Test Definition: SUPRA

Supersaturation Profile, Random, Urine

Overview

Useful For

Diagnosis and management of patients with renal lithiasis:
-Predicting the likely composition of the stone, in patients who have a radiopaque stone, for whom stone analysis is not available which may help in designing a treatment program
-Identifying specific risk factors for stones formation using a random urine collection
-Monitoring the effectiveness of therapy by confirming that the crystallization potential has indeed decreased
-Evaluation of kidney excretion of acid and urine pH

Profile Information

Test Id	Reporting Name	Available Separately	Always Performed
SRINT	Supersaturation, Random, U 1	No	Yes
RANAU	Sodium, Random, U	Yes, (order RNAUR)	Yes
RAKUR	Potassium, Random, U	Yes, (order RKUR)	Yes
RACAL	Calcium, Random, U	Yes, (order CACR3)	Yes
RAMAG	Magnesium, Random, U	Yes, (order MAGRU)	Yes
RACLU	Chloride, Random, U	Yes, (order RCHLU)	Yes
RAPOU	Phosphorus, Random, U	Yes, (order RPHOC)	Yes
RASUL	Sulfate, Random, U	No	Yes
RACIT	Citrate Excretion, Random, U	Yes, (order CITRA)	Yes
RAOXU	Oxalate, Random, U	Yes, (order ROXUR)	Yes
RAPHU	pH, Random, U	No	Yes
RAURA	Uric Acid, Random, U	Yes, (order RURC1)	Yes
RACTU	Creatinine, Random, U	Yes, (order RCTUR)	Yes
RAOSM	Osmolality, Random, U	No	Yes
RAAMM	Ammonium, Random, U	Yes, (order RAMBO)	Yes

Method Name

RACIT, RAAMM, RAOXU: Enzymatic
RAOSM: Freezing Point Depression
RASUL: High-Performance Ion Chromatography (HPIC)
RAMAG: Colorimetric Endpoint Assay
RACAL, RAPOU: Photometric
RAPHU: pH Meter
RANAU, RAKUR, RACLU: Potentiometric, Indirect Ion-Selective Electrode (ISE)
RACTU: Enzymatic Colorimetric Assay
RAURA: Uricase

NY State Available

No

Specimen

Specimen Type

Urine

Ordering Guidance

A timed 24-hour urine collection is the preferred specimen for measuring and interpreting this profile to determine kidney stone risk factors (SUP24 / Supersaturation Profile, 24 Hour, Urine). Random urine collections with individual analytes normalized to urinary creatinine may be of some clinical use in patients who cannot collect a 24-hour specimen, typically small children. Therefore, this test is offered on random collections for children less than 16 years old.

X-ray dyes and contrast media will affect uric acid test results.
-If a kidney X-ray with dye or computerized tomography (CT) scan with contrast has been performed, patient should wait a minimum of 1 day before starting collection.
-If a cholangiography (bile duct X-ray) has performed, patient should wait 7 days before starting collection.
-Urine must be collected before tablets have been taken for gallbladder X-ray, otherwise patient should wait 7 days before starting collection.

Necessary Information

Patient's age is required.

Specimen Required

Supplies:
-Urine Tubes, 10 mL (T068)
-Sarstedt Aliquot Tube, 5 mL (T914)
Collection Container/Tube: 90 mL urine container
Submission Container/Tube: 2 x 10 mL plastic urine tubes and 5 x 5 mL plastic urine tubes
Specimen Volume: 40 mL
Collection Instructions:
1. Collect a random urine specimen, mix collection container thoroughly and divide the urine into 7 plastic tubes (2 x 10 mL and 5 x 5 mL).
2. Refrigerate specimen after collection. Specimen pH should be between 4.5 and 8 and will stay in this range if kept refrigerated. Specimens with pH above 8 indicate bacterial contamination, and testing will be canceled. **Do not** attempt to adjust pH as it will adversely affect results.

Forms

If not ordering electronically, complete, print, and send a Renal Diagnostics Test Request (T830) with the specimen.

Specimen Minimum Volume

16 mL

Reject Due To

pH <4.5 or >8.0	Reject

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Urine	Refrigerated (preferred)	14 days	
	Ambient	72 hours	
	Frozen	14 days	

Clinical & Interpretive

Clinical Information

Urine is often supersaturated, which favors precipitation of several crystalline phases such as calcium oxalate, calcium phosphate, and uric acid. However, crystals do not always form in supersaturated urine because supersaturation is balanced by crystallization inhibitors that are present in the urine. Urinary inhibitors include ions (eg, citrate) and macromolecules but remain poorly understood.

