Instructions:
1. Centrifuge and aliquot serum into plastic vial.
2. Label specimen as serum.

Specimen Type: Urine
Supplies: Sarstedt Aliquot Tube, 5 mL (T914)

Specimen Volume: 5 mL
Collection Instructions:
1. Collect urine for 24 hours.
2. Refrigerate specimen within 4 hours of completion of 24-hour collection.
3. Label specimen as urine.
Additional Information: For multiple collections see Urine Preservatives-Collection and Transportation for 24-Hour Urine Specimens

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)

Urine Preservative Collection Options

Note: The addition of preservative or application of temperature controls **must occur within 4 hours of completion** of the collection.

Ambient	Preferred
Refrigerate	OK
Frozen	OK
50% Acetic Acid	OK
Boric Acid	OK
Diazolidinyl Urea	OK
6M Hydrochloric Acid	OK
6M Nitric Acid	OK
Sodium Carbonate	OK
Thymol	OK
Toluene	No

Specimen Minimum Volume

Serum: 0.5 mL
Urine: 1 mL

Reject Due To

Gross hemolysis	Reject

Gross lipemia	Reject

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Serum	Refrigerated (preferred)		
	Frozen		
Urine	Refrigerated (preferred)		
	Ambient		
	Frozen		

Clinical & Interpretive

Clinical Information

Estimated glomerular filtration rate (eGFR) using serum creatinine alone is calculated using the 2021 Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation:
eGFR = 142 x min(standardized Scr/k,1)alpha x max(Scr/k, 1)-1.200 x (0.9938 x age) x 1.012 (if patient is female)
where:
-age is in years
-Scr is serum creatinine concentration
-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 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 American and non-African American populations are no longer reported. The new 2021 CKD-EPI eGFR values cannot be directly compared to the previous 2009 CKD-EPI Cr eGFR values, which were separately reported for African American and non-African American populations.

The Kidney Disease: Improving Global Outcomes (KDIGO) CKD work group clinical practice guidelines,(1) as further defined by the National Kidney Foundation-Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) commentary,(2) provided 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 GFR estimating equation for initial assessment.
-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.
-1.4.3.3: We recommend that clinicians:
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 eGFR creat is less accurate.
-1.4.3.4: We recommend that clinical laboratories should:
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 m(2) in adults using the units mL/min/1.73 m(2).
-We recommend eGFRcreat levels less than 60 mL/min/1.73 m(2) 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.

Creatinine Clearance:
Creatinine is derived from the metabolism of creatine from skeletal muscle and dietary meat intake and is released into the circulation at a relatively constant rate. Thus, the serum creatinine concentration is usually stable. Creatinine is freely filtered by glomeruli and not reabsorbed or metabolized by kidney tubules. Therefore, creatinine clearance can be used to assess GFR. However, approximately 15% of excreted urine creatinine is derived from proximal tubular secretion. Because of the tubular secretion of creatinine, creatinine clearance typically overestimates true GFR by 10%

to 15%.

Creatinine clearance is usually determined from measurement of creatinine in a 24-hour urine specimen and from a serum specimen obtained during the same collection period. However, shorter time periods can be used. A key consideration is accurate timing and collection of the urine sample. Creatinine clearance normalized to body surface area is calculated by the equation:
2.54 cm=1 inch
1 kg=2.2 pounds (lbs)
Patient surface area (SA)=wt (kg)(0.425) X ht (cm)(0.725) X 0.007184

$$\text{Uncorr creat clear (mL/min)} = \frac{\text{Urine conc (mg/dL)} \times \frac{\text{24 hr urine volume (mL}}{\text{1440 minutes}}}{\text{Serum creat (mg/dL)}}$$

$$\text{Corr creat clear (mL/min/1.73m(2))} = \frac{\text{Urine conc (mg/dL)} \times \frac{\text{24 hr urine volume (mL)}}{\text{1440 minutes}}}{\text{Serum creat (mg/dL)}} \times \frac{\text{1.73 m(2)}}{\text{Patient SA}}$$

Reference Values

CREATININE CLEARANCE
Males:
0-18 years: Not established
19-75 years: 77-160 mL/min/body surface area (BSA)
> or =76 years: Not established

Females:
0-17 years: Not established
18-29 years: 78-161 mL/min/BSA
30-39 years: 72-154 mL/min/BSA
40-49 years: 67-146 mL/min/BSA
50-59 years: 62-139 mL/min/BSA
60-72 years: 56-131 mL/min/BSA
> or =73 years: Not established

CREATININE, URINE:
Reported in units of mg/dL

CREATININE, SERUM
Males:
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:
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
eGFR calculated using the 2021 CKD-EPI creatinine equation
Note: eGFR results will not be calculated for patients younger than 18 years old.

