## Overview

### Useful For

Diagnosis and management of patients with renal lithiasis:

-In patients who have a radiopaque stone, for whom stone analysis is not available, the supersaturation data can be used to predict the likely composition of the stone. This may help in designing a treatment program

-Individual components of the supersaturation profile can identify specific risk factors for stones

-During follow-up, changes in the urine supersaturation can be used to monitor the effectiveness of therapy by confirming that the crystallization potential has indeed decreased

-Urine ammonium can be used to evaluate renal 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 KNAUR) | Yes |
| KURR | Potassium, Random, U | Yes, (order RKUR) | Yes |
| CACR2 | Calcium, Random, U | Yes, (order CACR1) | Yes |
| MAGR | Magnesium, Random, U | Yes, (order MAGNR) | Yes |
| CLUR | Chloride, Random, U | Yes, (order RCHLU) | Yes |
| POUR | Phosphorus, Pediatric, Random, U | Yes, (order RPOU) | Yes |
| SULFR | Sulfate, Random, U | No | Yes |
| CITRR | Citrate Excretion, Peds, Random, U | Yes, (order RCITR) | Yes |
| OXUR | Oxalate, Pediatric, Random, U | Yes, (order ROXU) | Yes |
| UPHR | pH, Random, U | No | Yes |
| URCUR | Uric Acid, Random, U | Yes, (order RURCU) | 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: Enzymatic

OXUR: Enzymatic Using Oxalate Oxidase

UOSMR: Freezing Point Depression

SULFR: High-Pressure Ion Chromatography (HPIC)

MAGR: Colorimetric Endpoint Assay

CACR2: Photometric, NM-BAPTA Reaction

POUR: Molybdic Acid

UPHR: pH Meter

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

CTURR: Enzymatic Colorimetric Assay

URCUR: Uricase

## NY State Available

Yes

# Specimen

## Specimen Type

Urine

## Additional Testing Requirements

A timed 24-hour urine collection is the preferred specimen for measuring and interpreting this profile to determine kidney stone risk factors. 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.

## Necessary Information

**Patient's age is required.**

## Specimen Required

**Supplies:**

Urine Tubes, 10 mL (T068)

Aliquot Tubes, 5 mL (T465)

**Container/Tube:** 2 plastic, 10-mL urine tubes (T068) and 4 plastic, 5-mL urine tubes (T465)

**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.

### Specimen Minimum Volume

30 mL

### Reject Due To

| | |
|---|---|
| pH | <4.5 reject >8 reject |

### Specimen Stability Information

| Specimen Type | Temperature | Time | Special Container |
|---|---|---|---|
| Urine | Refrigerated (preferred) | 14 days | |
| | Frozen | 14 days | |

## Clinical and 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: 4.5-8.0

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 <18 years and >77 years of age

CALCIUM

Random Calcium/Creatinine Ratio:

18-83 years: <0.20 mg/mg

No reference values established for <18 years and >83 years of age

MAGNESIUM

Random Magnesium/Creatinine Ratio:

18-83 years: < or =0.035 mg/mg

No reference values established for <18 years and >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 "normal" 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) and a higher urine pH 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 nonstone 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;134:1242-1244

2. Parks JH, Coward M, Coe FL: Correspondence between stone composition and urine supersaturation in nephrolithiasis. Kidney Int 1997;51:894-900

3. Finlayson B: Calcium stones: Some physical and clinical aspects. In Calcium Metabolism in Renal Failure and Nephrolithiasis. Edited by DS David. New York, John Wiley and Sons, 1977, pp 337-382

## 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).(1) 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)

### PDF Report

Supplemental RE

### Day(s) and Time(s) Test Performed

Monday through Friday; 8 a.m.-4 p.m.

### Analytic Time

2 days; Excess capacity for this test is limited. Therefore, if sample volume exceeds analyzer and staff capacity, the turnaround time will increase. Please contact the lab supervisor for an estimate.

### Maximum Laboratory Time

5 days

## Specimen Retention Time

7 days

## Performing Laboratory Location

Rochester

# Fees and 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 Regional Manager. 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. This test has not been cleared or approved by the U.S. 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 | Test Result Name | Result LOINC Value |
|---|---|---|
| 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 |
| 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 |
| 31241 | Calcium Oxalate Crystal | 5774-5 |
| POCON | Phosphorus, Pediatric, Random, U | 2778-9 |
| URCO2 | Uric Acid, Random, U | 3086-6 |
| MGCON | Magnesium, Random, U | 19124-7 |
| CALC4 | Calcium, Random, U | 17862-4 |
| RAMCN | Ammonium, Random, U | 1842-4 |
| CACTR | Calcium/Creatinine Ratio | 9321-1 |
| MGCTR | Magnesium/Creatinine Ratio | 13474-2 |
| RATO6 | Uric Acid/Creatinine Ratio | 3089-0 |
| RATO5 | Phosphorus/Creatinine Ratio | 11141-9 |
| 31242 | Brushite Crystal | 42673-4 |
| OXCO2 | Oxalate Concentration | 2700-3 |
| RATO8 | Citrate/Creatinine Ratio | 13722-4 |
| RATO7 | Oxalate/Creatinine Ratio | 13483-3 |
| 31243 | Hydroxyapatite Crystal | 81622-3 |
| 31244 | Uric Acid Crystal | 5817-2 |
| 31245 | Sodium Urate Crystal | 53788-6 |
| 31246 | Interpretation | 69051-1 |