Urine supersaturation is calculated by measuring the concentration of all the ions that can interact (potassium, calcium, phosphorus, oxalate, uric acid, citrate, magnesium, sodium, chloride, sulfate, and pH). Once the concentrations of all the relevant urinary ions are known, a computer program can calculate the theoretical supersaturation with respect to the important crystalline phases (eg, calcium oxalate).(1)

Since the supersaturation of urine has been shown to correlate with stone type,(2) therapy is often targeted towards decreasing the urinary supersaturations identified. Treatment strategies include alterations in diet and fluid intake as well as drug therapy; all designed to decrease the urine supersaturation.

Reference Values

The following analytes do not have any established reference values:
Sodium, potassium, chloride, phosphorus, citrate, sulfate, and oxalate
pH: 4.5-8.0

CREATININE
> or =18 years old: 16-326 mg/dL
Reference values have not been established for patients who are younger than 18 years.

OSMOLALITY
0-11 months: 50-750 mOsm/kg
> or =12 months: 150-1,150 mOsm/kg

AMMONIUM
18-77 years: 3-65 mmol/L
Reference values have not been established for patients who are younger than 18 years or older than 77 years.

CALCIUM
1 month-<12 months: 0.03-0.81 mg/mg creat
12 months-<24 months: 0.03-0.56 mg/mg creat
24 months-<3 years: 0.02-0.50 mg/mg creat
3 years-<5 years: 0.02-0.41 mg/mg creat
5 years-<7 years: 0.01-0.30 mg/mg creat
7 years-<10 years: 0.01-0.25 mg/mg creat
10 years-<18 years: 0.01-0.24 mg/mg creat
18 years-83 years: 0.05-0.27 mg/mg creat
Reference values have not been established for patients who are younger than 1 month or older than 83 years.

MAGNESIUM
Magnesium/Creatinine Ratio:
1 month-<12 months: 0.10-0.48 mg/mg creat
12 months-<24 months: 0.09-0.37 mg/mg creat
24 months-<3 years: 0.07-0.34 mg/mg creat
3 years-<5 years: 0.07-0.29 mg/mg creat
5 years-<7 years: 0.06-0.21 mg/mg creat
7 years-<10 years: 0.05-0.18 mg/mg creat
10 years-<14 years: 0.05-0.15 mg/mg creat
14 years-<18 years: 0.05-0.13 mg/mg creat
18 years-83 years: 0.04-0.12 mg/mg creat
Reference values have not been established for patients who are younger than 1 month or older than 83 years.

Interpretation

Delta G (DG), the Gibbs free energy of transfer from a supersaturated to a saturated solution, is negative for undersaturated solutions and positive for supersaturated solutions. In most cases, the supersaturation levels are slightly positive, even in normal individuals, but are balanced by an inhibitor activity.

While the DG of urine is often positive, even in the urine of non-stone formers, on average, the DG is more positive in those individuals who do form kidney stones. The reference values are derived by comparing urinary DG values for the important stone-forming crystalline phases between a population of stone formers and a population of non-stone formers. Those DG values that are outside the expected range in a population of non-stone formers are marked abnormal.

A normal or increased citrate value suggests that potassium citrate may be a less effective choice for treatment of a patient with calcium oxalate or calcium phosphate stones.

If the urine citrate is low, secondary causes should be excluded including hypokalemia, renal tubular acidosis, gastrointestinal bicarbonate losses (eg, diarrhea or malabsorption), or an exogenous acid load (eg, excessive consumption of meat protein).

An increased urinary oxalate value may prompt a search for genetic abnormalities of oxalate production (ie, primary hyperoxaluria). Secondary hyperoxaluria can result from diverse gastrointestinal disorders that result in malabsorption.

Milder hyperoxaluria could result from excess dietary oxalate consumption or reduced calcium (dairy) intake, perhaps even in the absence of gastrointestinal disease.

Low urine ammonium and high urine pH suggest renal tubular acidosis. Such patients are at risk of calcium phosphate stones.