Interpretation

Decreased creatinine clearance indicates decreased glomerular filtration rate (GFR). This can be due to conditions such as progressive kidney disease or result from adverse effect on renal hemodynamics that are often reversible, including drug effects or decreases in effective renal perfusion (eg, volume depletion, heart failure).

Increased creatinine clearance is often referred to as hyperfiltration and is most commonly seen during pregnancy or in patients with early diabetes mellitus, before diabetic nephropathy has occurred. It may also occur with large dietary protein intake.

A major limitation of creatinine clearance is that its accuracy worsens in relation to the amount of tubular creatinine secretion. Often as GFR declines, the contribution of urine creatinine from tubular secretion increases, further increasing the discrepancy between true GFR and measured creatinine clearance.

Estimated 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 of function, present for more than 3 months, with implications for health.(1,2) CKD should be classified by cause, GFR category, and albuminuria category.(1,2)

KDIGO guidelines provide the following GFR categories(1,2):

Stage	Terms	GFR mL/min/1.73 m(2)
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.
Urinary albumin excretion can also be used to further subdivide CKD stages.

Cautions

One of the major limitations of creatinine clearance is erroneous results due to incomplete urine collections. Accurate results depend upon a complete and accurately timed collection.

Result can be falsely decreased in patients with elevated levels of N-acetyl-p-benzoquinone imine (metabolite of acetaminophen), N-acetylcysteine, and metamizole.

Clinical Reference

1. 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;63(5):713-735. doi:10.1053/j.ajkd.2014.01.416
2. National Kidney Foundation. KDOQI Clinical Practice Guideline for Diabetes and CKD: 2012 Update. Am J Kidney Dis. 2012;60(5):850-886. doi:10.1053/j.ajkd.2012.07.005. Erratum in: Am J Kidney Dis. 2013 Jun;61(6):1049
3. Inker LA, Perrone RD. Assessment of kidney function. In: Sterns RH, Forman JP, eds. UpToDate; 2021. Updated February 2024. Accessed April 1, 2024. Available at www.uptodate.com/contents/assessment-of-kidney-function
4. Kasiske BL, Keane WF. Laboratory assessment of renal disease: clearance, urinalysis, and renal biopsy. In: Brenner BM, ed. The Kidney. 6th ed. WB Saunders Company; 2000:1129-1170
5. Delaney MP, Lamb EJ. Kidney disease. In: Rifai N, Horvath AR, Wittwer CT, eds. Tietz Textbook of Clinical Chemistry and Molecular Diagnostics. 6th ed. Elsevier; 2018:1256-1323
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;68(4):511-520. doi:10.1093/clinchem/hvab278
7. Inker LA, Eneanya ND, Coresh J, et al. New creatinine- and cystatin C-based equations to estimate GFR without race. N Engl J Med. 2021;385(19):1737-1749. doi:10.1056/NEJMoa2102953

Performance

Method Description

The enzymatic method is based on the determination of sarcosine from creatinine with the aid of creatininase, creatinase, and sarcosine oxidase. The liberated hydrogen peroxide is measured via a modified Trinder reaction using a colorimetric indicator. Optimization of the buffer system and the colorimetric indicator enables the creatinine concentration to be quantified both precisely and specifically.(Package insert: Creatinine plus ver 2. Roche Diagnostics; V15.0, 03/2019)

PDF Report

No

Day(s) Performed

Monday through Sunday

Report Available
Same day/1 to 2 days

Specimen Retention Time
7 days

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
82575

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
CRCL	Creatinine Clearance	58446-6

Result ID	Test Result Name	Result LOINC® Value
CRE_U	Creatinine, U	20624-3
TM54	Collection Duration (h)	13362-9
VL52	Volume (mL)	3167-4
CRCL1	Creatinine Clearance	12195-4
CRTSA	Creatinine, S	2160-0
EGFR1	Estimated GFR (eGFR)	98979-8