Test Definition: SSATR

Supersaturation, Peds, Random, U

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. This 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
RRSUP	Supersaturation, Random, U	No	Yes
NAUR	Sodium, Random, U	Yes, (order RNAUR)	Yes
KURR	Potassium, Random, U	Yes, (order RKUR)	Yes
CACR2	Calcium, Random, U	Yes, (order CACR3)	Yes
MAGR	Magnesium, Random, U	Yes, (order MAGRU)	Yes
CLUR	Chloride, Random, U	Yes, (order RCHLU)	Yes
POUR	Phosphorus, Pediatric, Random, U	Yes, (order RPHOC)	Yes
SULFR	Sulfate, Random, U	No	Yes
CITRR	Citrate Excretion, Peds, Random, U	Yes, (order CITRA)	Yes
OXUR	Oxalate, Pediatric, Random, U	Yes, (order ROXUR)	Yes
UPHR	pH, Random, U	No	Yes
URCUR	Uric Acid, Random, U	Yes, (order RURC1)	Yes
CTURR	Creatinine, Random, U	Yes, (order RCTUR)	Yes
UOSMR	Osmolality, Random, U	No	Yes
RAMCN	Ammonium, Random, U	Yes, (order RAMBO)	Yes

Method Name

CITRR, RAMCN OXUR: Enzymatic

UOSMR: Freezing Point Depression

SULFR: High-Performance Ion Chromatography (HPIC)

MAGR: Colorimetric Endpoint Assay

CACR2: Photometric

POUR: Molybdic Acid

UPHR: pH Meter

NAUR, KURR, CLUR: Potentiometric, Indirect Ion-Selective Electrode (ISE)

CTURR: Enzymatic Colorimetric Assay

URCUR: 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 (order SAT24 / Supersaturation Profile, 24 Hour, Urine. Random 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.

Additional Testing Requirements

Necessary Information

Patient's age is required.

Specimen Required

Supplies:

Urine Tubes, 10 mL (T068)

Aliquot Tubes, 5 mL (T465)

Container/Tube: 3 Plastic, 10-mL urine tubes and 4 plastic, 5-mL tubes

Specimen Volume: 40 mL

Collection Instructions:

1. Collect a random urine specimen and divide the urine into 6 tubes.

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 over 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.

Reject Due To

pH <4.5 or >8.0	Reject

Specimen Minimum Volume

30 mL

Specimen Stability Information

Specimen Type	Temperature	Time	Special Container
Urine	Refrigerated (preferred)	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 also present in 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 those urinary supersaturations that are identified. Treatment strategies include alterations in diet and fluid intake as well as drug therapy, all designed to decrease the urine supersaturation.

Reference Values

pH: 4.5 to 8.0

OSMOLALITY

0-11 months: 50-750 mOsm/kg

> or =12 months: 150-1,150 mOsm/kg

AMMONIUM

18-77 years: 3-65 mmol/L

No reference values established for patient younger than 18 years and older than 77 years of age

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 than1 month of age.

Reference values have not been established for patients who are older than 83 years of age.

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 of age.

Reference values have not been established for patients who are older than 83 years of age

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 even more positive in those individuals who do form kidney stones. The reference values are simply 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 suggests 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 for calcium phosphate. Of note, a urine pH of less than 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 greater than 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)

Brushite: 0.21 DG

Hydroxyapatite: 3.96 DG

Uric acid: 1.04 DG

Sodium urate: 1.76 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, et al: Urinary oxalate and urate to creatinine ratios in a healthy pediatric population. Am J Kidney Dis. 1999;34: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, et al: Urinary oxalate and urate to creatinine ratios in a healthy pediatric population. Am J Kidney Dis. 1999;34: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, et al: Urinary phosphate/creatinine, calcium/creatinine, and magnesium/creatinine ratios in a healthy pediatric population. J Pediatr. 1997;131:252-257

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, et al: Urinary phosphate/creatinine, calcium/creatinine, and magnesium/creatinine ratios in a healthy pediatric population. J Pediatr. 1997;131:252-257

Citrate/Creatinine (mg/mg)

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

Srivastava T, Winston MJ, Auron A, et al: Urine calcium/citrate ratio in children with hypercalciuric stones. Pediatr Res. 2009;66:85-90

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 light 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 Dec;134(6):1242-1244

2. Parks JH, Coward M, Coe FL: Correspondence between stone composition and urine supersaturation in nephrolithiasis. Kidney Int. 1997 Mar;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 Feb;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;134:1242-1244; Moreira DM, Friedlander JI, Hartman C, et al: Using 24-hour urinalysis to predict stone type. J Urol. 2013;190:2106-2111)

PDF Report

Supplemental RE

Specimen Retention Time

7 days

Performing Laboratory Location

Rochester

Fees & Codes

Test Classification

This test was developed, and its performance characteristics determined by Mayo Clinic in a manner consistent with CLIA requirements. This test 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
SSATR	Supersaturation, Peds, Random, U	In Process

Result ID	Reporting Name	LOINC®
SULFR	Sulfate, Random, U	2975-1
UOSMR	Osmolality, Random, U	2695-5
UPHR	pH, Random, U	2756-5
CITR1	Citrate Concentration, Peds, Random, U	2128-7
RATO8	Citrate/Creatinine Ratio	13722-4
RCHLU	Chloride, Random, U	2078-4
RCTUR	Creatinine, Random, U	2161-8
RKUR	Potassium, Random, U	2828-2
RNAUR	Sodium, Random, U	2955-3
OXCON	Oxalate, Pediatric, Random, U	15086-2
OXCO2	Oxalate Concentration	2700-3
RATO7	Oxalate/Creatinine Ratio	13483-3
POCON	Phosphorus, Pediatric, Random, U	2778-9
RATO5	Phosphorus/Creatinine Ratio	11141-9
31241	Calcium Oxalate Crystal	In Process
31242	Brushite Crystal	In Process
31243	Hydroxyapatite Crystal	In Process
31244	Uric Acid Crystal	In Process

31245	Sodium Urate Crystal	In Process
31246	Interpretation	69051-1
URCO2	Uric Acid, Random, U	3086-6
RATO6	Uric Acid/Creat Ratio, Random, U	3089-0
MGCON	Magnesium, Random, U	19124-7
MGCTR	Magnesium/Creatinine Ratio	13474-2
CALC4	Calcium, Random, U	17862-4
CACTR	Calcium/Creatinine Ratio	9321-1
RAMCN	Ammonium, Random, U	1842-4