The results can be used to determine the likely effect of a therapeutic intervention on stone-forming risk. For example, taking oral potassium citrate will raise the urinary citrate excretion, which should reduce calcium phosphate supersaturation (by reducing free ionic calcium), but citrate administration also increases urinary pH (because it represents an alkali load), which promotes calcium phosphate crystallization. The net result of this or any therapeutic manipulation could be assessed by collecting a 24-hour urine and comparing the supersaturation calculation for calcium phosphate before and after therapy.

Important stone-specific factors:
-Calcium oxalate stones: Urine volume, calcium, oxalate, citrate, and uric acid excretion are all risk factors that are possible targets for therapeutic intervention.
-Calcium phosphate stones (apatite or brushite): Urinary volume, calcium, pH, and citrate significantly influence the supersaturation of calcium phosphate. Of note, a urine pH below 6 may help reduce the tendency for these stones to form.
-Uric acid stones: Urine pH, volume, and uric acid excretion levels influence the supersaturation. Urine pH is especially critical, in that uric acid is unlikely to crystallize if the pH is above 6.
-Sodium urate stones: Alkaline pH and high uric acid excretion promote stone formation.

A low urine volume is a universal risk factor for all types of kidney stones.

The following reference means for calculated supersaturation apply to 24-hour timed collections. No information is available for random collections.
Supersaturation Reference Means (Delta G: DG)
Men:
Calcium oxalate: 1.89 DG
Brushite: 0.46 DG
Hydroxyapatite: 4.19 DG
Uric acid: 1.18 DG

Women:
Calcium oxalate: 1.59 DG
Brushite: -0.11 DG
Hydroxyapatite: 3.62 DG
Uric acid: 0.89 DG

Values for individual analytes that are part of this panel on a random urine collection are best interpreted as a ratio to the creatinine excretion. Following are pediatric reference ranges for the important analytes for which pediatric data is available.

Oxalate/Creatinine (mg/mg)

Age (year)	95th Percentile
0-0.5	<0.175
0.5-1	<0.139
1-2	<0.103
2-3	<0.08
3-5	<0.064
5-7	<0.056
7-17	<0.048

Matos V, Van Melle G, Werner D, Bardy D, Guignard JP. Urinary oxalate and urate to creatinine ratios in a healthy pediatric population. Am J Kidney Dis. 1999;34(2):e1

Uric Acid/Creatinine (mg/mg)

Age (year)	5th Percentile	95th Percentile
0-0.5	>1.189	<2.378
0.5-1	>1.040	<2.229
1-2	>0.743	<2.080
2-3	>0.698	<1.932
3-5	>0.594	<1.635
5-7	>0.446	<1.189
7-10	>0.386	<0.832
10-14	>0.297	<0.654
14-17	>0.297	<0.594

Matos V, Van Melle G, Werner D, Bardy D, Guignard JP. Urinary oxalate and urate to creatinine ratios in a healthy pediatric population. Am J Kidney Dis. 1999;34(2):e1

Phosphate/Creatinine (mg/mg)

Age (year)	5th Percentile	95th Percentile
0-1	>0.34	<5.24
1-2	>0.34	<3.95
2-3	>0.34	<3.13
3-5	>0.33	<2.17
5-7	>0.33	<1.19
7-10	>0.32	<0.97
10-14	>0.22	<0.86
14-17	>0.21	<0.75

Matos V, van Melle G, Boulat O, Markert M, Bachmann C, Guignard JP. Urinary phosphate/creatinine, calcium/creatinine, and magnesium/creatinine ratios in a healthy pediatric population. J Pediatr. 1997;131(2):252-257

Magnesium/Creatinine (mg/g)

Age (year)	95th Percentile
0-1	<0.48

1-2	<0.37
2-3	<0.34
3-5	<0.29
5-7	<0.21
7-10	<0.18
10-14	<0.15
14-17	<0.13

Matos V, van Melle G, Boulat O, Markert M, Bachmann C, Guignard JP. Urinary phosphate/creatinine, calcium/creatinine, and magnesium/creatinine ratios in a healthy pediatric population. J Pediatr. 1997;131(2):252-257

Citrate/Creatinine (mg/mg)

Age (year)	95th Percentile
5-18	<1.311

Srivastava T, Winston MJ, Auron A, Alon US. Urine calcium/citrate ratio in children with hypercalciuric stones. Pediatr Res. 2009;66(1):85-90

Cautions

The urine is often supersaturated with respect to the common crystalline constituents of stones, even in non-stone formers.

Individual interpretation of the supersaturation values in the context of the clinical situation is critical. In particular, treatment may reduce the supersaturation with respect to one crystal type but increase the supersaturation with respect to another. Therefore, the specific goals of treatment must be considered when interpreting the test results.

Clinical Reference

1. Werness PG, Brown CM, Smith LH, Finlayson B. EQUIL2: a BASIC computer program for the calculation of urinary saturation. J Urol. 1985;134(6):1242-1244
2. Parks JH, Coward M, Coe FL. Correspondence between stone composition and urine supersaturation in nephrolithiasis. Kidney Int. 1997;51(3):894-900
3. Finlayson B. Calcium stones: Some physical and clinical aspects. In: David DS, ed. Calcium Metabolism in Renal Failure and Nephrolithiasis. John Wiley and Sons; 1977:337-382
4. Burtis CA, Bruns DE. Tietz Fundamentals of Clinical Chemistry and Molecular Diagnostics. 7th ed. Saunders; 2014
5. Tiselius HG, Daudon M, Thomas K, Seitz C. Metabolic work-up of patients with urolithiasis: indications and diagnostic algorithm. Eur Urol Focus. 2017;3(1):62-71. doi:10.1016/j.euf.2017.03.014

Performance

Method Description

The major analytes evaluated are potassium, calcium, phosphorus, oxalate, uric acid, citrate, magnesium, sodium, chloride, sulfate, and pH. Given the measured urine concentrations of these analytes and the known affinity constants of the ions for each other at the given pH, a computer program (EQUIL2) calculates a supersaturation for each ion pair of

interest (eg, calcium oxalate). Results are expressed as a delta G (DG) value for each ion pair. DG is the Gibbs free energy of transfer from a supersaturated to a saturated solution.(Werness PG, Brown CM, Smith LH, Finlayson B. EQUIL2: a BASIC computer program for the calculation of urinary saturation. J Urol. 1985;134[6]:1242-1244; Moreira DM, Friedlander JI, Hartman C, Elsamra SE, Smith AD, Okeke Z. Using 24-hour urinalysis to predict stone type. J Urol. 2013;190[6]:2106-2111)

PDF Report
Supplemental

Day(s) Performed
Monday through Sunday

Report Available
2 to 5 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 was developed and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. It has not been cleared or approved by the US Food and Drug Administration.

CPT Code Information
82310-Calcium
82436-Chloride
82507-Citrate excretion
82570-Creatinine
83735-Magnesium
83935-Osmolality
83945-Oxalate
83986-pH
84105-Phosphorus
84133-Potassium
84300-Sodium

84392-Sulfate
84560-Uric acid
82140-Ammonium

LOINC® Information

Test ID	Test Order Name	Order LOINC® Value
SUPRA	Supersaturation, Random, U	101929-8

Result ID	Test Result Name	Result LOINC® Value
OXMCO	Oxalate, Random, U (mmol/L)	15086-2
OXGCO	Oxalate, Random, U (mg/L)	2700-3
OXUCR	Oxalate/Creatinine Ratio, Random, U	13483-3
31246	Interpretation	69051-1
616399	Calcium Oxalate Crystal	101931-4
616400	Brushite Crystal	101932-2
616401	Hydroxyapatite Crystal	101933-0
616402	Uric Acid Crystal	101934-8
RAUAC	Uric Acid, Random, U	3086-6
UACCR	Uric Acid/Creat Ratio, Random, U	3089-0
RASUC	Sulfate, Random, U	2975-1
POUCO	Phosphorus, Random, U	2778-9
PHOCR	Phosphorus/Creat Ratio, Random, U	11141-9
RAPHU	pH, Random, U	2756-5
RAOSU	Osmolality, Random, U	2695-5
RANAC	Sodium, Random, U	2955-3
RAMGC	Magnesium, Random, U	19124-7
MAGCR	Magnesium/Creat Ratio, Random, U	13474-2
RACTU	Creatinine, Random, U	2161-8
RAKUC	Potassium, Random, U	2828-2
RACLC	Chloride, Random, U	2078-4
CITCO	Citrate Excretion, Random, U	2128-7
CITCR	Citrate/Creatinine Ratio, Random, U	13722-4
RACAC	Calcium, Random, U	17862-4
CALCR	Calcium/Creatinine Ratio, Random, U	9321-1
RAAMM	Ammonium, Random, U	1842-4